High-Count Species of the Stomiid Fish Genus *Astronesthes* from the Southern Subtropical Convergence Region: Two New Species and Redescription of *Cryptostomias* (= *Astronesthes*) *psychrolutes*

ROBERT H. GIBBS, JR.
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ABSTRACT

Gibbs, Robert H., Jr. and James F. McKinney. High-Count Species of the Stomiid Fish Genus *Astronesthes* from the Southern Subtropical Convergence Region: Two New Species and Redescription of *Cryptostomias* (=*Astronesthes*) *psychrolutes*. *Smithsonian Contributions to Zoology*, number 460, 25 pages, 14 figures, 2 tables, 1988.—Three species of *Astronesthes* having the highest serial-photophore counts (67–71 IC, 44–47 OA) and vertebral counts (60–63) in the genus, all occurring in the region of the southern Subtropical Convergence, are recognized. One species is associated with *Cryptostomias psychrolutes* Gibbs and Weitzman, 1965, which is redescribed. The genus *Cryptostomias* thereby becomes a synonym of *Astronesthes*. The other two species are described as new: *A. kreffti* and *A. spatulifer*. Both *A. psychrolutes* and *A. kreffti* occur in the Atlantic, Indian Ocean, and the eastern and/or western Pacific sectors of the Convergence region; *A. spatulifer* is known only from the central Pacific sector. Large specimens have distinctive patterns of pale luminous tissue on the operculum and body, and their barbels and barbel tips differ in length and conformation. Small specimens are more difficult to distinguish, but *A. psychrolutes* has 7 pectoral-fin rays (the other two species have 8 rays), and the barbel tip is short and flat in *A. spatulifer*, spheroidal or cylindrical in the other two. The so-called Subtropical Convergence distribution pattern is shown to be somewhat vague, partly because of differences in species distributions to the north and south of the Convergence, partly because few samples have been made in subtropical and subantarctic waters adjacent to the Convergence.

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Introduction

Gibbs and Weitzman (1965) described *Cryptostomias psychrolutes* as a new genus and species of the stomiiform family Astronesthidae (now included in Stomiidae after Fink, 1985) based on two small, late-metamorphic specimens from 30°08′S, 176°50′W, near the Kermadec Islands in the southwestern Pacific. The specimens were described as bearing a close resemblance only to *Rhadinesthes*, primarily on the basis of the short head and long, slender body, but could not be assigned to any of the recognized genera. Weitzman (1967), in his study of the osteology and relationships of the Astronesthidae, found many characters difficult or impossible to discern in *Cryptostomias*, because the two specimens (one cleared and stained) were poorly ossified or partially deossified. Most discernible characters, however, appeared to be similar to those of *Astronesthes* or *Borostomias*, but a parasphenethmoid, a bone unique to those two genera and present in all examined species (see also Fink, 1985) was not found. No fully metamorphosed cleared and stained juveniles or adults that might be *C. psychrolutes* have been examined osteologically, but radiographs of the species treated in this paper suggest that a parasphenethmoid is present and that failure to discern it in the types was the result of their poor ossification or of their deossification.

We now are certain that *psychrolutes* is a species of *Astronesthes*, but the situation has been complicated by the discovery of three species in the Southern Ocean that might be *psychrolutes*. All three have high serial-photophore counts: 67–71 in the ventral row (IC), 44–47 in the lateral row (OA). Among *Astronesthes*, only an undescribed species in the North Pacific and *A. gemmifer*, now known to be circumglobal and to impinge upon the southern Subtropical Convergence (Gibbs, unpublished data), have serial-photophore counts as high. The vertebral count of 60–63 in the three species treated here, however, is higher than in any other species of *Astronesthes*, including *gemmifer*. Among the other genera once included in Astronesthidae, only *Heterophotus ophistoma* and some species of *Borostomias* have both photophore and vertebral counts as high or higher, and these species can be eliminated from consideration in the *psychrolutes* question by differences in the subdivisions of these counts and by other, unrelated counts, even when the more obvious external generic characters are missing, as they are in the types of *psychrolutes*. For example, *Heterophotus* has 30 or more PV and OV photophores (vs. fewer than 23) and 20 or fewer VAV and VAL photophores (vs. 22 or more); the two species of *Borostomias* that might occur in the Subtropical Convergence, *B. mononema* and *B. antarcticus*, both have mostly 23 or more PV and 22 or more OV photophores (vs. mostly fewer than 23 or 22, respectively).

In this paper *Cryptostomias psychrolutes* Gibbs and

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Weitzman is associated with one of the three high-count species and redescribed, and the other two species are described as new. The genus *Cryptostomias* Gibbs and Weitzman, 1965, is relegated to the synonymy of *Astronesthes*.

Methods

Measurements (with dial calipers) and fin-ray counts were made according to Hubbs and Lagler (1964), with additional measurements as in Goodyear and Gibbs (1970). Counts and abbreviations of serial-photophore groups follow the common method used in stomiid work (Morrow, 1964; Goodyear and Gibbs, 1970). All methods are summarized in Gibbs et al. (1983).

All measurements have been compared on size-on-size and ratio-on-size scatter plots and have been checked for changes in proportions with growth. Several of those that show interspecific differences are depicted graphically in this paper.

The three species treated here, while quite distinct at larger sizes, have been difficult to distinguish when smaller than about 50 mm SL. Their counts are closely similar, and the apparent rapid changes in relative size of most body parts within a narrow range of SL's (34–47 mm) results in a range of proportions that often spans the extremes for all three species. Few differences are discernible in these small specimens, and any differences that might appear to exist are rendered uncertain by the paucity of small individuals of two of the species. The third species (herein described as *spatulifer*) is represented almost entirely by small specimens, which, fortunately, are identifiable by the structure of the barbel tip. It is this latter species that displays the extreme range in proportions at the small sizes. Small specimens missing a barbel tip or having a poorly developed one have been assigned to species either by virtue of having been taken together with identifiable specimens (*spatulifer*) or by having counts that best match the modes or the non-overlapping extremes determined from specimens of known identity. The association of the metamorphosing types of *C. psychrolutes* with one of the three species was accomplished in this manner.

The measurement data also have been difficult to compare throughout the range of sizes by virtue of uneven representation of sizes in the three species. *Astronesthes psychrolutes* is represented by 27 specimens: four 33.9–38.3 mm (two of them the types); nine 62.7–102.5 mm, with no more than 10 mm between specimens; and 14 127.0–304 mm, which cover the range well, but have large gaps between sizes. The second species, herein described as *Astronesthes kreffti*, is represented by a total of 13 specimens, four 35.0–41.5 mm and nine 105.2–245.8 mm, leaving a wide gap in the range where rapid changes in proportions are expected. Size gaps between specimens or clusters of specimens 105.2–245.8 mm are 20–40 mm. The third species, herein described as *Astronesthes spatulifer*, is represented by 19 small specimens, 35.8–48.0 mm, and only two larger specimens, one of 70.3 mm and one, badly damaged, of 122.0 mm.

Abbreviations.—Abbreviations for institutions from which collections were examined follow Leviton et al. (1985).

SL = standard length.

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R.H. Goodyear made some counts and measurements, and F.K. Gibbs aided in gathering data during trips to Japan, Australia, and New Zealand.

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The diagnoses in the following species accounts are intended to distinguish only *A. psychrolutes*, *A. kreffti*, and *A. spatulifer* from each other.

Key to *Astronesthes* Species with Relatively High Counts Found in the Southern Subtropical Convergence

(Morphometric characters are for specimens larger than 100 mm SL)

1. Photophores in ventral row without AC (IA) 44–49, with AC (IC) 56–62; photophores in lateral row (OA) 34–38; branchiostegal photophores 14–20, usually 15–18; total vertebrae 49–55; patches of white material present on middorsal and midventral caudal peduncle except in very small specimens . . . . *A. boulengeri*

   IA photophores 52–58; IC 62–71; OA 42–48; branchiostegal photophores 19–23; total vertebrae 55–63; no white patches on middorsal or midventral caudal peduncle 2

2. Swollen tip of barbel black on one side; no pale patches on operculum at any size; pectoral-fin rays 8–10, usually 9; AC photophores 8–12, usually 10 or 11; total vertebrae 55–59 . . . . *A. gemmifer*

Tip of barbel with no obvious black pigment; pale patches present on operculum except in very small specimens; pectoral-fin rays 7 or 8; AC photophores usually 12–15, seldom 11; total vertebrae 60–63 3

3. Tip of barbel with a short, flat expansion; dorsal-fin rays usually 13 or 14, occasionally 15; OV photophores usually 18 or 19, seldom 20; in larger specimens a row of pale spots behind eye and a pale patch on dorsal half of opercle (possibly more extensive when more large specimens are found) . . . . ***A. spatulifer***

Tip of barbel swollen, short and spheroidal to long and cylindrical; dorsal-fin rays 14–17, usually 15 or 16; OV photophores 19–22, usually 20–21; no pale patches behind eye; pale patch on operculum either extending for most of vertical length of operculum or forming a right angle in middle one-third 4

4. Pectoral-fin rays 8; head length 19–21% SL, isometric; barbel longer (Figure 5); swollen tip of barbel 3.8–6.8% SL, apparently isometric; body depth behind head 12–13% SL, isometric; pectoral and pelvic fins longer (Figures 10, 11); luminous patch on operculum, when developed, extending from top to bottom, not forming right angle; pale patches on sides of body, when present, scattered, not forming horizontal lines . . . . ***A. kreffti***

Pectoral-fin rays usually 7, rarely 8; head length 14–19% SL, decreasing with increasing SL; barbel shorter (Figure 5); swollen tip of barbel 0.5–3.4% SL, decreasing with increasing SL; body depth behind head 9–11.8% SL, decreasing with increasing SL; pectoral and pelvic fins shorter (Figures 10, 11); luminous patch on operculum, when developed, concentrated in center of height, forming a right angle with horizontal (dorsal) arm extending posteriad; patches on sides of body, when present, forming one or two horizontal lines . . . ***A. psychrolutes***

Astronesthes psychrolutes (Gibbs and Weitzman, 1965)

FIGURE 1

Cryptostomias psychrolutes Gibbs and Weitzman, 1965:265–271 [30°08′S, 176°50′W; figs.1 (lateral view of paratype), 2 (first gill arch)].—Weitzman, 1967:1–54 [comparative osteology].—Nielsen, 1974:28 [holotype at ZMUC].

Astronesthes sp.—Krefft, 1974:232 [convergence pattern of distribution in Atlantic].

Astronesthes psychrolutes.—Krefft, 1976:446 [convergence pattern of distribution in Atlantic; map fig.3].—Collins and Baron, 1981:9 [off southern Australia].

DIAGNOSIS.—Dorsal-fin rays 14–17, usually 16; pectoral-fin rays 7–8, usually 7; VAV 22–26, usually 24 or 25; OV 20–22, usually 20–21; VAL 23–27, mostly 25 or fewer; total groups of gill teeth on first arch 12–18, usually 16 or fewer; branchiostegal photophores 19–22; total vertebrae 61–63, usually 62 or 63. In specimens longer than 100 mm SL: head length 13.4–18.4% SL; length of swollen barbel tip 0.5–3.4% SL. Barbel tip spheroidal or cylindrical, usually with a small convexity at distal end. Luminous patches, when developed, including one in middle of operculum forming right angle with dorsal arm directed posteriad; in large specimens one or two lines along sides of body.

COUNTS.—Most counts given in Tables 1 and 2. Maxillary serra-like teeth increasing from 8–10 in small specimens to 25–29 in largest (276 mm).

PROPORTIONS OF BODY PARTS AS % SL.—*Apparently isometric:* predorsal length 52.1–59.4; prepelvic length 44.2–50.0; dorsal-fin base 13.9–19.5; anal-fin base 11.8–14.6.

Allometric: Preanal length 76.1–78.6 in smallest, decreasing to 74.5–76.0 at 60–100 mm, then increasing to 76.2–77.5 in the largest; head length 14.5–15.5 in types (33.9–35.5 mm), 19.4–22.7 in two specimens 35.0–38.3 mm, decreasing to 13.4–16.4 in the largest; barbel length 3.5–5.4 in types, increasing to as much as 42.9 at 60–80 mm, then decreasing to 7.2–10.5 in the largest; swollen tip of barbel 0.8 in holotype (not discernible in paratype), 4.3 in a 35.0 mm specimen, 2.1–4.5 at 60–100 mm, decreasing to 0.5 in largest; snout length 4.8–5.9 at 35–100 mm, decreasing to 4.0–4.5 in largest; fleshy orbit length 3.1–3.5 in types, 5.1 in a 35.0 mm specimen, 2.7–4.6 at 60–100mm, apparently isometric until about 250 mm, specimens larger than 250 mm 2.7–3.3; postorbital-organ length 0.6–1.7 in smallest, 1.1–2.2 at 60–100 mm, decreasing to 0.9 in largest; upper jaw length 10.9–12.4 in types, 18.0 in a 35.0 mm specimen, 13.8–15.5 at 60–100 mm, decreasing to 11.0–11.9 in largest; body depth just behind head 7.4–12.3 in the four smallest specimens, 8.4–11.2 at 63–103 mm, 10.4–11.5 at 127–141 mm, decreasing to 9.1 in the largest; greatest body depth located just behind head in smallest specimens, usually located near mid-length in larger specimens: 9.0–11.3 at 60–103 mm, increasing to 11.1–13.6 in those larger than 103 mm; caudal-peduncle depth 3.7–5.0 in specimens up to 141 mm, increasing to 4.9–5.1 in larger ones; pectoral-fin length 6.8–11.7 in smallest, increasing to 15.9–18.0 at 60–100 mm, then decreasing to 9.1–13.6 at greater than 100 mm; pelvic-fin length 8.8–16.3 in smallest, increasing to

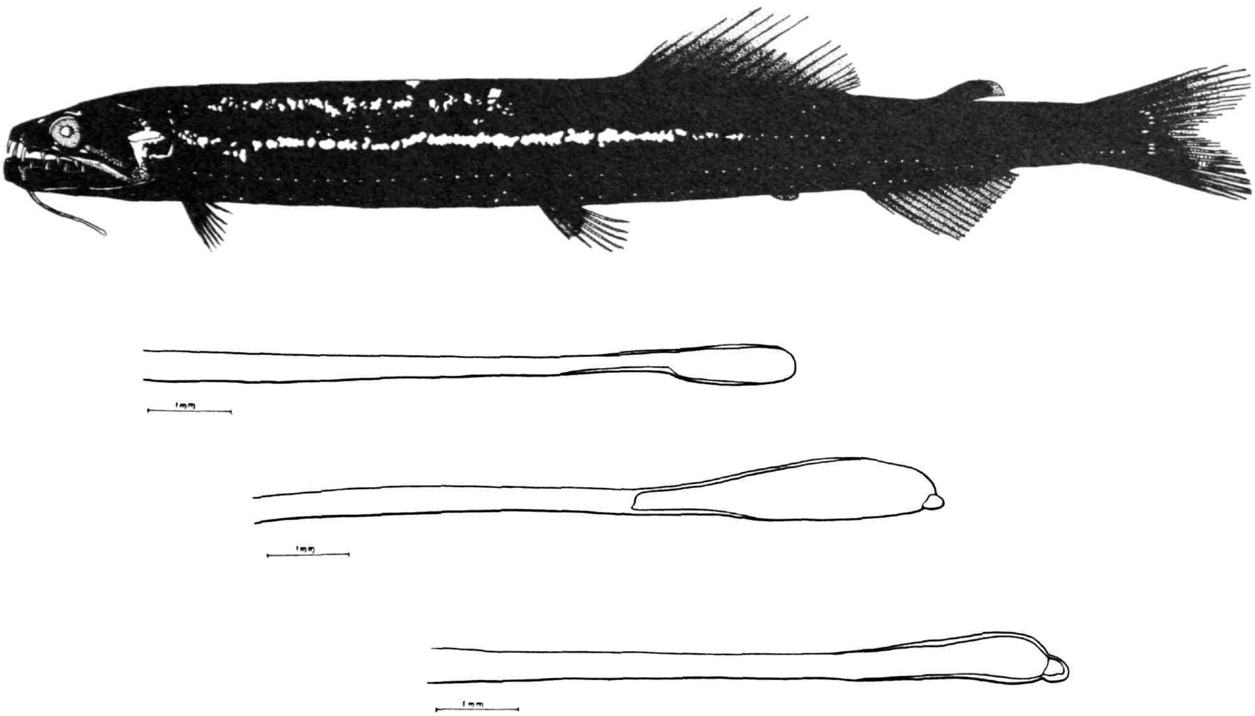

FIGURE 1.—*Astronesthes psychrolutes*. *Top:* Left lateral view of ISH 724/71, female, 276.7 mm; drawn by J.R. Schroeder. *Bottom:* Barbels of three specimens 72.1 mm (upper), 141.0 mm (middle), 276.7 mm (lower); drawn by P.K. Hollingsworth.

16.5–21.3 at 60–100 mm, then decreasing to 10.6–11.6 in largest; longest premaxillary tooth 4.2–4.3 in smallest (not well developed in types), 2.9–4.4 at 60–170 mm, decreasing to 2.2–2.7 at greater than 200 mm; longest mandibular tooth 4.7–5.7 in smallest (not including types), decreasing to 3.9–4.2 at 72–73 mm, 2.7–3.8 and apparently isometric to about 250 mm, 2.2 in the largest (276 mm).

BARBEL.—Stem and swollen tip pale, without dark pigment in most specimens; in large specimens, base of stem dark ventrally. Colors observed on swollen tip in five freshly caught specimens: 93.0 mm, proximal two-thirds white, subdistal one-third purplish-red, apex and small projection white; 98.5 mm, proximal one-fifth white, next two-fifths yellow, distal two-fifths purplish-red, small projection yellow; 102.5 mm, entirely white; 204.9 and 252.0 mm, entirely reddish-purple except narrow white band just distad of base.

LUMINOUS PATCHES.—A patch on the middle of the operculum forming a right angle, with its horizontal (dorsal) arm directed posteriad, is diagnostic for this species (Figure 1). This patch can not be seen in the types, but in two other small specimens (35.0 and 38.3 mm) the patch is obvious in one, suggested by lighter tones in the other. In all other specimens (62.7–304 mm), the patch is well developed. In freshly caught specimens 72.1 and 102.5 mm, this patch was all white. In two, 276.1 and 276.7, the dorsal part of the horizontal arm was reddish-purple and sharply demarcated from the ventral part of that arm and the vertical arm, which were white.

In at least some specimens 141.0 mm and larger, diffuse smaller pale patches are present above and below the large opercular patch, and small patches may form a row above the maxilla (Figure 1).

The smallest specimen in which pale body patches have been observed is 136.6 mm; indistinct roundish patches are present on the sides between its head and dorsal origin but do not form rows. In a 141.0 mm specimen, clusters of spots form two rows, one beginning behind the upper margin of the opercle and extending to below the anterior part of the dorsal fin, the other almost continuous with the horizontal arm of the opercular patch and extending to below the middle of the dorsal fin. This pattern is seen in all larger specimens with intact skin (Figure 1). In specimens larger than 200 mm, as many as 8 small patches are present at the bases of the middle caudal rays. The body and caudal spots were reddish-purple in two freshly caught specimens, 276.1 and 276.7 mm.

SEXUAL MATURITY.—Males as small as 127 mm showed some enlargement of the testes, but only the largest, 276 mm, appeared to be mature. A 183-mm female still had an

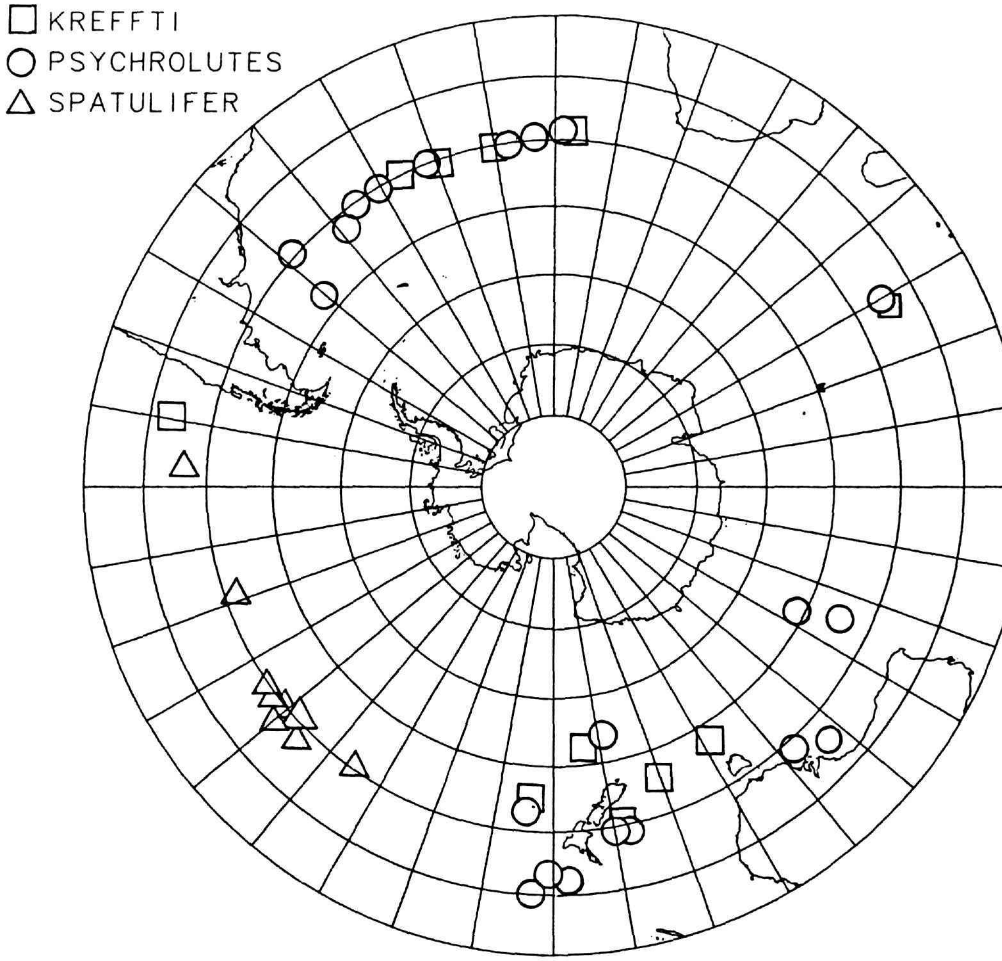

FIGURE 2.—Distribution map of *Astronesthes psychrolutes*, *kreffti*, and *spatulifer*.

undeveloped ovary with tiny, clear eggs. One of 261 mm had small eggs that were beginning to enlarge. The largest female, 267 mm, had a much-enlarged ovary, but its eggs still were small, less than 0.2 mm in diameter; probably it was approaching the time of egg maturation. (The 304-mm specimen was not sexed.)

GEOGRAPHIC DISTRIBUTION (Figure 2).—Atlantic, Indian, and Pacific sectors of the Southern Ocean, mostly between 35° and 45°S. Not yet taken from longitudes 00° in the eastern Atlantic to 50°E in the Indian Ocean, from 70° to 110°E, or from the Pacific east of 170°W. Only three specimens (136.6–304.5 mm) have been taken south of 45°S, but this may be due to the paucity of collections, particularly with large nets, in subantarctic waters. Four specimens have been taken in three collections north of 35°S in the vicinity of the Kermadec Islands (~177°E to 179°W); these include all except one of the specimens smaller than 70 mm. The only other small specimen (38.3 mm) was taken at 34°56′S, 60°05′E in the Indian sector. This suggests that spawning may be restricted to the northern part of the species range and that *psychrolutes* is, indeed, a Subtropical Convergence species.

VERTICAL DISTRIBUTION.—All specimens were taken in open nets, so only maximum fishing depth can be used in our analysis of vertical distribution. All four small specimens were taken in nets fishing at maximum depths of 1000 to 2275 m but probably were taken at shallower depths during the oblique parts of the tows. Six specimens 72–103 mm were taken in nets fished to 20–200 m at night; another was taken at 0–400 m, but time is not known; and another was taken at 0–708 m at night. Two specimens 137–141 mm were taken in nets fished to 350–400 m, time unknown. Two specimens 205–252 mm were taken in nets fished at 700–820 m at night; four others 183–239 mm were taken at maximum depths between 850 and 1000 m, time unknown.

These data suggest that smaller specimens inhabit the upper 200 m, with increasingly larger specimens occupying increasing depths to about 1000 m, at least at night. Our data are insufficient to show daytime depths or to indicate whether or not diel vertical migration occurs, but we suspect that at least the smaller specimens migrate, for few mesopelagic fishes occur as shallow as 20–200 m during the day.

MATERIAL EXAMINED.—*Atlantic sector:* IOAN uncat. (141.0) 42°S, 39°W, 0–353 m, 3 Feb 1961; ISH 523/71 (102.5), 39°18′S, 48°12′W, 0–100 m, 1945–2040, 6 Mar 1971; ISH 724/71 (276.1, 276.7), 40°18′S, 35°07′W, 0—2000 m, 1928–2345, 9 Mar 1971; ISH 768/71 (98.5), 40°00′S, 30°35′W, 0–200 m, 1958–2057, 10 Mar 1971; ISH 1041/71 (204.9) 40°01′S, 7°25′W, 0–820 m, 2115–2327, 18 Mar 1971; ISH 1074/71 (73.1), 39°19′S, 3°15′W, 0—2000 m, 1823–2310, 19 Mar 1971; ISH 208/76 (304.5), 46°44′S, 49°59′W, 0–980 m, 0800–1200, 21 Nov 1975; USNM 270299 (93.0, 252.0), 39°53′S, 21°33′W, 0–708 m, 2239–0037, 12 Mar 1971; USNM 270306 (72.1), 38°16′S, 1°12′E, 0–110 m, 1850–2000, 20 Mar 1971. *Indian sector:* ORIT uncat (168.6), 44°48′S, 114°57′E; TMH D1686 (82.2), 38°23′S, 137°43′E, 0–20 m, 2340–0700, 11 Jan 1980; TMH D1688 (73.2), 35°36′S, 132°45′E, 0–40 m, 0010–0700, 14 Jan 1980; USNM 270301 (38.3), 34°56′S, 60°05′E, 0–2275 m, 1745–2250, 9 Sep 1963; USNM 270304 (136.6), 51°03′S, 117°01′E, 19 Sep 1968. *Pacific sector:* NMNZ P4812 (127.0), 41°13′S, 174°42′E, 16 Jun 1968; NMNZ P16014 (261.4), 43°04′S, 174°56′W; NMNZ P16015 (239.2), 42°59′S, 175°25′W; NMNZ P16235 (78.3), 39°50′S, 172°02′E, 0—400 m, 20 Nov 1984; NMNZ P16768 (182.5), 54°01′S, 168°41′E, 0–968 m, 12 May 1971; NMNZ P16800 (62.7), 33°05′S, 179°13′W, 12 Apr 1976; NMNZ P17414 (217.7), 40°00′S, 170°00′E, 0—900 m; NMNZ P17940 (35.0), 31°57′S, 177°38′E, 0–1006 m, 24 Jul 1962; NMNZ uncat. (237.6), 39°04′S, 167°26′E, 0–913 m, 9 Jul 1984; USNM 198506 (33.9, paratype), 30°08′S, 176°50′W, 0—1500 m, 1545, 14 Dec 1928; ZMUC P203821 (holotype, 35.5), same data as paratype.

Astronesthes kreffti, new species

Figure 3

Astronesthes sp. nov.—Collins and Baron, 1981:9 [off southern Australia].

DIAGNOSIS.—Dorsal-fin rays 15–17, usually 15; pectoral-fin rays 8; VAV 25–27, usually 26 or 27; OV 19–21, usually 20; VAL 25–27, usually 26 or 27; total groups of gill teeth on first arch 14–17, usually 16 or fewer; branchiostegal photophores 21–23; total vertebrae 61–63, usually 62 or 63. In specimens longer than 100 mm SL: head length 18.8–21.0% SL; length of swollen barbel tip 3.9–6.8% SL. Barbel tip cylindrical (almost spheroidal in the smallest specimens), without a small convexity at distal end. Luminous patches, when developed, including one extending dorsoventrally for most of length of operculum; large specimens with scattered spots on sides.

COUNTS.—Most counts given in Tables 1 and 2. Maxillary serra-like teeth 14 in one small specimen, increasing to 39 in largest (246 mm).

PROPORTIONS OF BODY PARTS AS % SL.—*Apparently isometric:* predorsal length 51.6–56.7; preanal length 73.8–77.8; prepelvic length 43.7–49.2; dorsal-fin base 15.1–20.1; anal-fin base 14.2–15.8; longest premaxillary tooth 3.3–4.6; longest mandibular tooth 3.1–5.5.

Allometric: head length 21.4–22.9 in two small specimens, 18.8–21.0 and apparently isometric from 105–246 mm; barbel length 34.2–41.7 in three small specimens and in those 105–128 mm, then decreasing to 17.9 in the largest; swollen tip of barbel 1.1–4.6 in three small specimens, 3.7–6.8 and apparently isometric from 105 mm; snout length 6.3 in one small specimen, decreasing to 5.3 at 153 mm, then increasing to 5.9–6.1 in those longer than 200 mm; fleshy orbit length 3.1–4.0 in four small specimens, 2.9–3.9 at 105–128 mm, apparently increasing to 3.6–4.1 at 194–201 mm and 4.6 at 246 mm; postorbital-organ length 1.4–2.2 in four small specimens, 1.2–1.6 at 105–128 mm, apparently decreasing to 1.2–1.3 in largest; upper-jaw length 18.1 in one small specimen, 15.0–17.4 at 105–153 mm, decreasing to 15.3–15.5 in the two largest; body depth just behind head 11.0–13.1 in two small specimens, apparently decreasing to 10.5–12.7 at 105–128 mm, and then increasing to 12.2–13.0 in all over 150 mm; greatest body depth usually just behind head, occasionally near mid-length (13.9 in the largest specimen); caudal-peduncle depth 4.7–5.1 in two small specimens, decreasing to 4.0–4.2 at 105–120 mm, then increasing to 5.0 in the largest; pectoral-fin length 16.2 in one small specimen, 16.0–18.3 at 105–128 mm, decreasing to 12.9 in the largest; pelvic-fin length 22.2 in one small specimen, decreasing to 13.4 in the largest.

BARBEL.—Small specimens with stem and swollen tip unpigmented. Specimens 105–150 mm with or without pigment on ventral base of stem. Specimens 153–201 mm with ventral side of stem black on proximal 50–75%; largest (246 mm) specimen with ventral stem black until swollen tip. No black pigment observed in any tip. Colors were observed in two fresh Atlantic-sector specimens. A 123 mm specimen had the distal one-fourth of the tip reddish-purple, the rest white; in a 201 mm specimen the tip was all white.

LUMINOUS PATCHES.—Behind the preopercle, luminous material forms a slender patch extending almost the full vertical extent of the operculum. This patch is apparent, but not well developed, in a 36.5 mm specimen. It is well developed in all specimens 105 mm and larger. Sometimes the patch appears to be made up of several contiguous sections; in others it is continuous, often with a notch at its mid-length or with the dorsal half wider than the ventral half. Colors of the opercular patch have been noted in three freshly-caught specimens from the Atlantic sector: 105 mm, very lightly tinged with purple; 123 mm, light purple; 201 mm, all white.

In specimens 123 mm and larger in which the skin is

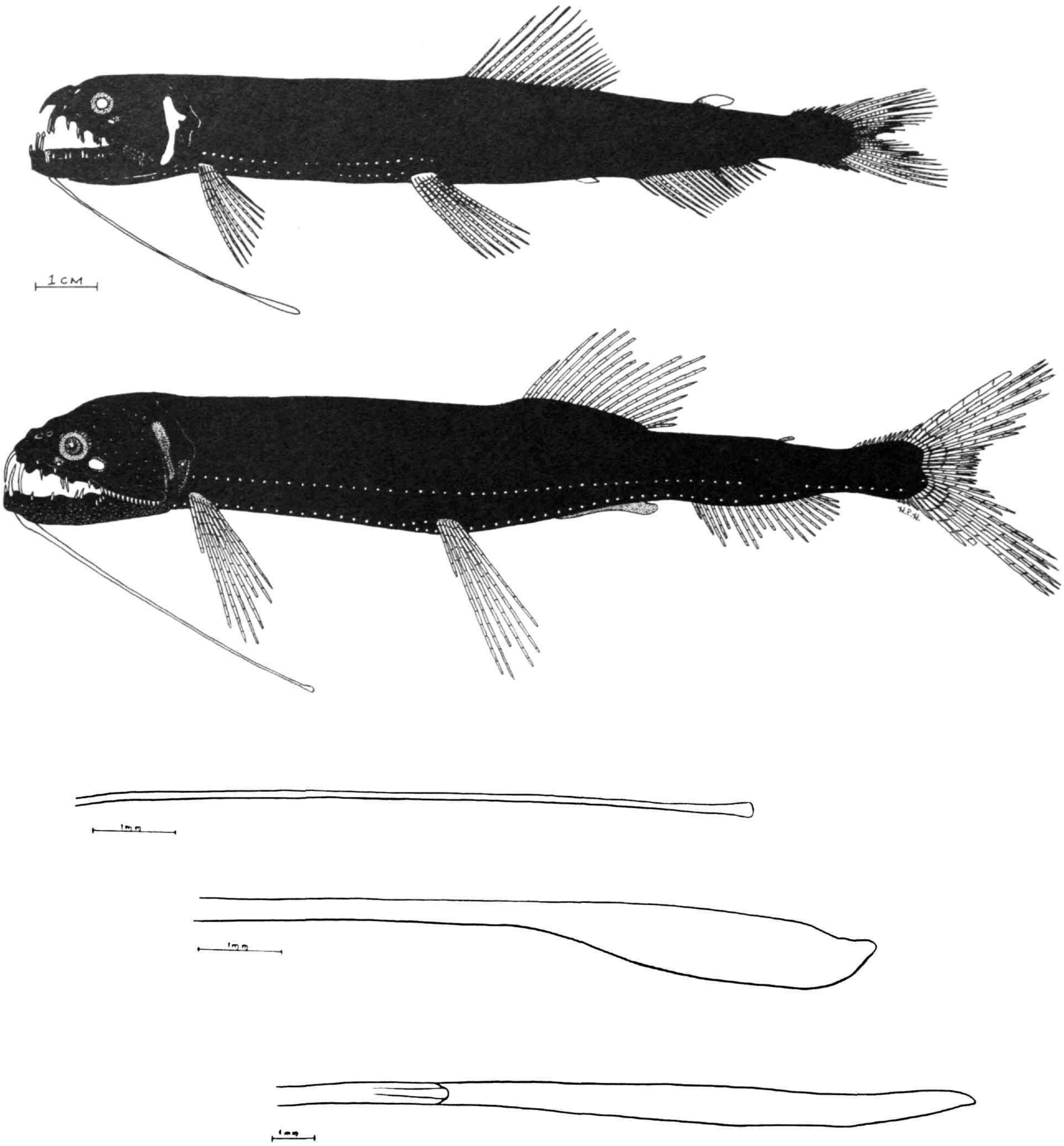

FIGURE 3.—*Astronesthes kreffti*. *Top:* Left lateral view of ISH 839/71, holotype female 128.4 mm; drawn by J.R. Schroeder. *Middle:* Left lateral view of MCZ 64504, juvenile 36.5 mm; Drawn by H.E. Hamman. *Bottom:* Barbel ends of three specimens 36.5 mm (upper), 120.0 mm (middle), and 201.2 mm (lower) showing elongation of tip with growth; drawn by P.K. Hollingsworth.

relatively intact, small spots are present on the sides in the middle one-third of the body height, extending from behind the head to or below the dorsal-fin base. In our specimens of this species the skin has been badly rubbed during capture, so that the full extent of any patches on the sides may not have been observed. No observations of color in the body patches have been made.

SEXUAL MATURITY.—The largest female was 194 mm and showed no sign of ovary or egg enlargement. The two largest specimens were males, 201 and 246 mm. The former had enlarging testes, and the latter had large testes and may have been approaching maturity.

GEOGRAPHIC DISTRIBUTION (Figure 2).—Atlantic, Indian, and Pacific sectors of the Southern Ocean, mostly between 38° and 47°S. The only two specimens taken north of 38°S include the only specimen from the Indian sector (34°56′S, 60°05′E) and the only specimen from the eastern Pacific (33°36′S, 79°32′W). These are the two smallest specimens known. The only specimen from south of about 47°S is 194 mm SL and was taken at 52°11′S, 172°53′E. There is a broad gap in the Pacific sector where no specimens have been taken, between 175°E and 80°W. *Astronesthes spatulifer* is known only from the region of this gap (Figure 2).

VERTICAL DISTRIBUTION.—All specimens were taken in open nets, so we were able to use only maximum fishing depths in our analysis. Of the four specimens smaller than 42 mm, one was taken during dusk or night at a maximum of 275 m, which may be within the actual night depth range for small specimens; the other three are from nets that reached maximum depths of 750–1375 m during crepuscular periods or at night, and because small specimens of other *Astronesthes* species usually occur at shallower depths at night, we believe that these three specimens were caught during setting or retrieval of the nets. A 153-mm specimen was taken at a maximum of 200 m at night; one 123 mm at a maximum of 320 m at night; and five others 105–246 mm were taken in nets fished to 610–820 m, three at night, two at unknown times.

The data indicate only that some specimens occur in the upper 320 m at night, probably migrating there from a deeper daytime depth. Specimens taken at maximum depths of 610–820 m might be contaminants or might occupy those depths day and night; there is no way to be certain.

ETYMOLOGY.—This species is named in honor of Dr. Gerhard Krefft, who enabled the senior author to participate in the cruise whereon the species was first recognized.

TYPES (*Atlantic sector* only).—*Holotype:* ISH 839/71 (128.4) 39°55′S, 26°02′W, 0—2000 m, 1835–2338, 11 Mar 1971. *Paratypes:* ISH 1022/71 (123.4) 40°02′S, 7°28′W, 0–320 m, 2000–2108, 18 Mar 1971; ISH 1042/71 (120.0) 40°01′S, 7°25′W, 0–820 m, 2115–2327, 18 Mar 1971; ISH 3441/71 (150.5) same data as holotype; USNM 270300 (201.2) 39°53′S, 21°33′W, 0–708 m, 2239–0037, 12 Mar 1971; USNM 270305 (105.2) 38°14′S, 1°15′E, 0–760 m, 2006–2210, 20 Mar 1971.

NON-TYPES.—*Indian sector:* USNM 270302 (35.0) 34°56′S, 60°05′E, 0—275 m, 1745–2250, 9 Sep 1963. *Western Pacific sector:* LACM 11313 (37.5) 40°22′S, 168°25′E, 0–750 m, 2000–2319, 2 Dec 1966; LACM 11325 (41.5) 45°19′S, 160°11′E, 0–1375 m, 0438–0916, 11 December 1966; NSMT P43136 (245.8) 44°33′S, 175°51′W, 0–805 m, 18 Mar 1983; NMNZ P16781 (193.8) 52°11′S, 172°53′E, bottom depth 610 m, 14 May 1979; TMH D1689 (153.4) 47°12′S, 148°27′E, 0–200 m, 0130–0640, 2 Jan 1980. *Eastern Pacific sector:* MCZ 64504 (36.5) 33°36′S, 79°32′W, 0–1250 m, 2105–0410, 13–14 Jan 1966.

We have chosen to recognize as types only specimens from the Atlantic sector, in case those from the Indian Ocean and Pacific sectors should be recognized as distinct in the future.

Astronesthes spatulifer, new species

FIGURE 4

Astronesthes sp. 3.—Parin et al, 1973:99–100 [122 mm specimen; examined by us].

DIAGNOSIS.—Dorsal-fin rays 13–15, usually 13 or 14; pectoral-fin rays 8; VAV 26–28, usually 26 or 27; VAL 25–28, usually 26 or 27; total groups of gill teeth on first arch 17–20; branchiostegal photophores 20–21; total vertebrae 60–62, usually 61. Barbel tip flattened, short and wide, often with a small convexity at distal end. Luminous patches, when developed, including crescent behind postorbital organ, row of spots between eye and preopercular margin, fairly large patch on dorsal half of operculum.

COUNTS.—Most counts given in Tables 1 and 2. Maxillary serra-like teeth increasing from 9 in some of the smallest specimens to 18 in the largest (122 mm).

PROPORTIONS OF BODY PARTS AS % SL.—All except two specimens are 35.8–48.0 mm SL, and in most characters the range of variation is large, presumably reflecting rapid changes with growth at these small sizes. The two larger specimens (70.3 and 122.0 mm) fall within this range of variation in most characters, making allometry difficult to assess. The largest specimen, furthermore, is badly damaged, and many measurements could not be made.

Apparently isometric: predorsal length 56.1–62.3; preanal length 74.6–81.0; prepelvic length 44.7–51.4; head length 20.5–25.1; fleshy orbit length 3.9–4.6; postorbital-organ length 1.0–1.7; body depth just behind head 11.2–15.7; greatest depth usually just behind head, occasionally near mid-body, where the depth becomes as much as 17.9; caudal-peduncle depth 3.9–5.9; pectoral-fin length 15.4–17.2 (damaged in both larger specimens); pelvic-fin length 19.5–23.2; dorsal-fin base 14.0–17.3; anal-fin base 12.9–14.6; longest premaxillary tooth 4.1–6.5; longest mandibular tooth 4.3–6.3.

Allometric: barbel length 15.1–20.4 in small specimens, decreasing to 13.0 in largest; expanded tip length 1.1–2.5 in small specimens, decreasing to 0.7 in largest; snout length 6.0–6.8 in small specimens, decreasing to 5.4 at 70.3 mm; upper-jaw length 17.7–22.3 in small specimens, decreasing to 16.6 at 70.3 mm.

BARBEL.—Stem and expanded tip unpigmented. Expanded tip flat except extension of stem core in proximal part, becoming wider distally, its length about twice as long as its greatest width. A small medial projection usually present at distal end of tip. No color observations have been recorded.

LUMINOUS PATCHES.—Patches are poorly developed in the few specimens in which they can be discerned. The largest

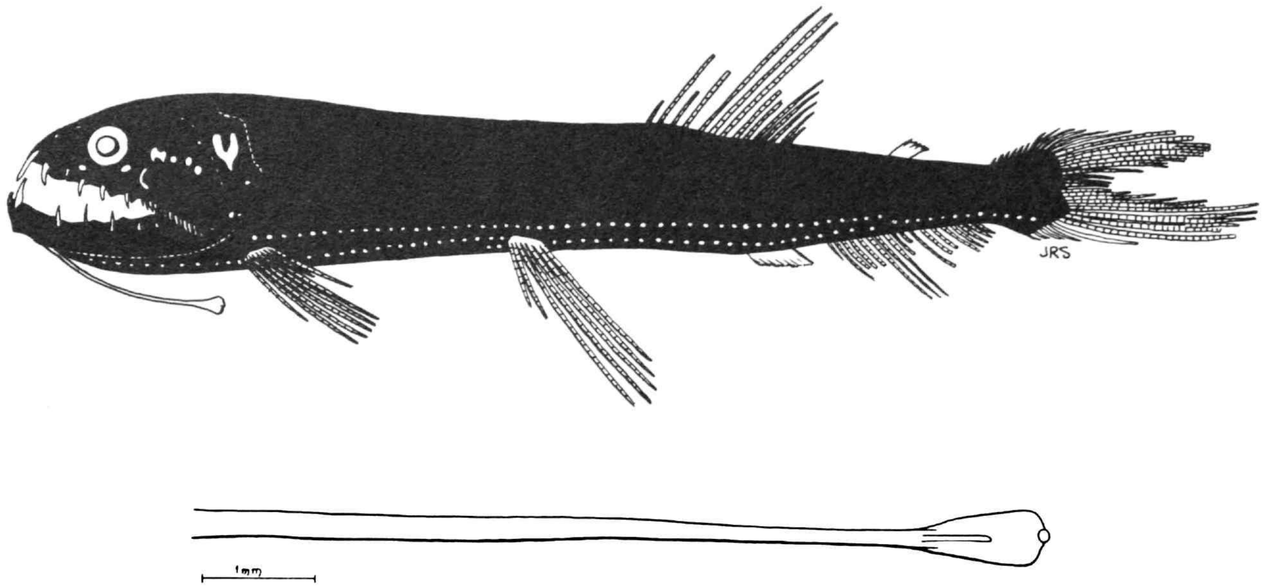

FIGURE 4.—*Astronesthes spatulifer*. *Top:* left lateral view of LACM 11289, holotype juvenile 45.3 mm; drawn by J.R. Schroeder. *Bottom:* Barbel of paratype, LACM 11274, 40.8 mm; drawn by P.K. Hollingsworth.

specimen is too damaged and the 70.3 mm specimen too faded to show patches. The best developed patches are illustrated in Figure 4. A slender crescent is present posterior to the postorbital organ. Several spots form a row from behind the middle of the eye almost to the anterior margin of the preopercle. A fairly large patch is present on the upper opercle; in the illustrated specimen (45.3 mm) it appears V-shaped, but in the few others on which it can be discerned it is irregular in shape. The shape and distribution of luminous patches in specimens larger than about 45 mm remain to be seen. No color observations have been recorded.

SEXUAL MATURITY.—Only the 122-mm specimen could be sexed. It was a male with testes beginning to enlarge but still slender.

GEOGRAPHIC DISTRIBUTION.—Known only from the central part of the Pacific sector, between 95° and 145°W and between 36° and 42° S. All specimens except one were taken on a single cruise of the R/V Eltanin in 1966.

VERTICAL DISTRIBUTION.—All specimens were taken in open nets. All except two specimens were 36–47 mm. During the day specimens were taken in nets fishing to 550–1350 m; seven were from 550–600 m, which, judging from what is known of other *Astronesthes* species, probably is the depth at which they occur; 6 others were taken at maximum depths of 950–1350 m and probably are contaminants. All six specimens taken at night were from maximum depths of 110–160 m. The single 70-mm specimen was taken at a maximum depth of 650 mm at night and probably is a contaminant. The 122-mm specimen was taken at 100 m, time unknown, but probably at night.

There is little question that small specimens, at least, live at or below 550 m during the day and migrate at night to the upper 160 m.

ETYMOLOGY.—The name *spatulifer* is an adjective derived from the Latin *spatula*, a broad, flat tool, and the suffix *-fer*, bearing or having, in reference to the flat barbel tip of the species.

TYPES.—*Holotype:* LACM 11289 (45.3) 37°25′S, 130°04′W, 0–~110 m, 2027–2147, 18 Aug 1966.

Paratypes: IOAN uncat. (122.0) 42°00′S, 109°00′W, 0–100 m, 25 May 1968; LACM 11258 (39.0) 40°15′S, 144°45′W, 0–~1125 m, 0204–0530, 26 Jul 1966; LACM 11274 (3, 35.8–40.8) 38°17′S, 134°32′W, 0–1250 m, 0707–1000, 9 Aug 1966; LACM 11279 (44.1) 40°22′S, 132°W, 0–~1350 m, 0557–0950, 13 Aug 1966; LACM 11284 (41.2) 39°40′S, 130°12′W, 0–~950 m, 1230–1543, 16 Aug 1966; LACM 11292 (43.8) 39°34′S, 127°18′W, 0–~550 m, 0842–1130, 20 Aug 1966; LACM 11294 (46.6) 39°46′S, 126°56′W, 0–~160 m, 1700–1812, 20 Aug 1966; LACM 11300 (6, 37.1–48.0) 39°33′S, 125°10′W, 0–600 m, 0752–1105, 24 Aug 1966; LACM 11307 (70.3) 36°34′S, 87°07′W, 0–~650 m, 1735–2030, 4 Sep 1966; USNM 270303 (4, 37.9–41.5) same data as holotype.

Common Counts

The following counts show no apparent differences among the three species and were not included in tables or text.

Pelvic-fin rays always 7. IP photophores 10 or 11; always

TABLE 1.—Frequency distributions of counts of fin rays, vertebrae, and gill teeth in three *Astronesthes* species.

Species	Dorsal Rays					Anal Rays				
	13	14	15	16	17	15	16	17	18	19
A. kreffti			10	1	1			5	6	
A. psychrolutes		1	9	15	1	2	8	11	2	2
A. spatulifer	8	11	2				3	4	12	2
		Total Gill Teeth								
		12	13	14	15	16	17	18	19	20
A. kreffti				4	4	4	1			
A. psychrolutes		2	2	1	7	9	4	1		
A. spatulifer							4	4	9	1
	Precaudal Vertebrae						Caudal Vertebrae			
	42	43	44	45	46		16	17	18	19
A. kreffti	1	3	5						2	7
A. psychrolutes			7	5	1		1	4	6	2
A. spatulifer			1	1				2		
		Total Vertebrae						Pectoral Rays		
		60	61	62	63			7	8	
A. kreffti			1	5	3				13	
A. psychrolutes			2	6	5			24	3	
A. spatulifer		2	7	2					20	

10 in *spatulifer*, more often 10 than 11 in *psychrolutes*, more often 11 than 10 in *kreffti*. Premaxillary teeth always 5 in the main row, 0–3 smaller lateral teeth. Mandibular teeth 7 or 8, plus 1 or 2 smaller lateral teeth. Vomerine teeth one on each side; 2 per side have been recorded, but the second probably was a replacement tooth. Palatine teeth 3–9; when more than 4, the posterior teeth are smaller than and separated by a space from the anterior teeth.

Comparisons

We discuss here the characters that differentiate *A. psychrolutes*, *kreffti*, and *spatulifer* from one another at all sizes or for part of their size ranges.

LUMINOUS PATCHES.—The opercular patch of *psychrolutes* is unique, forming a right angle in the middle one-third of the vertical length of the operculum with the horizontal (dorsal) limb directed posteriad (Figure 1). In *kreffti*, a patch extends with variable width for most of the vertical length of the operculum (Figure 3). The few specimens of *spatulifer*, all small, that show opercular patch development appear to have it concentrated in the dorsal half of the operculum; the best-developed patch is V-shaped (Figure 4). In *spatulifer*, there appear to be other patches on the head: a crescent behind the postorbital organ and a row of spots from behind the middle of the eye to the anterior border of the preopercle.

Large specimens of *psychrolutes* have one or two prominent pale horizontal lines on the side of the body and several small patches at the bases of the middle caudal rays. Large *kreffti* have scattered spots on the sides, but these do not form lines, and no caudal patches have been seen. No patches have been seen behind the head in *spatulifer*, but no large specimens are available to indicate whether or not patches may be present.

BARBEL (Figure 5).—In small specimens of *spatulifer* and *psychrolutes* the barbel does not exceed 20.4% SL; in the smallest *kreffti* it is 34.4–40.9%. When more small *psychrolutes* become available, however, some can be expected to have barbels as long as *kreffti*, for specimens of *psychrolutes* 63–78 mm have barbels as long as 42.9% SL, indicating a rapid increase before this size is reached. On the other hand, the barbel of *spatulifer* does not show such an increase, but remains short. After 80 mm SL, barbel growth slows in *psychrolutes*, and after about 150 mm there is a continuous decrease in absolute barbel length. In *kreffti* the barbel continues its rapid growth until about 130 mm SL, after which it stops growing and may decrease slightly in actual length. Thus, at any given size over about 100 mm SL, the barbel of *kreffti* is longer than that of *psychrolutes*, but the inflections in the growth curves

TABLE 2. Frequency distributions of photophore counts in three *Astronesthes* species.

Species	PV						VAV						
	19	20	21	22	23		22	23	24	25	26	27	28
A. kreffti	2	5	4							2	5	4	
A. psychrolutes		7	11	6	1		1	2	8	9	4		
A. spatulifer	8	10	1								8	11	1
		OV						VAL					
		18	19	20	21	22		23	24	25	26	27	28
A. kreffti			2	9	1					1	7	4	
A. psychrolutes				11	12	1		1	4	15	2	2	
A. spatulifer		6	11	1						1	10	8	1
		AC							Branchiostegal				
		11	12	13	14	15			19	20	21	22	23
A. kreffti			1	9	1						5	5	3
A. psychrolutes			4	15	3	2			6	9	11	1	
A. spatulifer		1	12	7						9	10		
			IA						IC				
			55	56	57	58			67	68	69	70	71
A. kreffti				5	2	4					4	4	3
A. psychrolutes			10	5	7	1			3	6	3	8	3
A. spatulifer			1	14	2	2			1	9	6	3	
			OA						OC				
			44	45	46	47			57	58	59	60	61
A. kreffti				2	6	3			2	6	3		
A. psychrolutes				12	8	3			3	7	7	5	1
A. spatulifer			1	12	4	1			10	6	2		

must be taken into account (Figure 5).

The swollen tip of the barbel in both *psychrolutes* and *kreffti* is spheroidal in the smallest specimens that show any swelling at all, but it soon elongates and becomes cylindrical. In *spatulifer* the tip is distinctively flattened (Figure 4). In both *psychrolutes* and *spatulifer* there usually is a small convexity at the distal end of the tip (Figure 1); no such convexity is present in *kreffti* (Figure 3). In *kreffti* the tip continues to grow throughout the known size range, while in *psychrolutes* after about 80 mm, it decreases in actual size (Figure 6)(one 137-mm specimen of *psychrolutes* appears to belie this pattern). Thus at sizes over about 100 mm, the swollen tip in *kreffti* is 3.8–6.8% SL, that of *psychrolutes* 0.5–3.4%. In *spatulifer* the tip appears not to grow, becoming relatively smaller in the two larger specimens; in small specimens the tip is 1.1–2.5% SL, decreasing to 0.7% at 122 mm (Figure 6).

DORSAL-FIN RAYS.—Usually 13–14 in *spatulifer*, 15 in *kreffti*, 15–16 in *psychrolutes* (Table 1).

PECTORAL-FIN RAYS.—Eight in *kreffti* and *spatulifer*, almost always 7 in *psychrolutes* (Table 1).

PV PHOTOPHORES.—Usually 19–20 in *spatulifer*, usually 20–21 in *kreffti*, 20–23 in *psychrolutes* (Table 2).

VAV PHOTOPHORES.—Usually 25 or fewer in *psychrolutes*, usually 26 or more in *kreffti* and *spatulifer* (Table 2).

OV PHOTOPHORES.—Usually 18–19 in *spatulifer*, usually 20 or more in *kreffti* and *psychrolutes* (Table 2).

VAL PHOTOPHORES.—Usually 25 or fewer in *psychrolutes*, usually 26 or more in *kreffti* and *spatulifer* (Table 2).

MAXILLARY SERRA-LIKE TEETH (Figure 7).—Fourteen in one small *kreffti*, 9–13 in small *psychrolutes* and *spatulifer*. Increasing in number more rapidly in *kreffti* than in the other two species, to a maximum of 39 in *kreffti*, 29 in *psychrolutes*;

spatulifer appears to follow *psychrolutes*, but no large specimens are known.

GILL TEETH.—The total number of groups of teeth on the first arch is usually 14–16 in *kreffti*, 17 or more in *spatulifer*; *psychrolutes* falls modally between the other two species, but some specimens have fewer (12–13) than either (Table 1).

BRANCHIOSTEGAL PHOTOPHORES.—21–23 in *kreffti*, 20–21 in *spatulifer*, 19–21 in *psychrolutes*, (one specimen has 22, see Table 2).

TOTAL VERTEBRAE.—Usually 62–63 in *kreffti* and *psychrolutes*, usually 61 or fewer in *spatulifer* (Table 1).

HEAD LENGTH (Figure 8).—Small specimens have relatively large heads in metamorphosed specimens (all except the types of *psychrolutes*) of all three species: 19.4–22.7% SL in *psychrolutes*, 21.4–22.9% in *kreffti*, 20.5–25.1% in *spatulifer*. Relative head length apparently decreases slightly in *kreffti* in the range where specimens are lacking and becomes isometric after 100 mm, being 18.8–21.0% in all larger specimens. The 70-mm specimen of *spatulifer* apparently follows *kreffti*, its head length being 21.1% SL. In *psychrolutes* the relative decrease is sharper; in specimens 60–100 mm, the head is 16.3–20.1% SL, mostly 19% or less, and in specimens over 100 mm the decrease continues, the minimum being 13.4%. Thus, in specimens larger than 100 mm, the head is 18.8% SL or larger in *kreffti*, less than 18.8% in *psychrolutes*.

SNOUT LENGTH.—Follows the pattern of head length, becoming shorter in *psychrolutes* than in *kreffti* after 100 mm (4.0–5.6% vs. 5.3–6.1%). The 70-mm specimen of *spatulifer* this time appears to follow *psychrolutes*, having a snout length 5.4% SL.

FLESHY ORBIT LENGTH.—This appears to show differences only at the largest sizes. The 246-mm specimen of *kreffti* has an eye 4.6% SL; four large *psychrolutes* (252–277 mm) have eyes 2.7–3.3%.

POSTORBITAL ORGAN.—As with the fleshy orbit, the postorbital organ appears to differ only in the largest specimens. No sexual dimorphism was detected. In three *kreffti* 194–246 mm, the organ is 1.2–1.3% SL; in six *psychrolutes* 204–276 mm, it is 0.9–1.1%.

UPPER-JAW LENGTH.—Both *spatulifer* and *kreffti* have longer upper jaws than *psychrolutes*. In small specimens, the jaw is 17.7–22.3% SL in *spatulifer*, 18.1% in the only *kreffti* measured, and only 10.9–18.0% in four *psychrolutes*. At 60–100 mm, the jaw is 16.6% in *spatulifer*, 13.8–15.5% in *psychrolutes*. At greater than 100 mm, it is 11.0–15.5% in *psychrolutes*, 15.0–17.4% in *kreffti*.

DEPTH BEHIND HEAD (Figure 9).—Small *spatulifer* tend to have deeper bodies (11.2–15.7% SL) than *kreffti* (11.0–13.1%) or *psychrolutes* (7.4–12.3%). At 60–100 mm, the depth is 11.9% in the 70-mm *spatulifer*, 8.5–11.2% in *psychrolutes*. There is overlap between *kreffti* and *psychrolutes* between about 100 and 130 mm, but at larger sizes, the depth is 12.2–13.0% in *kreffti*, 9.1–11.7% in *psychrolutes*.

PECTORAL-FIN LENGTH (Figure 10).—This fin decreases continuously in relative length after 100 mm in both *kreffti* and *psychrolutes*, in the former from 18.3% to 12.9% SL, in the latter from 13.6% to 9.1%. At any given size over 100 mm, the two are distinct.

PELVIC-FIN LENGTH (Figure 11).—Like the pectoral fin, the pelvic decreases continuously in relative length after 100 mm, in *kreffti* from 21.3% to 13.4% SL, in *psychrolutes* from 14.0% to 10.6%. The two species are distinct at any given size after 100 mm.

ANAL-FIN BASE (Figure 12).—With two exceptions, *kreffti* and *psychrolutes* differ at all sizes in this apparently isometric character. All *kreffti* have an anal base longer than 14% SL; in almost all *psychrolutes* it is shorter than 14%. The picture is obscured by two *psychrolutes* specimens 137 and 141 mm with anal bases 14.5% and 14.6% SL; the 201-mm specimen of *kreffti* measures 14.2%, whereas all others are 14.7% or longer. Thus, it appears that, at any given size, the species still may be distinct. All except one specimen of *spatulifer* fall within the range of *psychrolutes*.

LONGEST PREMAXILLARY TOOTH (Figure 13).—*A. spatulifer* has the longest premaxillary tooth, at least in its represented size range — in one small specimen the tooth is 4.1% SL; in all others it is 4.8–6.5%. In the 70-mm specimen the tooth is 5.1% SL and in the 122-mm specimen it is 5.2%, both relatively longer than the largest tooth of either of the other two species. Two small *psychrolutes* have the tooth 4.2–4.3%, and in one small *kreffti* it is 4.1%. At sizes from 60 mm to about 170 mm, the tooth appears to be about equally long in both *kreffti* and *psychrolutes* (2.9–4.6%). In the largest specimens of both species, however, the tooth of *psychrolutes* appears to decrease in relative size to 2.2–2.7% SL and is smaller than that of large *kreffti*, in which its growth is isometric and the tooth 3.5–3.7% SL.

LONGEST MANDIBULAR TOOTH (Figure 14).—Differences in tooth size in small specimens of the three species are not marked. At sizes over 100 mm, however, although there is some overlap, *spatulifer* and *kreffti* generally have a longer tooth than *psychrolutes*. Most *kreffti* in this size range have the tooth 3.1–5.5% SL, and in *spatulifer* it is 5.2%. Only three of eight specimens of *kreffti* have the tooth less than 4.2% SL. In *psychrolutes* it is 2.2–3.7% SL.

Association of *Cryptostomias psychrolutes*

The type-specimens of *Cryptostomias psychrolutes* Gibbs and Weitzman 1965 are so poorly developed that many of the characters that differentiate the three species with which they might be associated are not present. Morphometric characters are unreliable at such small sizes, because rapid growth and changes in proportion are occurring. Most counts overlap to some degree in the three species, but they provide the most convincing means of associating the types with better-developed specimens.

The most convincing character that associates the types of

C. psychrolutes with one of the species is the pectoral-fin ray count of 7; the other two species consistently have a count of 8. The dorsal-fin ray count of 16 is higher than in any *spatulifer* and most *kreffti*. The PV-photophore count of 22 in the paratype is higher than any recorded for *kreffti* or *spatulifer*, but the count of 21 in the holotype overlaps the extreme high counts of both other species. The OV count of 21 in both types is higher than in any *spatulifer* and at the high extreme of *kreffti*. The VAV and VAL counts of 24 in the holotype are lower than any recorded for either of the other two species; counts of 25 in the paratype are lower for VAV than any *spatulifer* and at the low extreme for *kreffti*, and for VAL are at the low extreme of both other species. The branchiostegal-photophore count is 19 in the holotype (not 20 as stated in the original description), and in the paratype it is 20 on the right side, 21 on the left side; the count of 19 is lower than in either of the other two species, and 20 is lower than in any *kreffti*.

This evidence has enabled us to associate with confidence the types of *C. psychrolutes* with the species redescribed here as *Astronesthes psychrolutes*.

Subtropical Convergence Species

Our designation of the three species described in this paper, as well as *A. boulengeri*, as Subtropical Convergence species is somewhat questionable, as is the definition of the Convergence and of other species regarded as characteristic inhabitants of it.

As a physical phenomenon, the southern Subtropical Convergence represents the transition zone between warmer, more saline waters of the subtropical gyres to the north and cooler, fresher subantarctic waters to the south. It appears to be primarily a surface phenomenon, which leads one to wonder whether it really influences the distribution of mesopelagic organisms that spend most of their time below it. It is, however, a mixing zone, in which increased primary and secondary productivity occur, and such areas elsewhere are known for their endemic mesopelagic organisms.

The Convergence appears to be a somewhat inconstant phenomenon, and it is defined differently by different workers. Deacon (1966:884) recognized it as a region in which the temperature from south to north rises from 10–14°C in winter and from 14–18°C in summer. This temperature change occurs over a relatively short distance, sometimes as little as a mile (examples in Deacon, 1937:56–63). McGinniss (1982:5) preferred to recognize the Convergence as the area within salinities 34.6–34.8 per mil.

In terms of distributions of mesopelagic animals, Gibbs (1968:3–4) recognized a number of stomiid species as having Convergence patterns and suggested that such distributions could define a distinct zoogeographic region encircling the Southern Ocean. McGowan (1971: figs. 1.7, 1.8, 1.30) charted distributions of invertebrate species with transition zone distributions in the South Pacific, the boundaries of which were mainly between 30°–50°S and include the Subtropical Convergence. McGinniss (1982: 69, 74–75) indicated 21 species of lanternfishes (Myctophidae) as being distributed in and near the southern Subtropical Convergence, referring to them as transitional water species. Some of these were distributed circumglobally, but others were more restricted. Krefft (1974:232, fig.14; 1976:446–448) recognized a Convergence pattern within a southern group of Atlantic midwater fishes, and Hulley (1981:283) recognized a Convergence subpattern within a South Temperate pattern for Atlantic Myctophidae. Parin (1984:21, fig.7G) recognized a transitional type of distributional range for macroplanktonic fishes that included the "Zone of Subtropical Convergence" circumglobally.

The problem with defining a Convergence or transitional pattern of distribution, at least among midwater fishes, is that some species appear to be distributed mainly in and south of the Convergence (are they rather subantarctic species?), others mainly within five or 10 degrees of latitude on both sides of the Convergence (true Convergence species?), and still others mainly in and north of the Convergence (are they rather semisubtropical species?). The position of the southern Subtropical Convergence has been placed within a few degrees of 40°S except where southward-flowing western boundary currents extend it southward and eastern boundary currents extend it northward. *Astronesthes boulengeri* has been taken circumglobally mainly between 30° and 40°S, extending north in the eastern Pacific to equatorial waters. *A. spatulifer* has been taken only within a few degrees of 40°S. *A. kreffti* has been taken mainly at or south of 40°S to 52°S, and *A. psychrolutes* mainly between 35° and 45°S but reaching 54°S. While *A. spatulifer* and *psychrolutes* conform fairly well to a convergence pattern, *A. kreffti* might be a subantarctic species, and *A. boulengeri* might be a semisubtropical species.

Our tendency is to refer to distributions that are mainly between 35°–45°S as Convergence (or transitional) distributions, even if some specimens are taken to the north or south of these limits, and for the moment we regard all four *Astronesthes* species mentioned here as Convergence (or transitional) species.

In closing, we would point out that any discussion of the distributions of mesopelagic fishes between about 20°–50°S suffers from insufficient sampling. Most of the samples that produced specimens used in this study, other than collections not far from the coasts of South America, Africa, Australia, and New Zealand, were made by the German research vessel "Walther Herwig" in the Atlantic and the U.S. research vessel "Eltanin" in the Pacific. There are virtually no collections from the southern Indian Ocean. The "Walther Herwig" made transects to 60°S along 40° and 50°W; the rest of the South Atlantic was covered by a transect that was along approximately 40°S (close to the Subtropical Convergence), and by north–south transects north of 40°S on the eastern and western sides of the ocean (maps in Krefft, 1976:441; Hulley, 1981:5). There are no samples from east of about 40°W that provide data on presence or absence of species in subantarctic waters, and no samples from southern subtropical waters except on the east and west sides, within the influence of the Brazil Current and the Benguela flow, respectively. The "Eltanin" focused on Antarctic studies, and most of its sampling in the Pacific sector was conducted south of about 55°S (see Savage and Caldwell, 1965, 1966, 1967). It appears that only one cruise was devoted to sampling between about 35° and 45°S, and this was the one that took most of the specimens of *A. spatulifer*. As in the Atlantic, there has been little midwater trawling in subantarctic and southern subtropical parts of the Pacific sector except on the eastern and western sides. Our concept of a Subtropical Convergence pattern of distribution, therefore, is biased by the fact that most collections are from the vicinity of the Convergence, and few are available from north or south of it.

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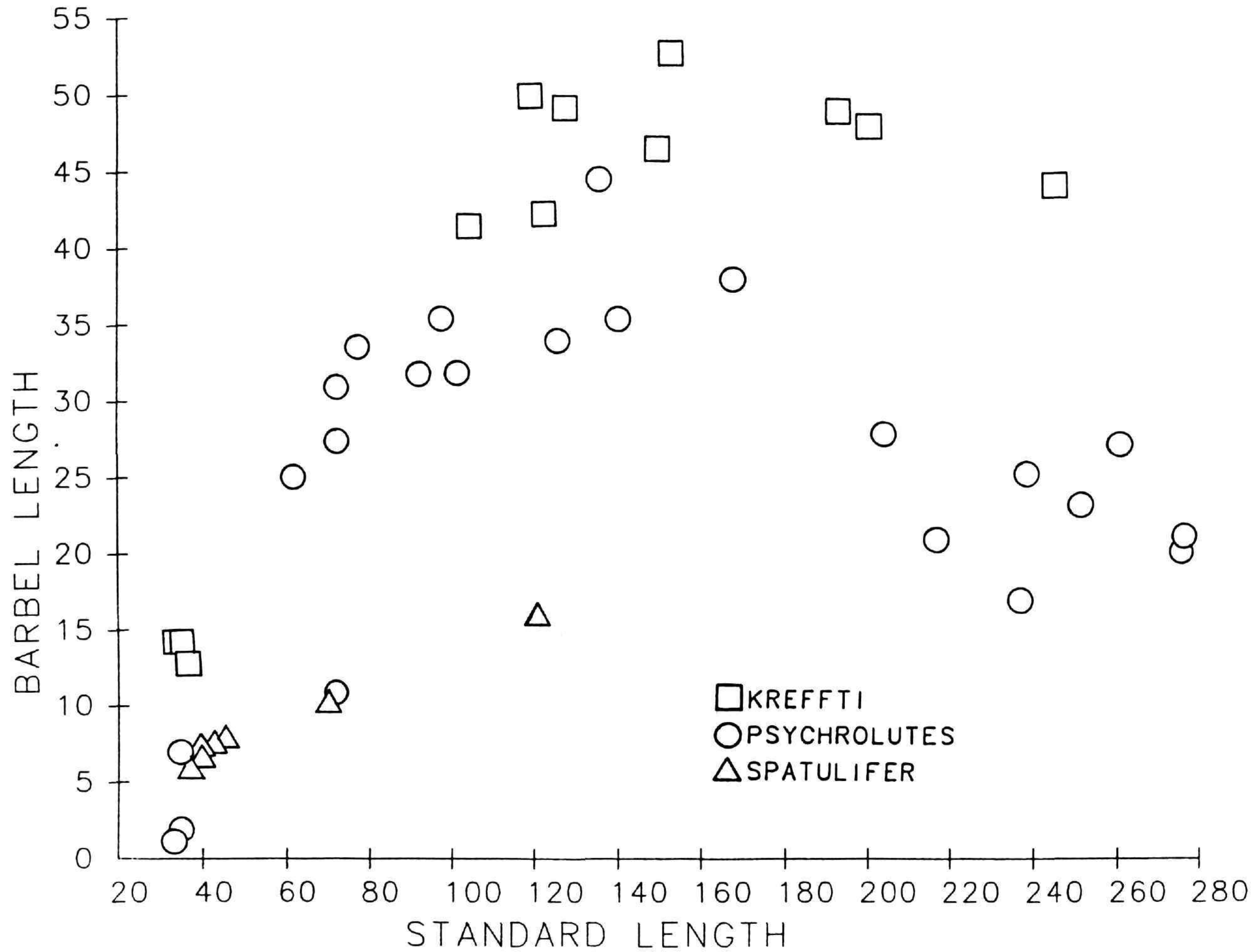

FIGURE 5.—Barbel length (mm) vs. standard length (mm) in three *Astronesthes* species.

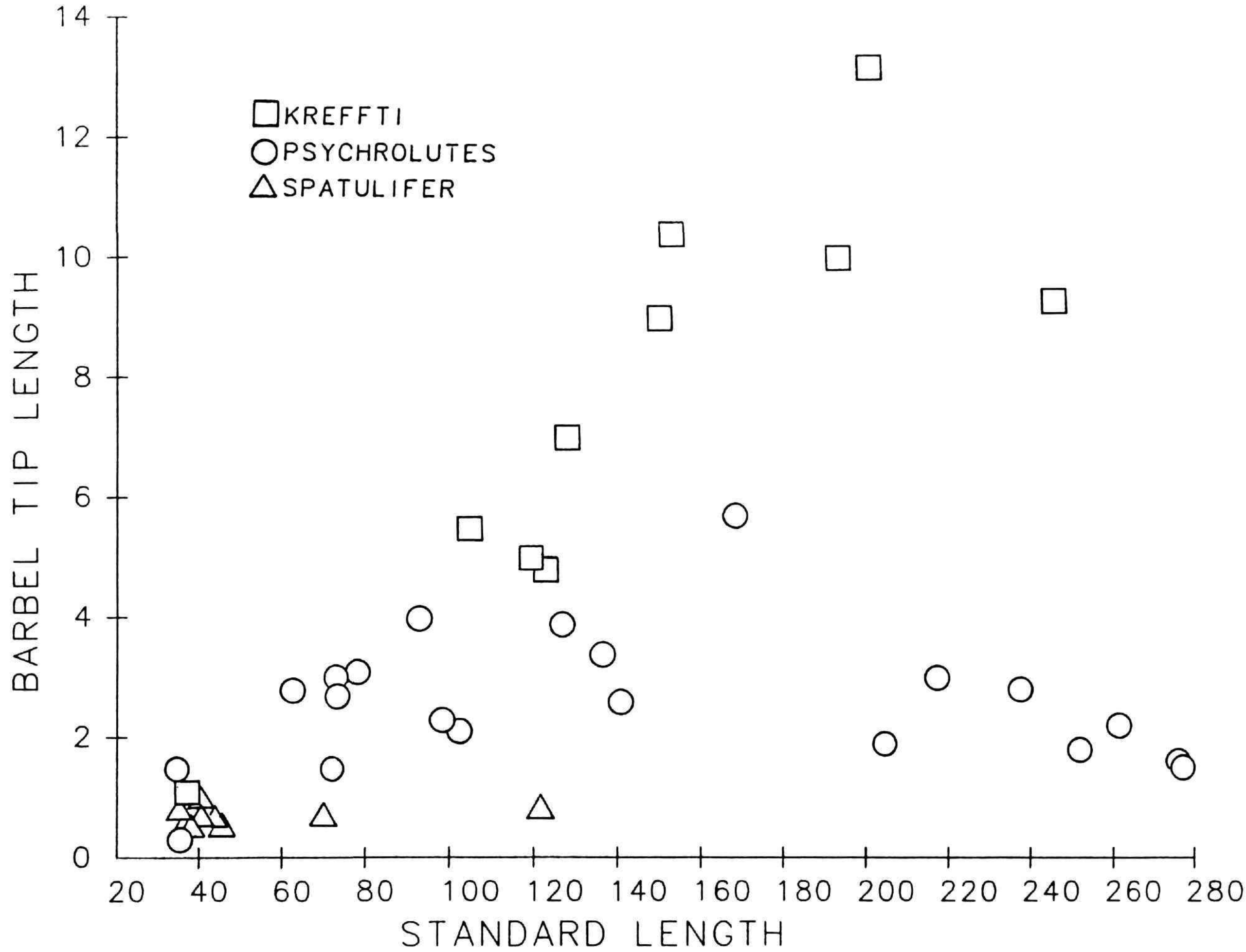

FIGURE 6.—Barbel-tip length (mm) vs. standard length (mm) in three *Astronesthes* species.

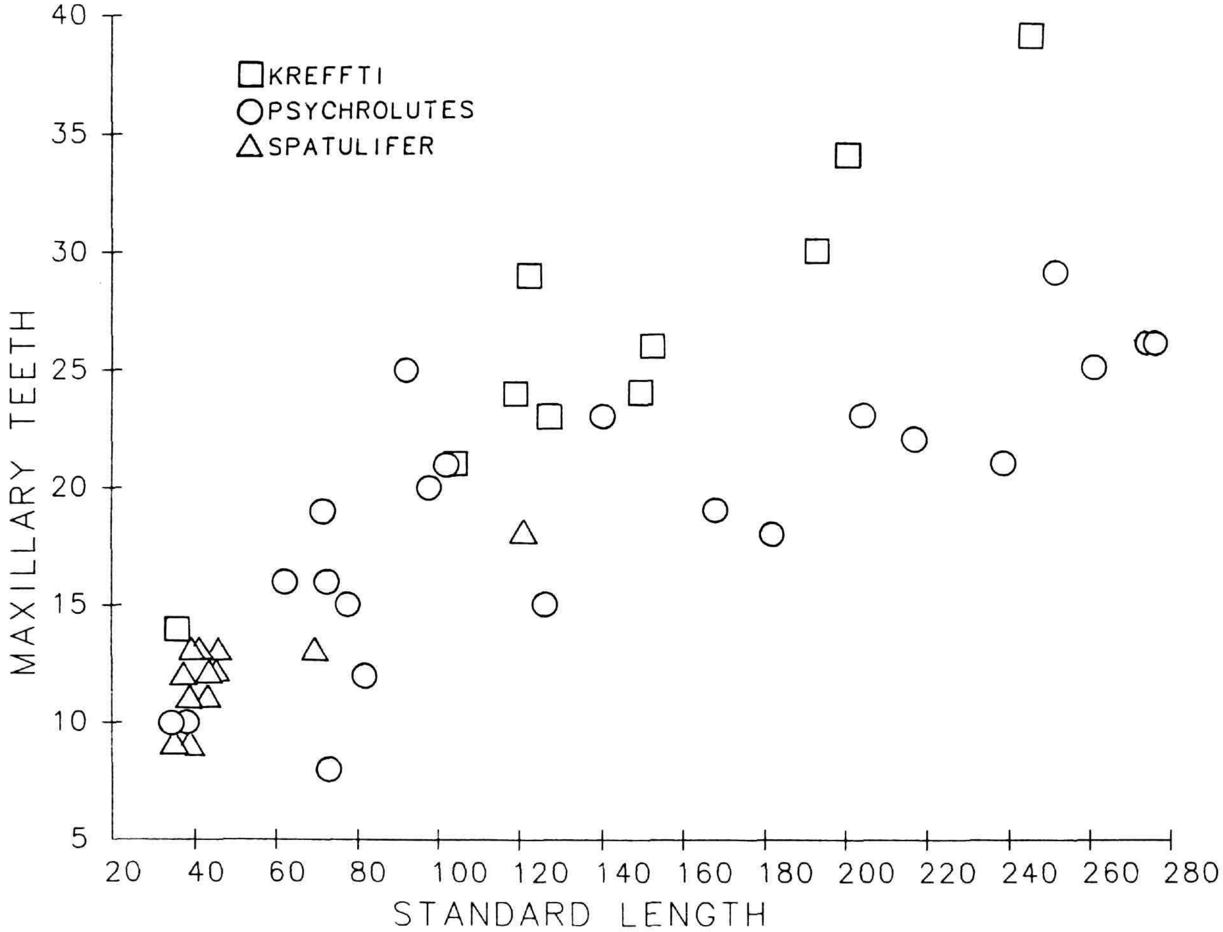

FIGURE 7.—Number of maxillary teeth vs. standard length (mm) in three *Astronesthes* species.

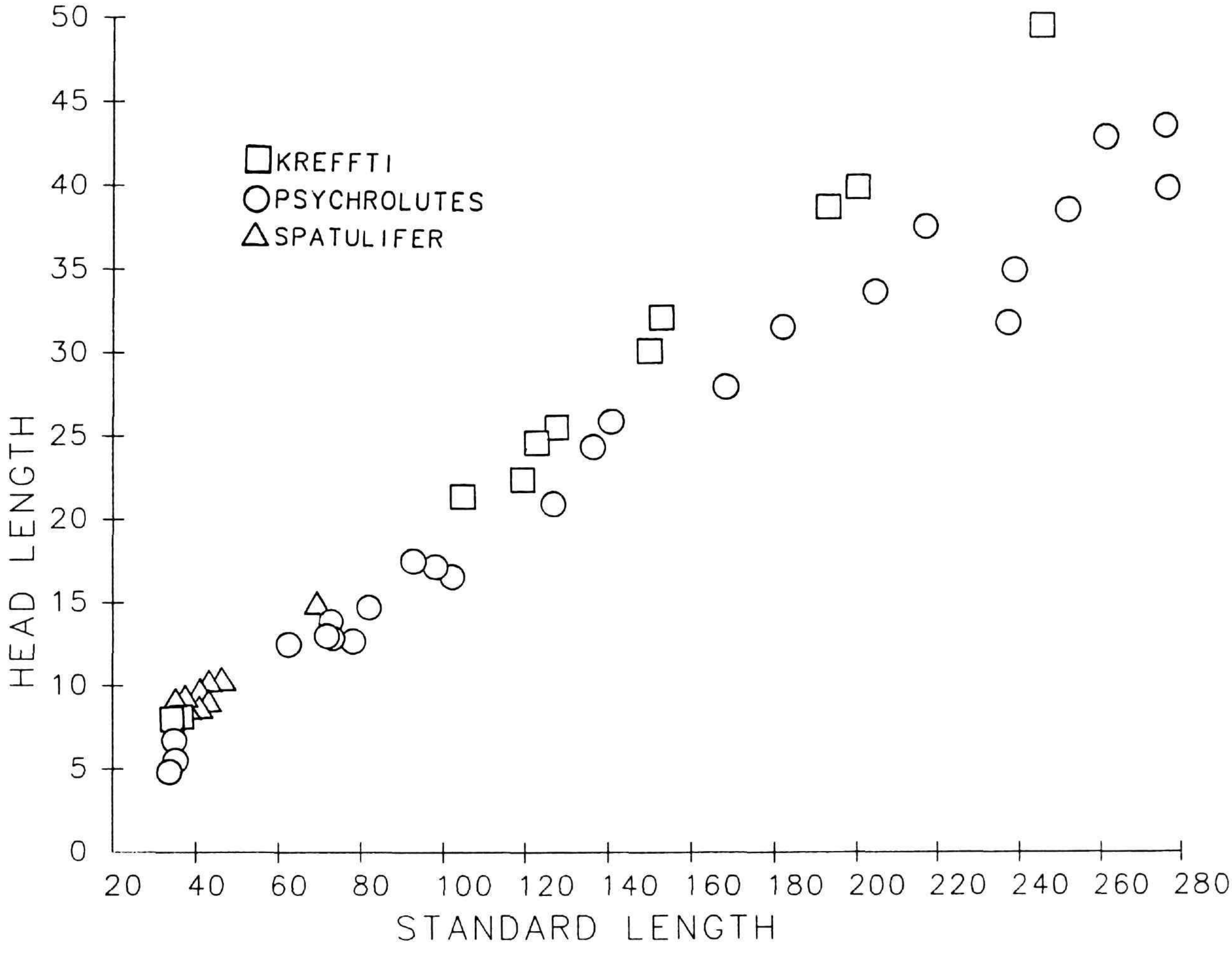

FIGURE 8.—Head length (mm) vs. standard length (mm) in three *Astronesthes* species.

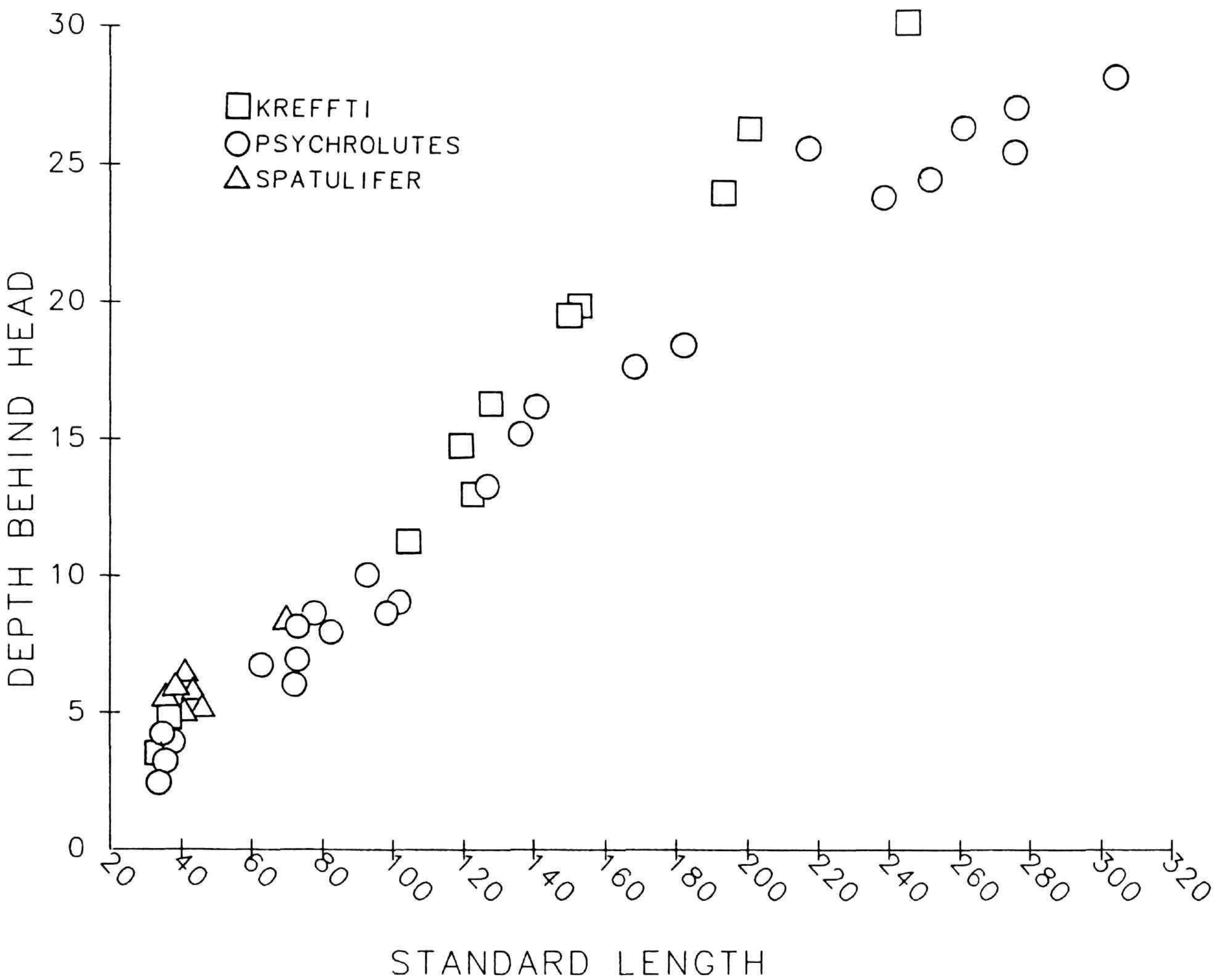

FIGURE 9.—Depth behind head (mm) vs. standard length (mm) in three *Astronesthes* species.

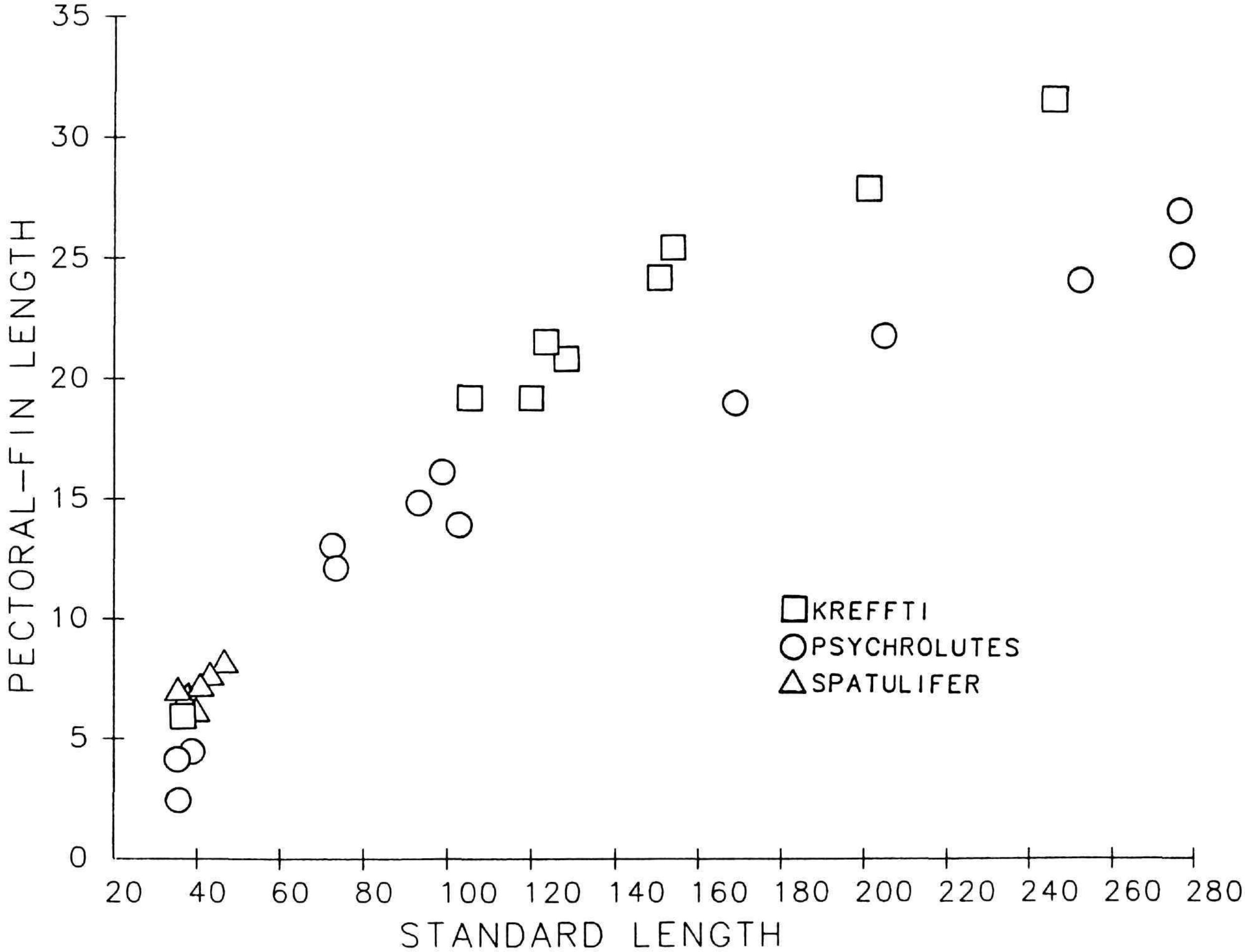

FIGURE 10.—Pectoral-fin length (mm) vs. standard length (mm) in three *Astronesthes* species.

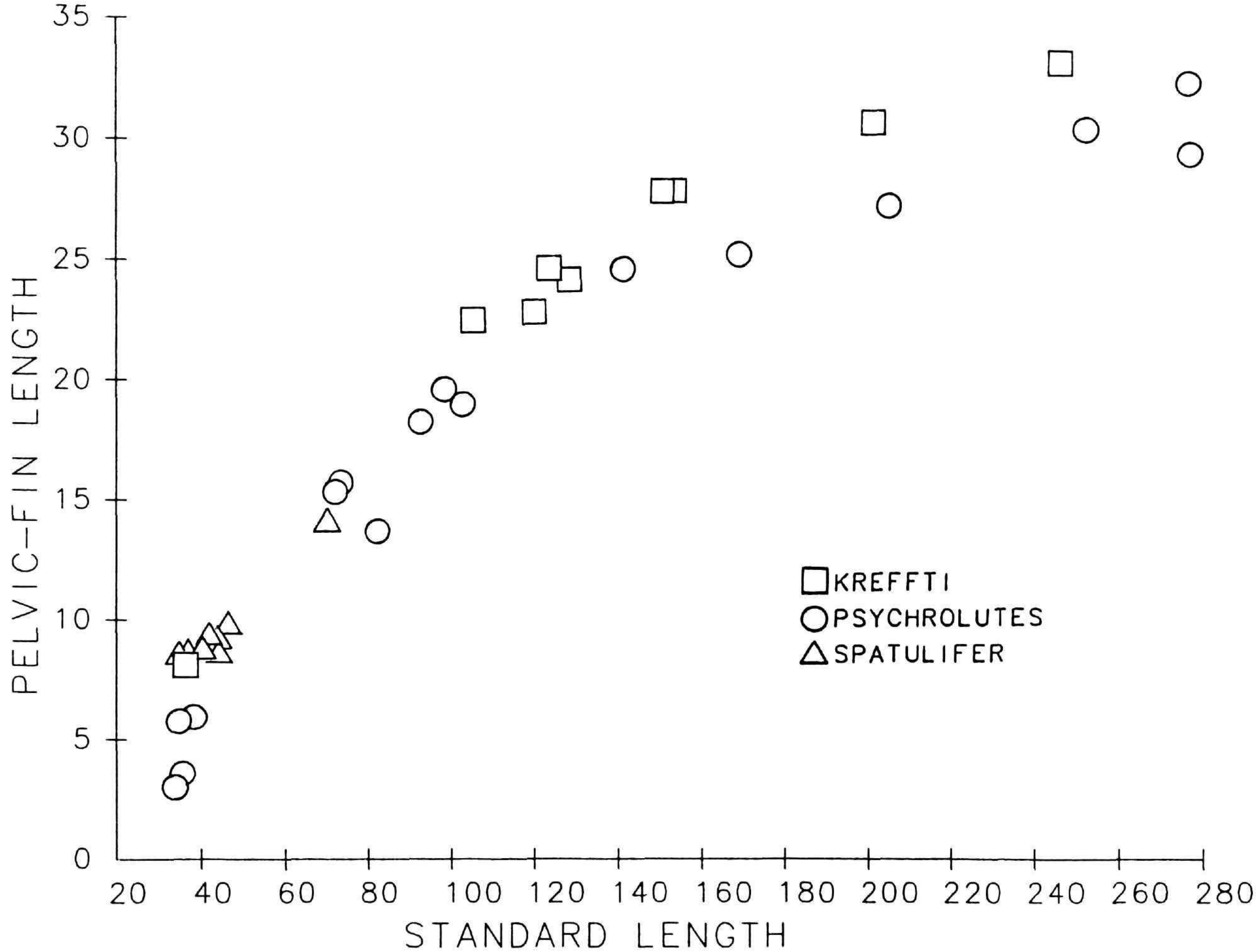

FIGURE 11.—Pelvic-fin length (mm) vs. standard length (mm) in three *Astronesthes* species.

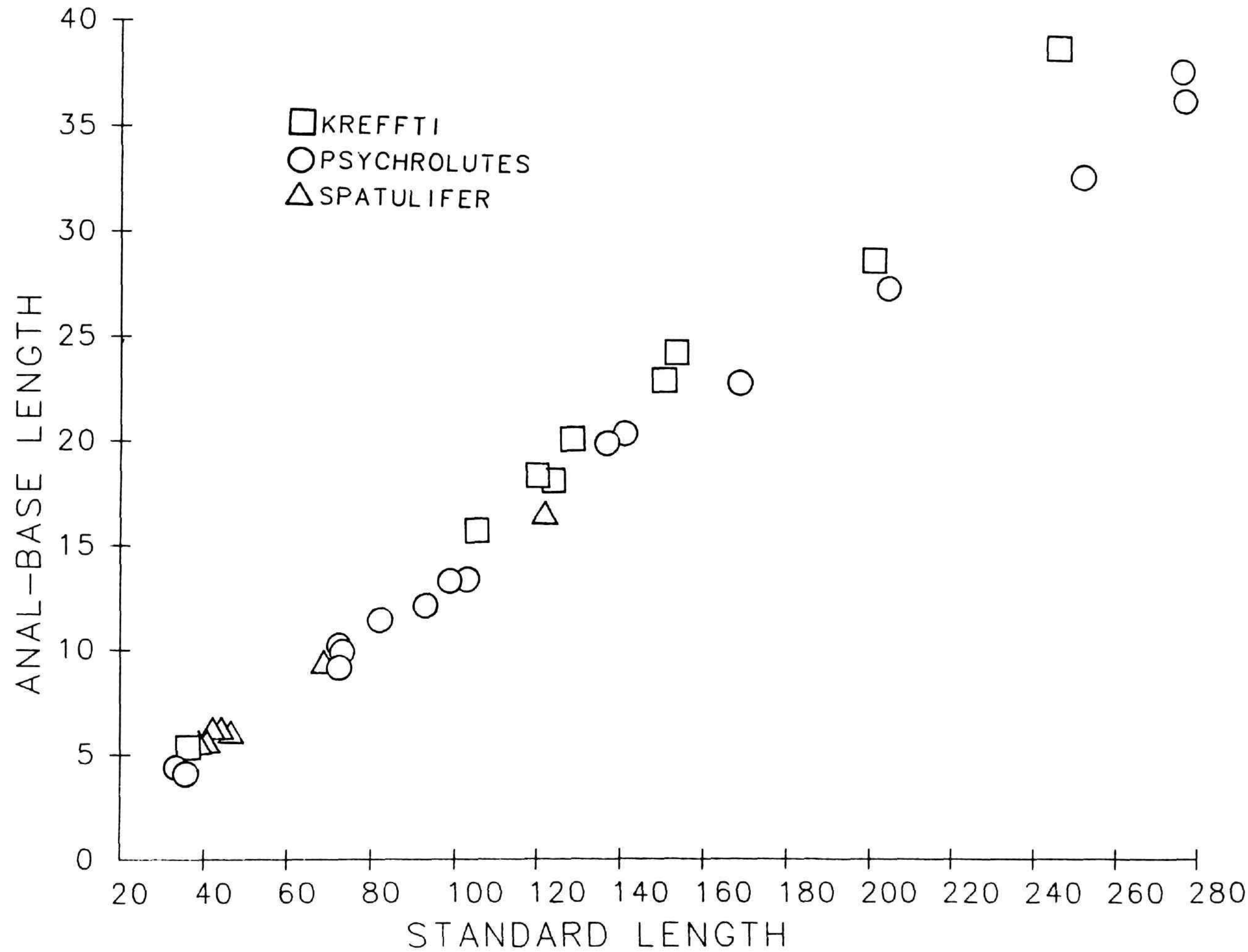

FIGURE 12.—Anal-base length (mm) vs. standard length (mm) in three *Astronesthes* species.

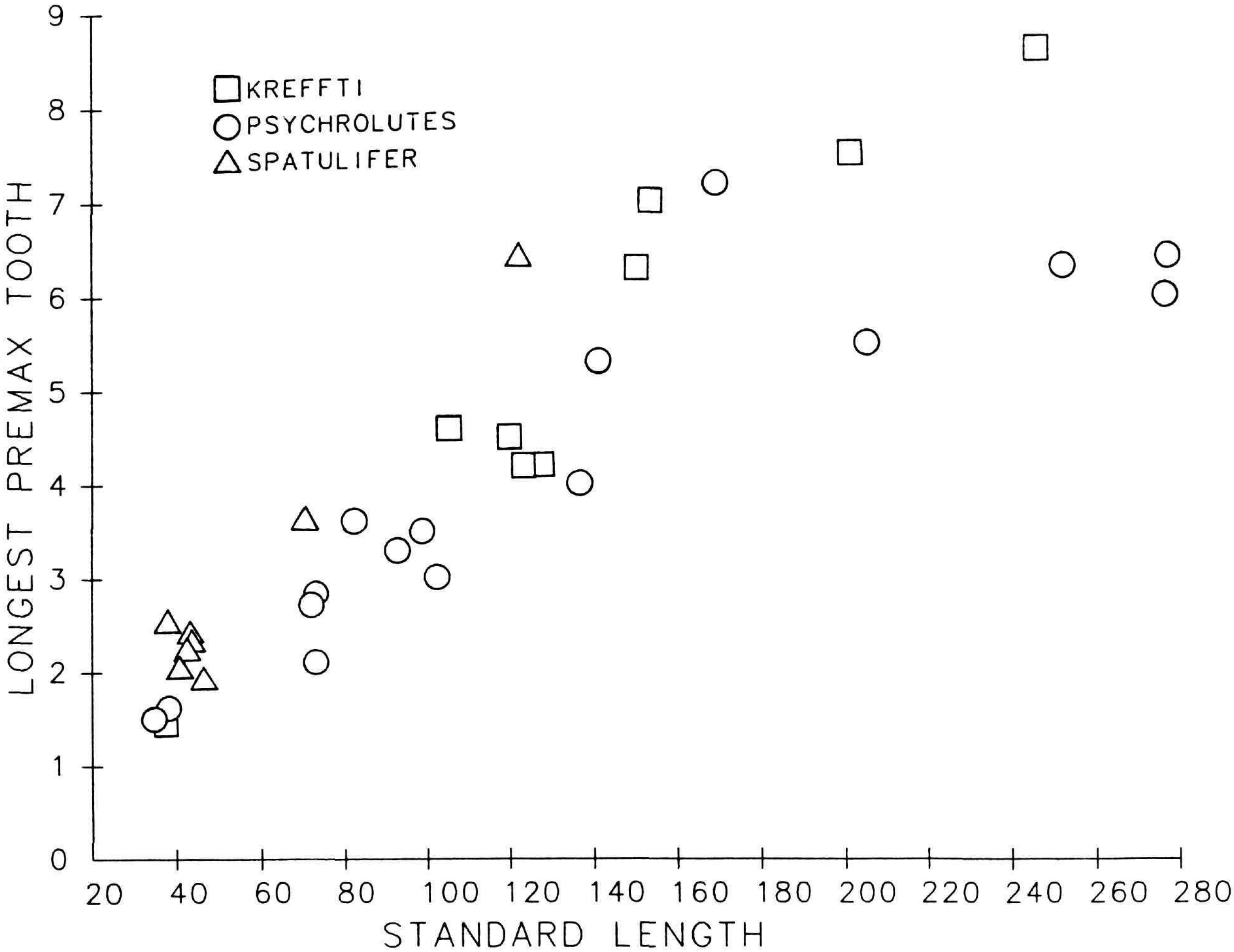

FIGURE 13.—Length of longest premaxillary tooth (mm) vs. standard length (mm) in three *Astronesthes* species.

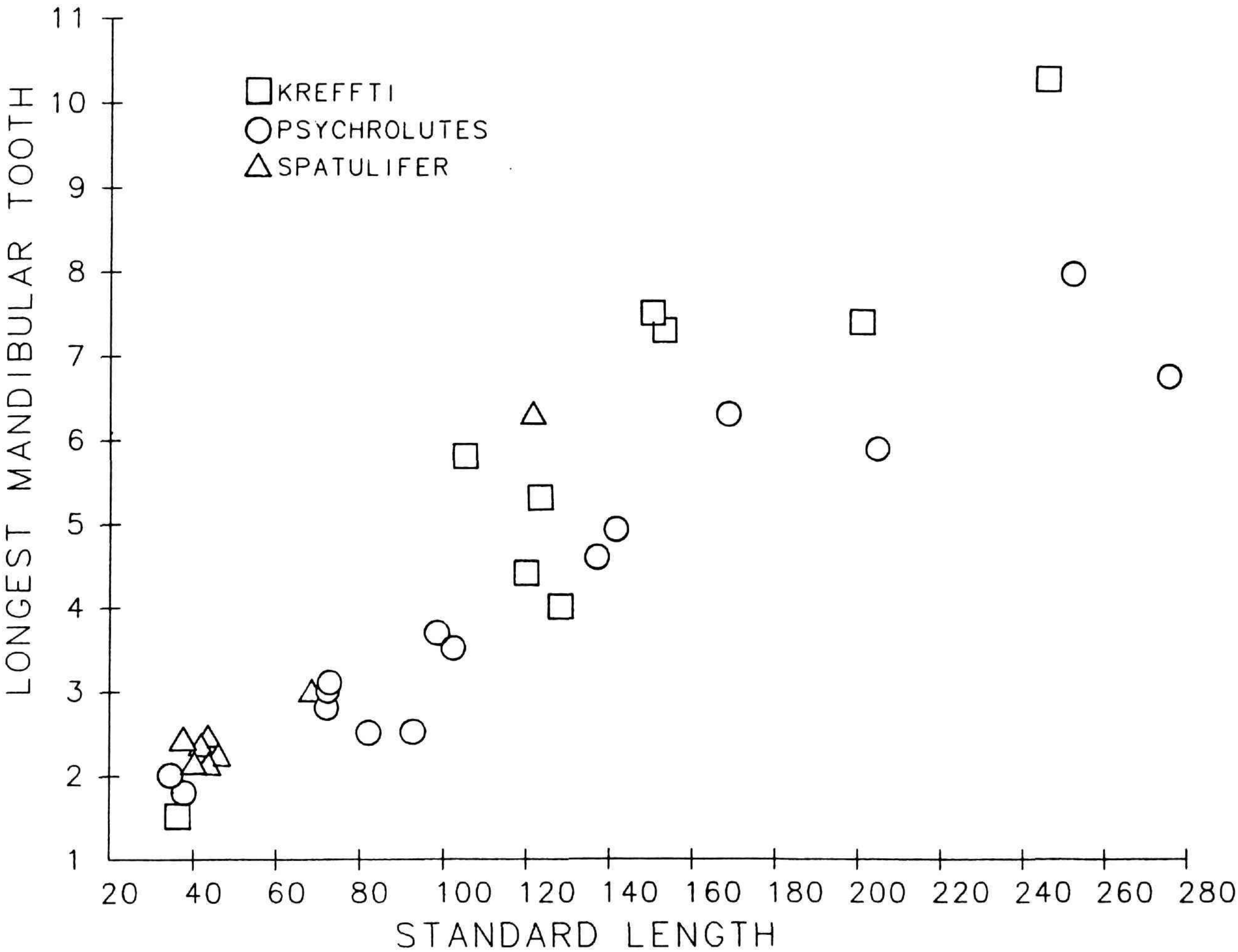

FIGURE 14.—Length of longest mandibular tooth (mm) vs. standard length (mm) in three *Astronesthes* species.

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