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A new species of the hatchetfish genus *Argyripnus* (Stomiiformes: Sternoptychidae) from the Indo-Pacific

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Abstract.—The sternoptychid species *Argyripnus brocki* Struhsaker, originally described from the Hawaiian Islands, has been reported in the literature from various Indo-Pacific localities and to the west off east Africa. We have made univariate and multivariate comparisons, using sheared principal components analysis, of specimens from this broad area and found there to be evidence of two distinct species: *Argyripnus brocki,* endemic to the Hawaiian Islands and vicinity, and *A. pharos* n. sp., occurring in all other investigated areas. These two species are distinguished from the other four in the genus by their relatively low numbers of gill rakers, vertebrae, and certain photophores. *Argyripnus pharos* is distinguished from *A. brocki* by several features but most clearly by its VAV + ACA photophore cluster, which is dorsally inflected in an arch-like form and reaches a higher elevation on the flank.

Fishes of the order Stomiiformes are mainly meso- and bathypelagic fishes, found in all oceans but more diverse at tropical and subtropical latitudes. The relationships and composition of the order have been examined in a series of papers by Weitzman (1974), Ahlstrom et al. (1984), Harold and Weitzman (1996), and Harold (1998). Four families are currently recognized in the order: Gonostomatidae, Photichthyidae (also spelled Phosichthyidae), Stomiidae, and Sternoptychidae. The last comprise the hatchetfishes, to which *Argyripnus* belongs. Unlike the deep-bodied hatchetfish genera, *Argyropelecus, Polyipnus* and *Sternoptyx* (see Baird, 1971, and Harold, 1994), *Argyripnus* species are quite shallow-bodied and overall rather similar to gonostomatids (bristlemouthes). Unlike the many pelagic stomiiforms, *Argyripnus* species are considered to be benthopelagic (Badcock and Merritt 1972), living in association with the benthic community and geographically restricted to the continental slope and other features of positive topographic relief.

Grey (1961, 1964) recognized three *Argyripnus* species: *A. atlanticus* Maul 1952, *A. ephippiatus* Gilbert and Cramer 1897, and *A. iridescens* McCulloch 1926. *Argyripnus brocki* Struhsaker 1973 and *A. electronus* Parin 1992 were added subsequently, bringing the total in the genus to five. Struhsaker (1973) reviewed species occurring in the Indo-Pacific region and described *A. brocki* from off the Hawaiian Islands. Low gill-raker counts and other features in combination were used to distinguish it from the most similar congeneric species, *A. ephippiatus* and *A. iridescens.* Strusaker (1973:835) examined several non-Hawaiian specimens, some of which he tentatively ascribed to *A. brocki,* stating that the geographic range of the species "may extend from Hawaii to the Indian Ocean." We report on additional collections of "low count" *Argyripnus* from the Philippines and other areas of the Pacific and Indian oceans and describe the non-Hawaiian specimens as a new species, *Argyripnus pharos.* In making comparisons with *A. brocki* we rely on standard morphometric and meristic tabular and graphical presentations, as well as a sheared principal components analysis (PCA) (sensu Humphries et al. 1981, Bookstein et al. 1985) of a subset of the morphometric characters.

Materials and Methods

Specimen length is standard length (SL) in mm. Morphometric, meristic, photophore and other characters were determined following the methods and terminology of Weitzman (1986) and Harold (1994). Terminology of the photophores is repeated here for convenience, and to describe and illustrate certain photophore characters not covered by previously published works. The abbreviation for each photophore or photophore series ("cluster," in cases where associated photophores joined in a common organ) and its anatomical location, as defined by Weitzman (1986), and with modifications of the AC series terminology according to Harold (1994), are as follows: ACB (cluster dorsal to central portion of anal fin), ACC (cluster along ventral surface of caudal peduncle), BR (cluster on branchiostegal membranes), IP (cluster on isthmus), OP 1 (single photophore associated with anterior base of preopercle), OP 2 (single photophore near anterodorsal margin of opercle, posterior to center of eye), OP 3 (single very large photophore associated with subopercle), ORB (single photophore anteroventral to eye), OV (dorsal abdominal series/cluster posterior to pectoral fin base), PV (ventral abdominal cluster between bases of pectoral and pelvic fins), and VAV + ACA (combined VAV and ACA clusters of other sternoptychids in a long organ extending from above pelvic-fin base to vertical through about seventh to tenth anal-fin ray; VAV/AC_1 of Badcock and Merrett, 1972:fig.1). Counts of fin rays and numbers of photophores in clusters are the total number of elements in all cases. Elevation of the VAV + ACA photophore cluster is a character developed specifically for this study, determined by taking the distance from the dark pigment border of the dorsalmost VAV + ACA photophore to the base of the immediately ventral anal-fin ray.

A sheared principal components analysis was performed on a subset of morphometric characters for which the greatest number of specimens had values for all characters. Humphries et al. (1981) discussed computational aspects of the procedure. The program "Shear," written by N. MacLeod, was used for the analysis (McLeod 1990); this software was published as part of the Proceedings of the Michigan Morphometrics Workshop (Rohlf & Bookstein 1990).

One of the difficulties with systematic study of deep-sea fishes is their delicate nature and the resultant poor condition of trawl-captured material. Specimens may lack structures, rendering them of little value for analyses such as PCA, in which a complete set of data for each is specimen is desirable. Damaged specimens were adequate for making counts and some measurements included in the description but were excluded from multivariate analysis. A complete truss network was not utilized, but instead selected homologous point-to-point measurements were used that provide critical shape comparisons.

Sources of material for this project are listed as institutional acronyms and associated catalog numbers for *A. pharos* in the account and for other *Argyripnus* species in Appendix I. Institutional abbreviations are as listed in Leviton et al. (1985).

Argyripnus pharos new species
Fig. 1

Argyripnus sp.—Grey, 1961:470–474, tables 1, 2, 3 (USNM 135402, Philippines).—Grey, 1964:207 (off northern Mindinao, Philippines; Key to Species).—Bourret, 1985:57–58 (USNM 135402).

Argyripnus brocki.—Struhsaker, 1973:835 (part, USNM 207984, Indian Ocean).—Parin, 1992:136 (part, northwestern Australia, northwestern Madagascar).—Har-

Fig. 1. *Argyripnus pharos*, holotype, BMNH 1986.9.22.41, 78.9 mm SL.

old, 1999:1901 (part, western Central Pacific). [not *Argyripnus brocki* Struhsaker, 1973]

Holotype.—BMNH 1986.9.22:41, (1, 78.9 mm), Saleh Bay, South Java, approx. 8°30′S, 118°00′E, field no. TGT 1676, coll. T. Gloerfelt-Tarp (no other data available).

Paratypes.—AMS I.24338002 (2, 55.7–79.3 mm), Saleh Bay, South Java, 8°30′S, 117°46′E, 150–280 m, coll. T. Gloerfelt-Tarp, Jul 1981. BMNH 1986.9.22:42–45 (4, 59.4–76.6 mm), collected with holotype.

Non-type material.—AMS I.31174005 (11, 58.6–72.3 mm), Shark Bay, Western Australia, 26°42.3–42.1′S, 112°38.4–38.5′E, (0–) 285 m, coll. J. Paxton, 30 Jan 1991. CSIRO H2169-01 (1, 57.8 mm), E of Fraser Island, Queensland, Australia, 24°44.2–47.7′S, 154°12.5–14.8′E, (0–) 492 m, R/V Soela, Sta. S00685/7, 17 Nov 1985. IOAN uncataloged (2, ~45–51.4 mm), western Indian Ocean, 12°31′S, 48°17′E, (0–) 380 m, R/V Vityaz, Cr. 17, Sta. 2603, 12 Nov 1988. MNHN 1979–98 (1, 67.9 mm), Philippines, 13°49′N, 120°04′E, (0–) 200 m, R/V MUSORSTOM I, Sta. 51CP4, Mar 1976. MNHN 1979–99 (1, 62.4 mm), Philippines, 14°00′N, 120°16′E, (0–) 195 m, R/V MUSORSTOM I, Sta. 64CP4, Mar 1976. USNM 135402 (1, 78.4 mm), N of Mindinao, Philippines, 8°48.5′N, 123°35.5E, (0–) 366 m, R/V Albatross, Sta. D5542, 20 Aug 1909. USNM 207984 (1, 47.8 mm), Indian Ocean, 06°51′S, 39°54′E, (0–) 100 m, R/V Anton Bruun, Cr. 9, Sta. 422, 19 Nov 1964. YPM 10015 (12, 52.3–80.8 mm), Albay Gulf, Philippines, 13°10′N, 124°00′E, 22 Sep 1995.

Diagnosis.—Characters that in combination serve to distinguish *Argyripnus pharos:* gill rakers 15–16, usually 16, with typically 12 on the ventral limb; VAV + ACA photophores 13–18; total number of vertebrae 42–44, usually 42 or 43; dorsal-fin rays 9–12; VAV + ACA photophore elevation 3.7–6.4% SL. No uniquely derived characters known.

Description.—Moderate-sized species, maximum observed adult body length 80.8 mm SL (Table 1; Philippines, YPM 10015) with shallow body profile, body depth 24.7–31.9% SL. Head large (up to 35.1% SL), lateral profile forming a slightly rounded angle of about 90 degrees, with its apex at dentary symphysis. Mouth large, oblique. Scales deciduous, none remaining in any specimens examined; based upon observations of scale pockets, scales quite large and dorsoventrally elongate. Adipose fin present. Maximum body depth located at vertical through occiput, body nearly as deep at dorsal-fin origin. Dorsal-fin origin approximately at vertical through base of most lateral pelvic-fin ray, and located at about mid-body (predorsal length 47.0–55.2% SL, prepelvic length 44.1–53.5% SL). Body profile gently tapered posterior to dorsal-fin origin to shallowest point at about middle of caudal peduncle; caudal peduncle slightly flared posteriorly.

Orbit circular to slightly dorsoventrally elongate, and large, up to 47.1% of head

Table 1.—Morphometric characters expressed as percentages of head length (orbit diameter and snout length) or standard length (all others) and meristic character values for *Argyripnus pharos* holotype (BMNH 1986.9.22: 41), and other material, and *Argyripnus brocki* holotype (USNM 207653), and other material combined.

	Argyripnus pharos				*Argyripnus brocki*			
	Holotype	Other	Mean	N	Holotype	Other	Mean	N
Standard length	78.9	47.8–80.8	65.8	35	81.5	48.8–89.0	69.6	80
Orbit diameter	37.7	37.7–47.1	41.1	33	39.8	38.6–46.8	42.2	64
Snout length	21.0	21.6–26.0	23.7	32	21.9	21.1–29.0	24.2	65
Head length	32.6	29.0–35.1	32.1	33	30.8	27.9–33.8	30.8	68
Body depth	27.6	24.7–31.9	28.9	35	27.7	25.3-31.6	28.3	73
Caudal peduncle length	16.2	12.8–18.1	14.2	34	13.0	12.2–17.4	14.7	67
Caudal peduncle depth	8.3	8.1–11.3	9.4	34	8.2	7.7–11.6	9.2	72
Dorsal fin length	13.1	12.1–18.3	14.1	35	13.5	12.0–17.1	14.3	71
Anal fin length	25.3	23.7–35.1	29.3	26	27.6	25.1–33.3	28.4	65
Preanal length	61.3	52.2–62.4	58.2	31	57.5	53.6–62.8	58.4	65
Predorsal length	48.9	47.0–55.2	49.4	32	49.4	44.4–52.4	48.7	65
Prepelvic length	51.0	44.1–53.5	48.2	30	49.5	45.2–54.6	49.4	58
Postdorsal length	54.5	52.8–62.5	55.5	33	53.7	52.0–60.0	56.3	60
Postanal length	42.9	39.1–47.6	43.5	33	40.4	41.0–47.8	43.9	63
Dorsal-pelvic length	28.2	24.4–30.6	28.4	33	27.4	24.3–34.6	28.3	66
OP 3 height	3.0	1.8–3.9	2.8	32	4.3	2.9–6.0	4.7	53
VAV + ACA elevation	5.6	3.7–6.4	5.2	34	3.6	2.8–4.9	3.8	56
VAV + ACA − ACB length	3.7	1.8–8.0	4.3	34	4.4	2.9–7.4	5.0	56
ACB − ACC length	6.1	6.4–11.2	8.8	34	9.0	7.8–14.3	10.0	67
ACC length	9.6	4.7–8.7	7.0	33	10.1	8.6–12.7	10.6	64
Dorsal-fin rays	11	9–12	10.9	35	11	10–13	11.1	75
Anal-fin rays	21	20–24	22.1	32	21	18–24	21.2	75
Pectoral-fin rays	15	14–17	15.6	33	16	14–16	14.9	77
Pelvic-fin rays	7	6–7	6.9	32	7	6–7	6.9	66
Dorsal gill rakers	4	3–4	4.0	29	4	3–4	3.9	14
Ventral gill rakers	12	11–12	11.7	29	12	12–13	12.1	14
Total gill rakers	16	15–16	15.7	29	16	15–17	16.0	14
Total vertebrae	42	42–44	42.8	21	41	41–43	41.9	40
VAV + ACA photophores	15	13–18	15.3	34	15	13–18	15.4	54
ACB photophores	5	5	5.0	35	5	5	5.0	76
ACC photophores	11	9–12	10.2	32	10	8–12	10.1	66

length. No spines or serrae present in association with elements of the head skeleton or elsewhere. Premaxillary teeth uniserial, differing in size and shape, ranging from, medially, three widely spaced conical to recurved large teeth (about 1 mm in length in 78.9 mm SL holotype) interspersed with much shorter teeth; laterally, a short comb-like patch of minute teeth (each about one tenth the length of the largest premaxillary teeth) along extremity of alveolar process. Maxillary teeth uniserial, subequal, conical to recurved, up to about one half the length of the largest premaxillary teeth, variable in number: 17 in series in 59.4 mm SL paratype, and 29 in 78.9 mm SL holotype. Dentary teeth biserial, inner row comprising numerous (more than 20) minute, recurved teeth increasing in length toward the jaw angle, outer row three or four widely-spaced larged recurved teeth similar in size and shape to largest teeth of premaxilla. One or two large, recurved vomerine teeth located laterally on extremity of each anterior wing-like process; no teeth present on posterior shaft. Four or five minute, conical palatine teeth in a longitudinal row. Mesopterygoid teeth absent. Pseudobranch present and well-developed.

Photophore counts as for genus (Ahlstrom et al. 1984), except VAV + ACA and ACC: AC group combined with VAV, from anterior to posterior, VAV + ACA (13–18), forming a distinctive arch in central portion of cluster directly dorsal to third or fourth anal-fin ray. ACB (5). ACC (9–12), beginning adjacent to second or third last anal-fin ray and continuing posteriorly to near anteriormost ventral procurrent caudal-fin ray. BR (6). IP (6). OP 3. ORB 1. OV (6) + 1. PV (10).

Color in preservative.—Dark brown chromatophores on head in association with iris, photophores (BR, IP, OP, and ORB), posterior portion of cranium, areas immediately dorsal, ventral, and posterior to orbit including dorsal portion of opercle, symphysial portions of premaxilla and dentary, anterior margin of medial one half of maxilla, and entire medial one half of posterior supramaxilla. Reflective guanine pigment associated with photophores, iris, and most of gill cover. Dorsal portion of body above lateral septum pigmented with dark brown chromatophores, with greatest concentration between pectoral girdle and dorsal-fin origin, in a patch on caudal peduncle, delineating myosepta, and forming predorsal stripe between occiput and dorsal-fin origin. Other areas of concentration include patches of dark pigment at bases of dorsal- and procurrent-caudal rays, and covering main body of all photophores. Reflective guanine pigment on body on lateral surface of pectoral-fin base associated with posterior IP photophore reflector; guanine pigment also associated with other photophores, especially ventrolateral area of the abdomen lining OV and PV organs and region of body wall between these clusters. Fin rays largely unpigmented. Pectoral fins with lines of small dark brown chromatophores along basal portions of fin rays and widely separated spots of dark pigment distally. Longest three or four rays of both lobes of caudal fin darkly pigmented along approximately one quarter to one third of their lengths.

Etymology.—The specific name *pharos* is based on the feminine Greek noun pharos, meaning lighthouse or beacon, with reference to the dorsally displaced elements of the VAV + ACA photophore cluster.

Distribution.—West Pacific, from Philippines southward through Indonesian Archipelago and Coral Sea, and western Indian Ocean off Africa.

Ecology.—In almost all cases *Argyripnus* species, including *A. pharos,* have been captured at mesopelagic depths (100–492 maximum depth of capture for *A. pharos*) but near the sea floor. Captures have most typically been made by bottom trawl, although Badcock and Merrett (1972) reported collections of *A. atlanticus* made by a rectangular midwater trawl (RMT8/5) when it was towed near (within 40 m) or on the bottom. The specimens caught were juveniles and subadults (26.0–53.0 mm SL), suggesting the existence of a population of *A. atlanticus* near the sea floor. Available collection data for *A. pharos* indicate that this species likely occurs typically in this near-bottom, benthopelagic habitat. Certain other sternoptychids, such as *Sonoda* and *Polyipnus,* are also reported to have such affinity with the sea floor.

Remarks.—A multivariate statistical approach, sheared principal components analysis, was used to quantify aspects of shape variation in the complex of forms here recognized as *A. brocki* and the new species *A. pharos.* Characters used in the analysis are listed in Table 2. The principal components analysis extracted three components, with their eigenvalue and total variance, respectively, as follows: PC 1 (0.049, 62.262), PC 2 (0.020, 23.604), and PC 3 (0.005, 5.964). The cumulative percent of variance accounted for by these principal components is 91.831. The size vector, PC 1, is not important in addressing the issue of interspecific discrimination in this problem. Variable loadings for PC 1 and two sheared principal components (PC 2 and PC 3), the shape components, for each specimen are reported in Table 2, with the five most important variables in terms of variance explained indicated. Analyzed speci-

Table 2.—Sheared principal component loadings for eighteen morphometric characters from analysis of *Argyripnus pharos* and *A. brocki,* 27 and 39 specimens, respectively. Five highest loadings for each principal component followed by *.

Character	PC 1 (size)	PC 2 (sheared)	PC 3 (sheared)
1 Standard length	0.251959	−0.026222	0.064297
2 Head length	0.240692	0.015219	−0.027908
3 Orbit diameter	0.233235	−0.045382	0.010296
4 Snout length	0.255381*	−0.008259	0.010706
5 Caudal-peduncle length	0.223821	0.017732	0.216135*
6 Caudal-peduncle depth	0.205857	−0.097824	−0.035673
7 Dorsal-fin length	0.253762	−0.112102*	0.033499
8 Anal-fin length	0.191146	−0.129438*	−0.051035
9 Preanal length	0.293429*	−0.020121	0.062156
10 Predorsal length	0.262491*	0.009478	0.054128
11 Prepelvic length	0.293861*	−0.000413	0.084425
12 Postdorsal length	0.232723	−0.058346	0.078760
13 Postanal length	0.215870	−0.088821	0.027782
14 Dorsal-fin origin to pelvic-fin origin	0.260888*	−0.000512	0.083734
15 ACC photophore cluster length	0.242147	0.064465	0.219743*
16 Posterior ACB to anterior ACC photophore	0.183837	−0.331822*	0.267798*
17 Posterior VAV + ACA to anterior ACB photophore	0.112730	−0.782794*	−0.509556*
18 VAV + ACA photophore cluster elevation	0.224150	0.445263*	−0.740109*

mens are plotted with respect to sheared PC 2 and PC 3 scores in Fig. 2. The character VAV + ACA photophore elevation was found to be an important discriminating feature in PC space and is therefore plotted separately as a bivariate with standard length (Fig. 3).

Argyripnus pharos shares with the other five species in the genus a united series of VAV + ACA photophores (18–32 photophores overall for the genus), dorsal fin with 10 to 14 rays and originating near or anterior of vertical through anal-fin origin (Weitzman 1974, 1986). The six species are separated into two main groups of morphologically similar species (see key to species, Grey 1964:207): (1) those with the dorsal fin originating nearly directly above the origin of the anal fin and with numerous (28–32) VAV + ACA photophores (*A. atlanticus* and *A. electronus*), and (2) those with the dorsal fin originating well anterior of a vertical through the anal-fin origin, and fewer (13–21) VAV + ACA photophores (*A. brocki, A. ephippiatus, A. iridescens,* and *A. pharos*). The new species, *A. pharos,* and *A. brocki* are clearly most similar, based upon the presence of relatively few gill rakers (15–17, usually 16, as compared with 18–22 overall in *A. ephippiatus* and *A. iridescens*), fewer VAV + ACA photophores (13–18, as compared with 19–21), and low vertebral counts (41–44 total vertebrae, as compared with 44–53). Meristic features that, in part, distinguish *A. pharos* from *A. brocki* include the presence of slightly more vertebrae (42–44 in *A. pharos,* as compared with 41–43 in *A. brocki*), and fewer dorsal-fin rays (9–12, as compared with 10–13, respectively). In terms of morphometric features, *A. pharos* compared with *A. brocki* has more highly elevated VAV + ACA photophores (elevation 3.7–6.4% SL, as compared with 2.8–5.9, respectively, a larger head (head length 29.0–35.1% SL, as compared with 27.9–33.8), and the dorsal-fin origin located slightly posteriorly (predorsal length 47.0–55.2% SL, as compared with 44.4–52.4).

Grey (1961) reported on an *Argyripnus* specimen (USNM 135402) from off Mindinao, Philippines, that she was unable to place to species level, and consequently referred to *Argyripnus* sp. The specimen, with

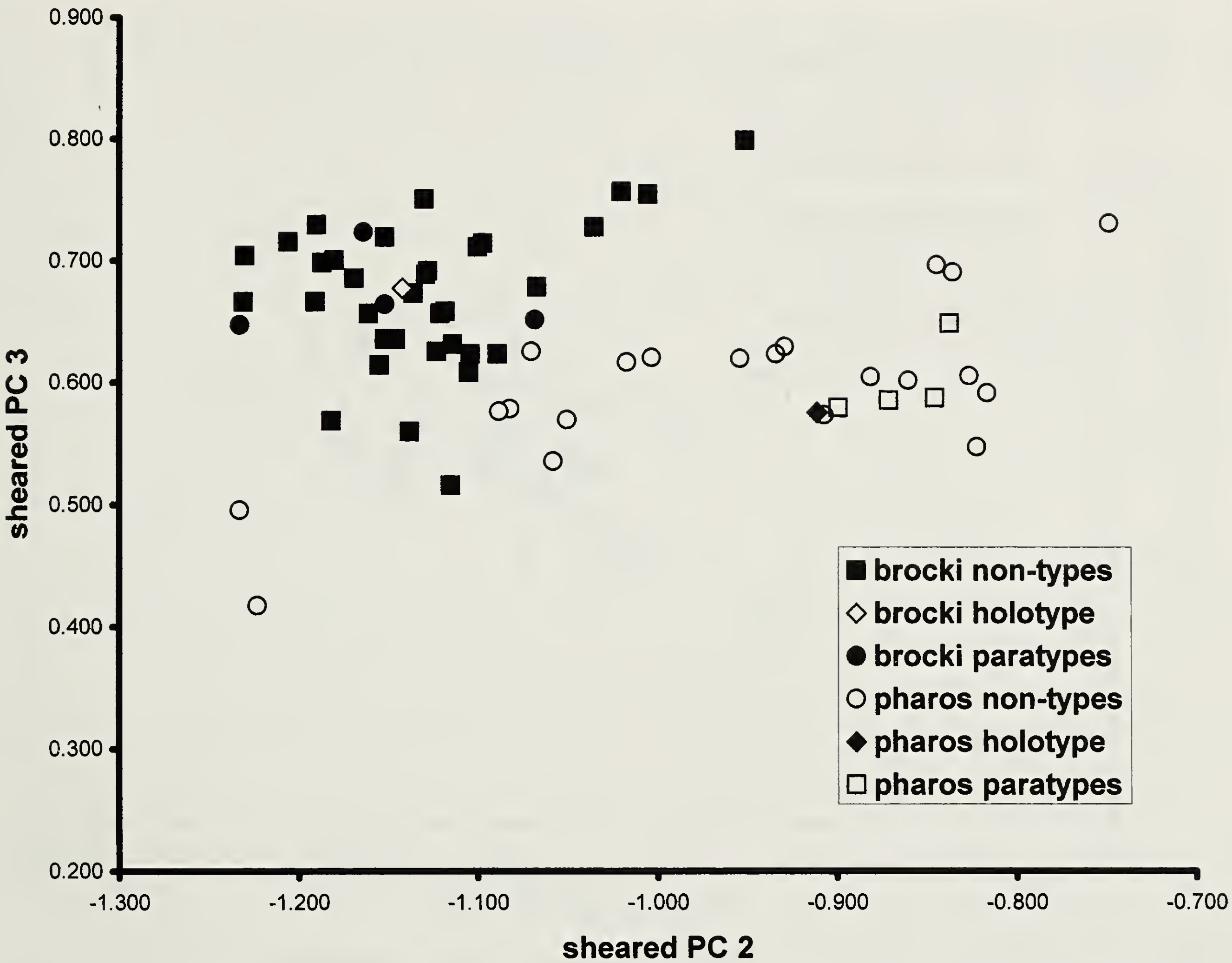

Fig. 2. Plot of principal component scores for *Argyripnus pharos* and *A. brocki* with respect to the first two sheared (shape) principal components, PC 2 and PC 3. The size axis, PC 1, is not illustrated.

that same designation, was later incorporated into a Key to Species (Grey 1964); lack of additional material apparently prevented Grey from describing what was evidently a representative of an undescribed *Argyripnus* species. Neither was Struhsaker (1973) able to assign USNM 135402 to a species, although the single specimen was reported to be very similar to his new species, *A. brocki,* from the Hawaiian Islands. He did, however, assign another geographically removed specimen (USNM 207984, western Indian Ocean) to *A. brocki.* These specimens were examined and placed herein well within the ranges of variation of *A. pharos.* Other Indian Ocean material examined, from off the east coast of Africa (IOAN uncataloged, 12°31S, 48°17E) is assigned to *A. pharos.*

In conclusion, *A. brocki* is an endemic of the Hawaiian Islands vicinity. The similar, and likely phylogenetically related species, *A. pharos,* occurs in the Indo-Australian region, from the Coral Sea northwards to the Philippines, and in the western Indian Ocean off Africa. There are, however, no records of *A. pharos* from the central Indian Ocean. This situation could be due to a paucity of slope habitat at appropriate latitude and, concomitantly, collections of benthopelagic fishes in the region, although it is possible the species has disjunct western and eastern populations.

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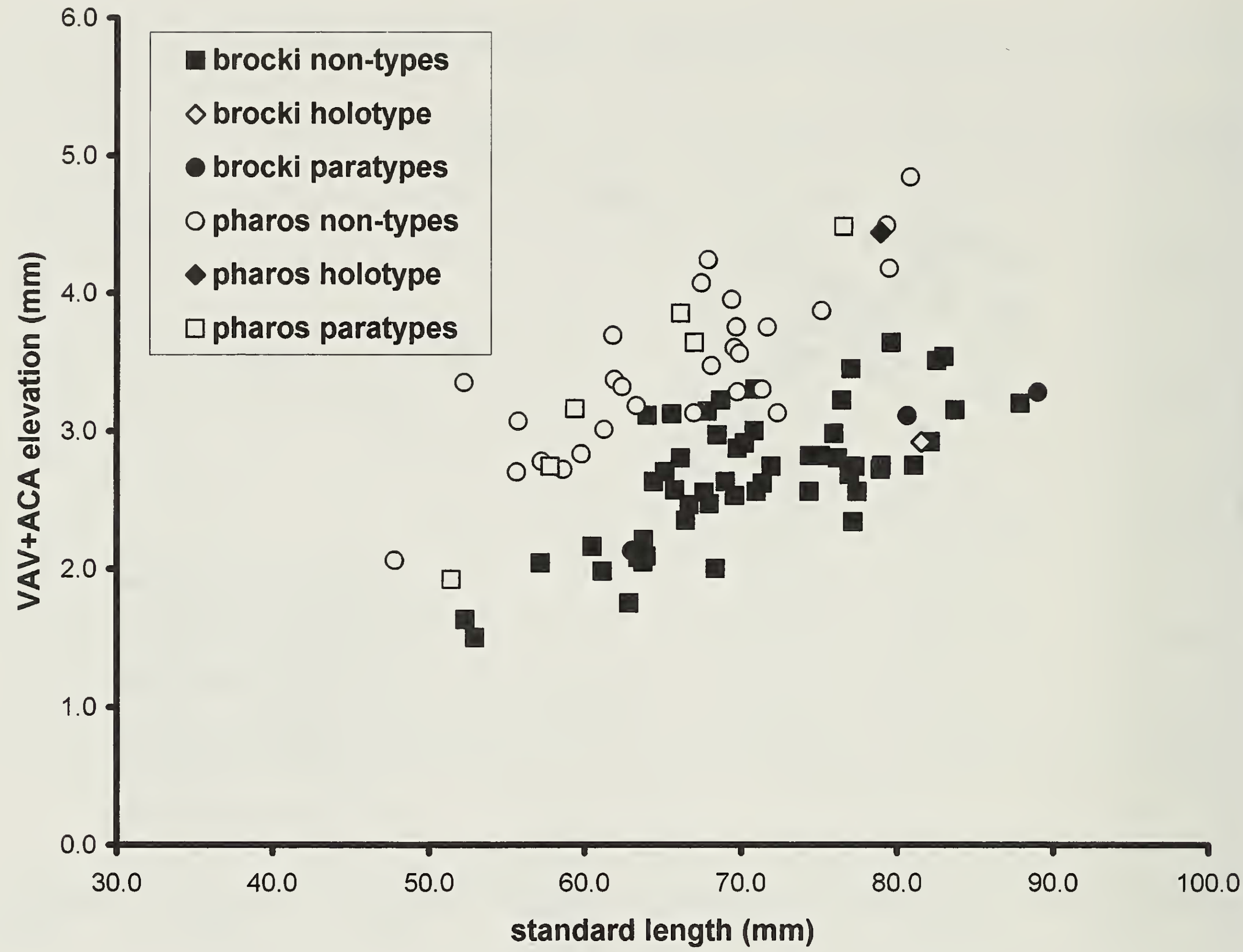

Fig. 3. Bivariate plot of VAV + ACA photophore elevation (mm) versus standard length (mm) for *Argyripnus pharos* and *A. brocki.*

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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.

Badcock, J. R., & N. R. Merrett. 1972. On *Argyripnus atlanticus*, Maul 1952 (Pisces, Stomiatoidei), with a description of post-larval forms.—Journal of Fish Biology 4:277–287.

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

Bookstein, F. L., B. Chernoff, R. L. Elder, J. M. Humphries, Jr., G. R. Smith, & R. E. Strauss. 1985. Morphometrics in evolutionary biology. Academy of Natural Sciences of Philadelphia, Special Publication 15, 277 pp.

Bourret, P. 1985. Poissons téléostéen: Gonostomatidae, Sternoptychidae, et Myctophidae (MUSORSTOM II). Muséum National d' Histoire Naturelle, Mémoirs, Séries A, Zoologie 133:55–82.

Gilbert, C. H., & F. Cramer. 1897. Report on the fishes dredged in deep water near the Hawaiian Islands, with descriptions and figures of twenty-three new species. Proceedings of the United States National Museum 19 (1114):403–435, (pls. 36–48).

Grey, M. 1961. Fishes killed by the 1950 eruption of Mauna Loa, Part V Gonostomatidae.—Pacific Science 15:462–476.

———. 1964. Family Gonostomatidae. Pages 78–240 *in* H. B. Bigelow, ed., Fishes of the western North Atlantic.—Memoir Sears Foundation for Marine Research Number 1 (Part 4), 599 pp.

Harold, A. S. 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. Phylogenetic relationships of the Gonostomatidae (Teleostei: Stomiiformes).—Bulletin of Marine Science 62:715–741.

———. 1999. Sternoptychidae. Pp. 1900–1902 *in* K. Carpenter & V. H. Niem (eds.), Western central Pacific identification guide for fishery purposes. FAO Species Identification and Data Programme, Volume 3, 2067 pp. (pls. 1–4).

———, & 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.

Humphries, J. M., Jr., F. L. Bookstein, B. Chernoff, G. R. Smith, R. L. Elder, & S. G. Poss. 1981. Multivariate discrimination by shape in relation to size.—Systematic Zoology 30:291–308.

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.

McLeod, N. 1990. SHEAR. Computer software published with F. J. Rohlf & F. L. Bookstein, eds., Proceedings of the Michigan Morphometrics Workshop. University of Michigan Museum of Zoology, Special Publication Number 2, 380 pp.

Maul, G. E. 1952. Additions to previously revised families.—Boletim do Museu Municipal do Funchal Number 6 (Article 16):51–62.

McCulloch, A. R. 1926. Report on some fishes obtained by the F. I. S. "Endeavour" on the coasts of Queensland, New South Wales, Victoria, Tasmania, South and South-Western Australia. Part V. Biological Results "Endeavour" 5 (Part 4): 157–216 (pls. 43–56).

Parin, N. V. 1992. *Argyripnus electronus*, a new sternoptychid fish from the Sala y Gomez Submarine Ridge.—Japanese Journal of Ichthyology 39:135–137.

Rohlf, F. J., & F. L. Bookstein (eds.). 1990. Proceedings of the Michigan Morphometrics Workshop. University of Michigan Museum of Zoology, Special Publication Number 2, 380 pp.

Struhsaker, P. 1973. *Argyripnus brocki*, a new species of stomiatoid fish from Hawaii, with observations on *A. ephippiatus* and *A. iridescens*.—Fishery Bulletin 71:827–836.

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.

———. 1986. Family No. 75: Sternoptychidae. Pp. 253–254 *in* M. M. Smith, & P. C. Heemstra. eds., Smith's sea fishes. MacMillan South Africa, Johannesburg, 1047 pp.

Appendix I
Comparative Material Examined

Lots are listed alphabetically by species, general geographical area, and then by catalog number. Numbers in parentheses indicate number of specimens in a lot.

Argyripnus atlanticus.—Western North Atlantic: FMNH 64551 (1), 65693 (1), 65694 (1), 71018 (2), 71587 (1), 71600 (4), 71735 (2), USNM 324583 (1).

Argyripnus brocki.—Hawaiian Islands: BPBM 23979 (30), 23995 (35), USNM 207653 (holotype), 207658 (4 paratypes), 204739 (11).

Argyripnus ephippiatus.—Hawaiian Islands: BPBM 24965 (21), 24962 (2), 24968 (21), USNM 47708 (holotype), 126079 (2), 207663 (12), 207664 (3).

Argyripnus electronus.—Sala y Gomez Ridge, eastern Pacific: AMS I.28181001 (3 paratypes), IOAN uncataloged, R/V Professor Shtokman, Cr. 18, Sta. 1976 (8), Cr. 19, Sta. 1977 (1).

Argyripnus iridescens.—Great Australian Bight: CSIRO H 2604-06 (6), T 999 (7), T 1068 (8), T 1129 (10).