SYNOPSIS OF THE BATHYLACONIDAE (PISCES, ISOSPONDYLI)

WITH A NEW EASTERN PACIFIC SPECIES

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The genus *Bathylaco* was described in 1896 by GOODE & BEAN. Since then it has been referred to various families and orders. One of the latest surveys of this genus was made by MAUL (1959), whose material only contained four specimens (Nos. 1, 2 and 6 of *B. nigricans* (cf. p. 222) and the holotype of *Macromastax gymnos* Beebe, 1933). This paper is based on 12 specimens, one of which represents a new species. Some of these are in an excellent condition, so it is now possible to give a more thorough description, to get an idea of the variation and to contribute to the discussion about the affinities of the genus *Bathylaco*.

All counts and measurements are taken in accordance with HUBBS & LAGLER (1958). The oceanographic terms are those proposed by BRUUN (1956 and 1957). Each of the *B. nigricans* specimens are assigned a number (cf. p. 222); these numbers are most often used when referring to particular specimens in the text. When a character forms less than 10 % of the standard length the uncertainty factor has been put at 0.1, between 10 % and 50 % at 0.5, and over 50 % at 1. The same factor is used in the "average" (Table 1, column 11).

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BATHYLACONIDAE

Bathylaconidae Parr, 1948, p. 51, type genus *Bathylaco* Goode & Bean, 1896, by monotypy.

Diagnosis:
There is apparently not a particular character by which the Bathylaconidae can be separated from the related families, but the following combination of characters seems to be typical for this family:

Skeleton poorly ossified, with large unossified parts of the chorda between the centra. Pleural, epipleural and neural ribs long and thin. Description of the caudal skeleton on p. 228. A short, heavy mesocoracoid. Mouth-opening very large. Upper jaw consists mainly of the maxillary. Rather thin, pointed teeth on the dentary, premaxillary, maxillary, vomer, palatine and sometimes on the pterygoid. One supramaxillary. Broad and flat upper branchiostegal rays. A pseudobranch with 10-12 filaments. More rakers in the outer row of the second gill arch than in that of the anterior arch. Eyes large with a well-developed anterior lid fold and a prominent aphakic aperture. Large cycloid scales. Dorsal and anal fins opposite each other. No adipose fin developed. Large lateral line pores in the head. Photophores absent. No swimbladder. A few well-developed pyloric caeca.

Relationships:
The Bathylaconidae are most closely related to the Alepocephalidae (cf. the discussion on p. 236).

Bathylaco Goode & Bean, 1896

Bathylaco Goode & Bean, 1896, p. 57, type species *Bathylaco nigricans* Goode & Bean, by monotypy.
Macromastax Beebe, 1933, p. 161, type species *Macromastax gymnos* Beebe, by monotypy (cf. p. 231).

Diagnosis: See the family diagnosis.

Species: We consider the genus *Bathylaco* to contain two species. The following description of *B.*

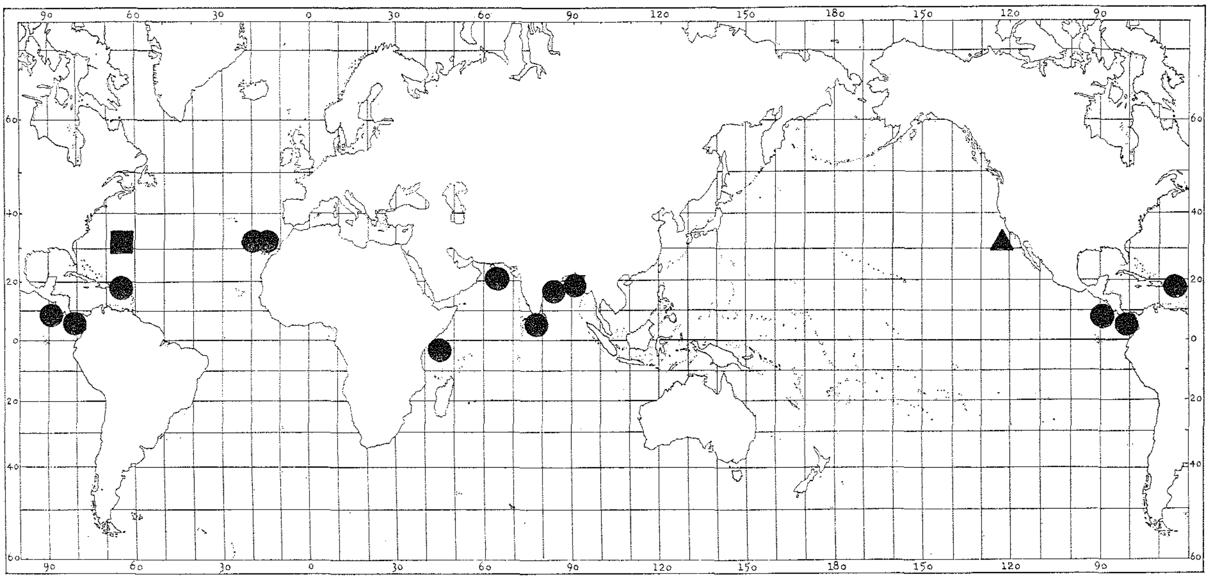


Fig. 1. Distribution of *Bathylaco* (● *B. nigricans*, ▲ *B. macrophthalmus*, ■ *Macromastax gymnos*).

Key to species of *Bathylaco* (adult specimens)

1. Number of anal fin-rays 11-12; horizontal diameter of pigmented eye 3.8-6.0 % and base of dorsal fin 20.5-28.0 % of standard length .... *B. nigricans* Goode & Bean, 1896
2. Number of anal fin-rays 17; horizontal diameter of pigmented eye 7.4 % and base of dorsal fin 17.0 % of standard length .... *B. macrophthalmus* n. sp.

nigricans shows a very high variation in several characters, so high, that one should expect this circumtropical species (Fig. 1) to consist of more than one species. However, the present material does not justify a splitting up of *B. nigricans*. MAUL (1959, p. 7) suggested that there probably is an Atlantic and a Pacific form, but this is not supported by the present, enlarged material.

Macromastax Beebe, 1933

BEEBE (1933) referred *Macromastax* to the Alepocephalidae and made comparisons with several alepocephalid genera. However, he did not compare it to *Bathylaco* which at that time was placed among the Synodontidae. PARR (1948) considered, with a question-mark, *Macromastax* to be synonymous with *Bathylaco*. The complete lack of scales in the former genus can either be a juvenile character or the scales may have been rubbed off in the net.

See the specific treatment on p. 231.

Bathylaco nigricans Goode & Bean, 1896
(Pl. XV, Fig. 1)

Bathylaco nigricans Goode & Bean, 1896 (pp. 57-58, fig. 69); JORDAN & EVERMANN 1896 (p. 540); JORDAN 1920 (p. 467); JORDAN 1923 (p. 154); JORDAN, EVERMANN & CLARK 1930 (p. 164); PARR 1948 (pp. 48-54, figs. 1-2); GREY 1956 (p. 127); NORMAN 1966 (p. 126); BERTIN & ARAMBOURG 1958 (pp. 2259-2260, fig. 1606); MAUL 1959 (pp. 1-8, fig. 1); PARR 1960 (p. 3); BIGELOW 1964 (pp. 561-565, figs. 150-151); BERRY & PERKINS 1966 (p. 654, fig. 19).

? *Macromastax gymnos* Beebe, 1933 (pp. 161-163, fig. 40); BEEBE 1933a (pp. 80-82, fig. 22).

Material examined (10 specimens + one radiograph):

1. Holotype of *Bathylaco nigricans* (std. 1. 208 mm, ♂); "Blake", off Santa Cruz, between St. Croix and St. Thomas, Virgin Isl. (17° 56′N, 64° 54′W); 4376 m; Agassiz trawl. 2. Jan. 1879. Mus. Comp. Zool., Harvard. Cat. No. 28061.
2. 1 specimen (std. 1. 214 mm, ♂); "Dana" St. 1208 IV, Gulf of Panama (6°48′N, 80°33′W); 3500 m wire; 3 m ringnet. 16. Jan. 1922, 8^{10} a.m. Zool. Mus., Copenhagen. Cat. No. P 1780.
3. 1 specimen (std. 1. 340 mm, ♀); "Galathea" St. 237, Madagascar-Mombasa (2°18′S, 45°18′E); estimated fishing depth 450-750 m above 4670 m; triangular otter trawl. 12. Mar. 1951. 6^{10} p.m. Zool. Mus., Copenhagen. Cat. No. P 1781.
4. 1 specimen (std. 1. 317 mm, ♀); "Galathea" St.

282, Seychelles-Ceylon (5°32'N, 78°41'E); 4040 m; blackish mud; herring otter trawl. 11. Apr. 1951. 2°° p.m. Zool. Mus., Copenhagen. Cat. No. P 1782.

5. 1 specimen (std. 1. 220 mm, ♂); "Galathea" St. 299, Bay of Bengal (17°10'N, 84°30'E); 2820 m; mud; herring otter trawl. 24. Apr. 1951. 5²⁵ p.m. Zool. Mus., Copenhagen. Cat. No. P 1783.
6. 1 specimen (std. 1. 210 mm, ♂); Madeira; from stomach of *Aphanopus carbo*. 3. Oct. 1959. Mus. Municipal do Funchal. Cat. No. 16400.
7. 1 specimen (std. 1. 126 mm); Madeira; from stomach of *Aphanopus carbo*. 27. Jan. 1962. Mus. Municipal do Funchal. Cat. No. 18925.
8. 1 specimen (std. 1. 232 mm, ♂); St. 86.92, C 6303 (32°07.3'N, 122°35.5'W – 32°00.5'N, 122°41.4' W); estimated fishing depth 0-ca. 1170 m above 4206 m; Cobb Mark II pelagic trawl. 6. Mar. 1963. Scripps Inst. Oceanogr., La Jolla. Cat. No. SIO 63-374.
9. 1 specimen (std. 1. 268 mm, ♀); IIOE "Anton Bruun" Cruise 1, St. 52 A (18°55'N, 91°59'E); 1900-1910 m; bottom trawl. 6-7. Apr. 1963. Smithsonian Oceanogr. Sorting Center, Washington, D.C.
10. 1 specimen (std. 1. 234 mm, ♀); IIOE "Anton Bruun" Cruise 4 A, St. 186 (21°30'N, 64°08'E); pelagically, 1000-2000 m; Bé sampler. 30. Oct. 1963. Smithsonian Oceanogr. Sorting Center, Washington, D.C.

A radiograph of the holotype of *Macromastax gymnos* (std. 1. 35 mm)[1]; Bermuda Oceanographic Exped., net 210, eight miles south of Nonsuch Island, Bermuda; 1829 m; 1 meter net. 22. June 1929. U. S. National Museum. Cat. No. 170960.

Condition of the material: No. 1 is in very poor condition. All the skin and most of the fin-rays are lacking. Also the head is much molested. – No. 2 is in fine condition. However, the head has been cut off and cleared, stained and sectioned in order to prepare it for an osteological study. – Of the three "Galathea" specimens, No. 3 is in excellent condition except for the partly missing skin, while No. 4 has the abdomen torn. No. 5 has been cleared and stained according to the trypsin-alizarin technique described by TAYLOR (1967). – The two specimens from the museum in Funchal are in extremely bad condition owing to the fact that they were found in the stomach of *Aphanopus carbo* Lowe, 1839. No. 7 is, besides being partly digested, broken in two pieces. – No. 8 has most of the skin intact enabling a precise counting of the scale-pockets. – The two best preserved specimens are those caught during the IIOE by the "Anton Bruun". Many scales remain on No. 10.

Comments to Table 1: The variation and average of *B. nigricans* (s. str.) does not include the morphometric but only the meristic characters of specimen No. 7 since this specimen is much smaller than the rest of the material.

Regarding the variation and average of the number of ventral fin-rays, pectoral fin-rays and branchiostegal rays there is made no distinction between those from the dextral and sinistral side.

The number of vertebrae is given as precaudal + caudal vertebrae (cf. p. 228).

The numbers indicating the amount of gill rakers signify: epibranchial rakers + the raker in the angle between the epi- and ceratobranchiale + the rakers on the cerato- and hypobranchiale (cf. p. 227).

The letters "d" and "s" refer to the right and left side, respectively.

Diagnosis and relationships:

See the comparison with *B. macrophthalmus* on p. 231.

Description:

Most of the meristic and morphometric characters are shown in Table 1. The following description exposes for many characters a variation within *B. nigricans* which is unusually high for the specific level. However, there does not seem to be any correlation between geographical areas and the variation which can indicate the presence of more than one species in the material. When additional material becomes available *B. nigricans* might turn out to contain more than one species.

Meristic characters. The number of ventral fin-rays (6-9), pectoral fin-rays (6-11), gill rakers on the anterior arches (11-17) and pyloric caeca (6-12) is very variable.

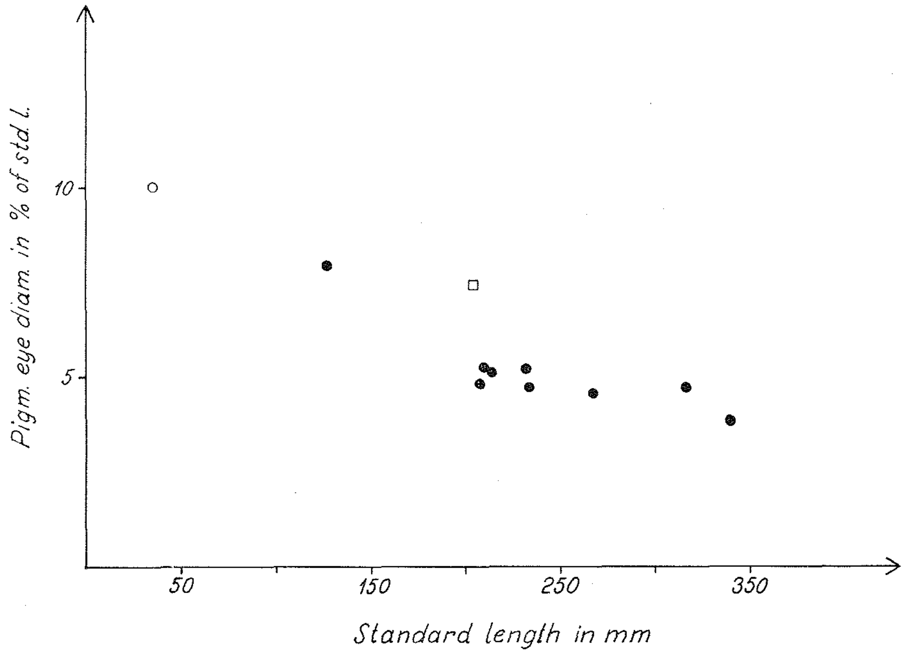
Morphometric characters. The variation of the morphometric characters is also very high even if the two smallest specimens (columns 12-13) are excluded. However, the variation of some of the characters can probably be explained as allometric growth when more material becomes available. In the present material there is only one character that

1. *M. gymnos* is discussed on p. 231.

Table 1. Meristic and morphometric characters of the genus *Bathylaco*.

	Bathylaco nigricans												*Macromastax gymnos*	*Bathylaco macrophthalmus*
	Holotype "Blake" No. 1	"Dana" St. 1208 No. 3	"Galathea" St. 237 No. 3	"Galathea" St. 282 No. 4	"Galathea" St. 299 No. 5	Funchal No. 16400 No. 6	Scripps SIO 63-374 No. 8	IIOE St. 52A No. 9	IIOE St. 186 No. 10	Variation	Average	Funchal No. 18925 No. 7	Holotype U.S.N.M. No. 170960	Holotype "Galathea" St. 716
Standard length	208	214	340	317	220	210	232	268	234			126	35	203
Sex	♂	♂	♀	♀	♂	♂	♂	♀	♀			juv.	juv.	♂
Meristic characters														
Dorsal fin	21	18	20	19	19	22	19	18	18	18-22	19.4	20	25	17
Anal fin	11	11	12	12	11	11	12	12	12	11-12	11.5	11	12	17
Ventral fins (d-s)	7-8	6-7	9-9	6-7	7-7	7-7	8-8	7-7	9-8	6-9	7.6	—	7	8-8
Pectoral fins (d-s)	—	6-7	9-10	7-7	-7	7-7	6-6	8-9	11-10	6-11	8.0	9-9	ca. 10	4-4
Gill rakers on anterior arch d	3+1+9	4+1+8	4+1+9	4+1+10	4+1+9	3+1+8	4+1+9	4+1+12	4+1+10	12-17	14	4+1+8	—	4+1+10
Gill rakers on anterior arch s.....	3+1+8	4+1+8	4+1+9	4+1+10	4+1+9	3+1+7	5+1+9	4+1+12	4+1+12	11-17	14	3+1+8	3+1+6	4+1+9
Branchiostegal rays (d-s)	9-10	—	10-10	10-10	10-10	10-10	9-9	10-10	9-10	9-10	9.7	9-9	9	9-9
Vertebrae (incl. urostyle)	28+17	28+19	28+18	32+17	29+20	28+17	27+18	29+17	28+18	27-32 + 17-20	28.5+18	—	—	27+19
Pyloric caeca..........	12	7	10	10	7	11	6	10	9	6-12	9.1	—	—	8
Morphometric characters as % of standard length														
Head	25.0	27.0	24.5	30.0	30.0	29.5	29.0	30.0	32.5	24.5-32.5	28.5	38.0	36.5	28.5
Depth at anterior dorsal fin.................	15.5	17.0	14.0	16.5	16.0	16.0	15.0	15.0	19.0	14.0-19.0	16.0	18.0	18.5	15.0
Snout	3.4	4.7	3.9	3.8	5.4	5.2	4.7	5.2	7.3	3.4-7.3	4.8	6.3	6.0	5.9
Upper jaw............	18.0	18.0	18.5	20.5	20.5	19.0	18.5	20.5	22.5	18.0-22.5	19.5	27.0	24.0	18.5
Lower jaw............	18.5	18.5	17.5	21.0	21.5	19.5	19.0	21.0	24.5	17.5-24.5	20.0	29.5	—	19.0
Horizontal diameter of pigmented eye.......	4.8	5.1	3.8	4.7	5.9	5.2	5.2	4.5	4.7	3.8-5.9	4.9	7.9	10.0	7.4
Bony interorbital width.	3.8	3.3	4.1	5.4	5.9	4.3	4.7	5.2	6.4	3.3-6.4	4.8	6.4	—	4.4
Preventral	55	53	56	55	57	56	56	59	60	53-60	56	—	—	59
Preanal	71	71	74	74	74	74	71	74	76	71-76	73	65	—	73
Predorsal.............	53	56	55	60	57	57	57	56	60	53-60	57	64	—	61
Base of dorsal fin	27.5	21.5	28.0	21.0	23.0	24.0	23.5	20.5	22.0	20.5-28.0	23.5	24.0	—	17.0
Base of anal fin	12.0	11.0	11.0	9.5	10.0	10.5	11.0	10.4	9.4	9.4-12.0	10.5	18.5	—	14.5

Fig. 2. Allometric growth of "Pigmented eye diameter" in *Bathylaco* (● *B. nigricans*, □ *B. macrophthalmus*, ○ *Macromastax gymnos)*.



gives an evident example of allometry, viz., the "horizontal diameter of the pigmented eye", which becomes relatively shorter with increasing standard length. (Fig. 2 also shows the eye-diameter of *M. gymnos* and *B. macrophthalmus*.) Table 1 shows that in five out of 12 cases the morphometric characters of specimen No. 1 hold an extreme value, indicating that the holotype is rather atypical. The morphometric characters of specimen No. 10 occupy an extreme value of the variation in ten cases. The inaccuracy is rather high for the morphometric characters owing to the poor condition of most of the specimens.

General description. The scaleless head has a blunt snout and is almost circular in cross-section. The eyes are placed above the anterior half of the upper jaws. The eye's horizontal diameter is a little larger than its vertical diameter. The impression of an oval eye in *B. nigricans* is intensified by a well-developed aphakic aperture which enlarges the field of vision. The eye diameter seems to vary much (3.8-10.0 % of the std. l.), but it is evident from Fig. 2 that this character is subject to allometric growth. The anterior nostril is circular and the posterior is a curved fissure, the two being separated from each other by a narrow bridge (Fig. 3). The black taste-buds are very well developed throughout the oral cavity. The opercular bones are very thin and soft. The operculum and suboperculum are striated; together with the upper two or three branchiostegal rays, which are somewhat broadened, they form the posterior part of the gill cover. A large comma-shaped lid fold is placed immediately in front of the eye (MUNK 1968). The cycloid scales are rather large. Most of the specimens have very few scales left. The number of lateral line and transversal scales could be counted only in four specimens (Nos. 2, 8, 9 and 10), verying from 45-48 and 11-12, respectively. Very small (approx. 2 mm) otoliths are found in specimens Nos. 1, 8 and 9. The otoliths in the holotype indicate that it is not the period of preservation which determines whether the otoliths are present or not.

The dorsal fin issues slightly behind the midpoint of the body (predorsal average 57 % of the std. l.). The spaces between the rays are considerably shorter anteriorly and posteriorly than between the middle dorsal rays. The few specimens with an intact dorsal fin show that the anterior two rays are shorter than the following rays. The caudal fin is always in a poor condition, but seems to have been emarginate. Radiographs show that there are 10 + 9 principal rays. The anal fin originates below the posterior part of the dorsal fin (preanal average 73 % of the std. l.). The interspaces are shorter than between the dorsal fin-rays. The anterior two rays are much shorter than the rest. The ventral fins are placed below the anterior end of the dorsal fin. They are usually much damaged. The small pectoral fins insert on the lower part of the body a little in advance of a vertical line through the apex of the operculum.

Lateralis system. Beginning posteriorly, the lateral line follows the midline of the body. After passing the dorsal fin it curves slightly upwards and levels

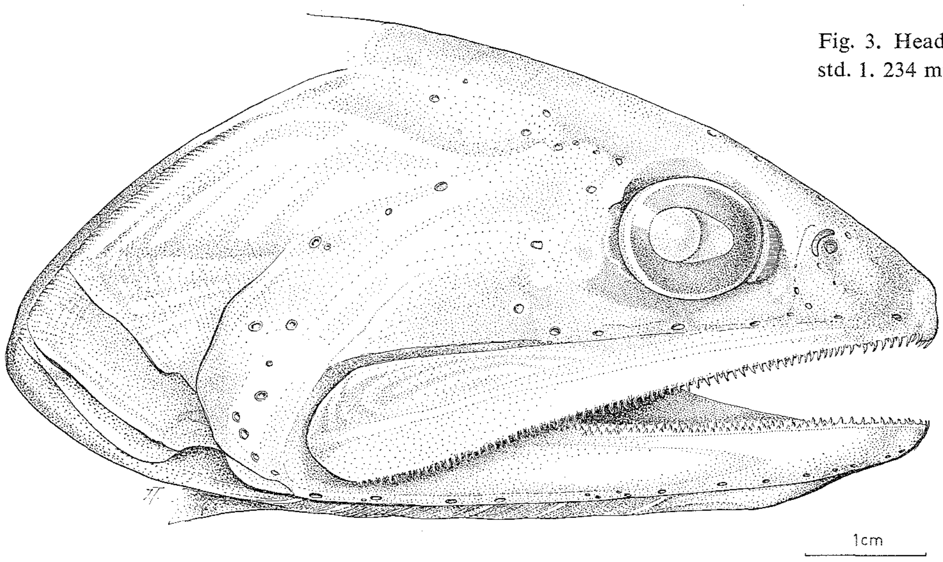


Fig. 3. Head of *B. nigricans* (No. 10, std. l. 234 mm).

out before reaching the gill cover where it again bends downwards. The lateralis system on the head is difficult to read because the skin is not intact in any of the specimens. Fig. 3 shows the head canals of the best preserved specimen. The following description is based on the better preserved material:

The preoperculo-mandibular, supraorbital and infraorbital canals are all well-developed. All three canals join the lateral line in the same place. The supraorbital canal originates close to the tip of the snout and runs straight backwards on the flat dorsal part of the head. When it reaches the level of the preoperculum it bends sharply away from the dorsal midline and joins the other canals. The two supraorbital canals do not meet behind the eyes, but they run very close to each other. Fig. 3 clearly shows the pores in the preoperculo-mandibular and the infraorbital canals.

Dentition (Table 2). The upper jaw consists of two dentigerous bones. The premaxillary and the maxillary, of which the latter forms ca. 85 % of the jaw. The premaxillaries are missing in six of the specimens examined and in the remaining ones they are rather loosely attached. The flat bone bears a few tooth-rows in continuation of those on the maxillary. The maxillary dentition consists of 1-3 rows of fang-like, flexible teeth. Most of them are hooked and spear-shaped. The ventral profile of the maxillary is in a lateral view straight or convex in young specimens, while the profile in older specimens is distinctly concave. One large supramaxillary is developed. The vomer is dentigerous in five speci-

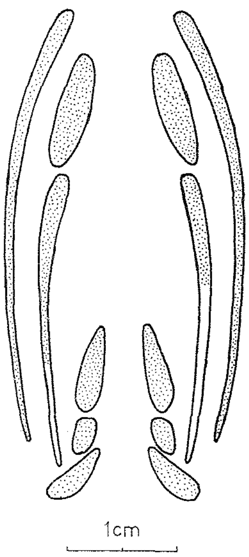


Fig. 4. Dentition of the maxillaries, palatines, pterygoids and upper pharyngeal bones of *B. nigricans* (No. 6, std. l. 210 mm).

Table 2. Dentition of certain bones in *Bathylaco nigricans*

	Specimen No.										Holotype of *M. gymnos*
	1	2	3	4	5	6	7	8	9	10	
Pterygoids	+		+	—	—	+	+	—	—	—	—
Vomer	—	—	+	—	+	—	+	—	+	+	—
Premaxillaries ...	—	—	—	—	+	—	+	—	+	+	+

+ = teeth present; — = teeth absent.

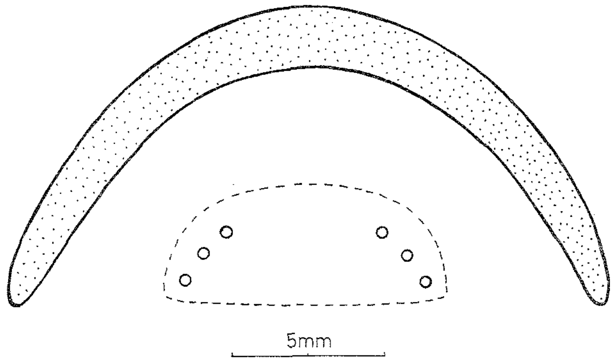


Fig. 5. Dentition of the premaxillaries and vomer of *B. nigricans* (No. 10, std. 1. 234 mm).

mens, carrying from 2-10 symmetrically arranged teeth similar to those on the maxillaries. In Fig. 5 the outline of the vomer is shown with a stippled line, indicating that it is not possible to see the transition between the vomer and the parasphenoid. The lack of the teeth on the vomer and on the premaxillaries, and sometimes even lack of the premaxillary bones themselves, is apparently due to mechanical influence from the collecting gear. In all the cases where the premaxillaries or remains of these bones are present there are also teeth on the vomer. Only specimen No. 3 is provided with vomerine teeth without the premaxillaries being present. However, owing to the great variation of some of the characters of this species it cannot be excluded that the vomer sometimes is edentate from natural reasons. The dentition of the palatines forms an oval pattern with the teeth placed in 2-5 irregular rows. They are rather similar to the maxillary teeth. The dentition of the pterygoids is subject to much variation which is not likely to have been caused by rough handling since their position far back in the mouth roof gives a good protection against damage. The four specimens with dentigerous pterygoids show a very variable pattern: No. 3 has the best developed dentition with 3-4 tooth-rows on both pterygoids. No. 1 has two tooth-rows anteriorly and one posteriorly, equally developed on both bones. No. 6 is provided with the same number of rows as No. 1, but the rows on the left pterygoid continue further back than those on the right bone (Fig. 4). No. 7 has eight small teeth on the right pterygoid and none on the left. The ventral profile of the dentary is straight to slightly convex. It is much more strongly built than the maxillary, with the posterior end being broader. The teeth are of the same type in the two bones. The number of rows varies, but in each particular specimen there is always one more row in the dentary than in the maxillary. The longest teeth are found in the inner row. There are no teeth on the basihyal and on the basibranchials.

There are three upper and two lower pharyngeal tooth-plates. The teeth vary somewhat in size, but are always shorter than the maxillary teeth.

Gill cavity. The number of gill rakers in the outer row on the epibranchial is 3-4, one raker being placed in the angle between the two arms, and 6-12 rakers are found on the cerato-and hypobranchial. An anterior gill arch of *B. nigricans* is very similar to one from *B. macrophthalmus* (Fig. 8). All the rakers in the outer rows are dentigerous and, like the anterior arch, also some of the rakers on the second and third arches are relatively well-developed. Table 3 shows the variation of the number of rakers (including both long and very short ones) from the outer row, with the average for the ten specimens given in the parentheses. The numbers in the fourth column give the average length of the raker in the angle expressed as percentage of the standard length:

Table 3. Number of gill rakers of the outer rows.

Gill arch	Dextral	Sinistral	Length of angle-raker as % of std.l.
1.	12(14.0)17	11(14.0)17	3.0 %
2.	13(14.9)16	12(15.5)18	2.0 %
3.	12(13.5)15	11(12.8)15	1.5 %
4.	9(12.4)13	9(12.6)13	0.8 %
5.	8(8.9)12	6(9.3)13	0.5 %

Table 3 shows that there are more rakers on the second arch than on the first, a rather extraordinary feature. It also shows that the variation between the specimens is very large. The maximum variation in the number of rakers from the two sides of a specimen was found to be 2.

Generally, the rakers in the inner rows are less developed than those in the corresponding outer rows. Half of the specimens have no rakers at all in the inner row of the anterior arch. Specimen No. 9 has no rakers in the inner row of the anterior two arches and specimen No. 4 has but small, irregularly developed rakers in the inner row of the first and second arches.

In two of the specimens (Nos. 6 and 10) the number of gill filaments were counted on the sinistral first and second arches. The former specimen has 101 and 107 and the latter 90 and 97 filaments. All filaments are of a very simple composition.

A pseudobranch provided with 10-12 simple filaments was found in all specimens.

Vertebral column. The examination of the vertebral column was based on radiographs of all the specimens and on a trypsin-alizarin stained specimen (No. 5). There are 27-32 precaudal and 17-20 caudal vertebrae with a total variation of 45-49 vertebrae. The most anterior vertebra with a haemal spine is considered the first caudal vertebra and the last vertebra with a haemal arch pierced by the caudal vein is the last caudal vertebra (= first preural vertebra). In some cases it is rather difficult to find the transition between the precaudal and the caudal vertebrae. Plate XIV, Figs. 2 and 3, shows a radiograph of the caudal part of two specimens (Nos. 3 and 5). They clearly indicate that the ossification is very poor and also that the degree of ossification increases during growth. In No. 5 (220 mm in standard length) the posterior vertebral centra only have calcifications in the chordal sheath. The radiograph of No. 3 (340 mm in standard length) shows that the first two preural vertebral centra are not ossified. The vertebral centra are very high and short. There are no calcified or ossified centra behind the first preural vertebra. The intermediate unossified parts of the chorda are larger than or of the same size as the centra. The neural spine of the first preural vertebra varies in length, but is always much shorter and thinner than the spine of the second preural vertebra. Each of the posterior 5-10 neural spines is provided with an anteriorly directed bony membrane which in the most posterior spines is so large that it reaches the previous neural spine. A pair of epineural ribs is fastened to the basis of all the precaudal neural arches and to the 1st-5th caudal neural arches. The number of caudal epineural ribs varies from one specimen to another. Except for the relatively short hindmost ones all the epineural ribs are of the same length as the corresponding neural spines, at least judging from the cleared and stained specimen. Apparently, no parapophyses are developed, so the pleural ribs fasten directly to the centra. Epipleural ribs are found in the same number and are of the same shape as the epineural ribs. They fasten in the abdominal part to the basis of the pleural ribs and in the caudal part to the basis of the haemal arches. The posterior haemal spines are provided with an anteriorly directed bony membrane.

Caudal skeleton. The caudal skeleton is somewhat difficult to interpret, both when the examination is based on the radiographs (Plate XIV, Figs. 2 and 3) and when it is based on the cleared and stained specimen. (Plate XIV, Fig. 3 exemplifies a variation of the caudal skeleton, as the last two neural arches are placed anterior to the corresponding haemal arches and calsified vertebral centra). The following caudal elements were found: three epurals, of which the third one is the shortest, and six hypurals, of which the third is the largest. The latter has the basis much expanded on both sides of the notochord. The stained specimen shows the presence of two small neural processes belonging to ural vertebrae (last one is part of un_1 on Fig. 9). There are three pairs of uroneurals. The anterior uroneural is a very long and arched element which originates at the basis of the first preural neural arch. It has two anterior and three postero-dorsal processes. The posterior uroneurals are small, slender rods. The distal end of the last one is hook-shaped. The caudal fin-formula of No. 5 is 12/1/9/8/1/14. The 12 dorsal epichordal and 14 ventral hypochordal dermal rays are not shown on Fig. 9.

Colour. Judging from the few undamaged specimens the skin is black or dark brown all over the fish. The head is somewhat darker than the body.

Viscera. The diameter of the oesophagus and the stomach is almost the same. They are both rather thick-walled and provided with a few, high, longitudinally running folds which considerably enlarge the inner surface. The blind end of the stomach is long and pointed with numerous villi. The stomach ends far back above or a little in front of the ventral fins. The intestine is almost straight, only provided with 1-2 small coils. It is thin-walled and much more narrow than the stomach. The number of pyloric caeca varies from 6-12. As shown by MAUL (1959, fig. 1), the length also varies much. The longest caecum forms 13.0-15.5 % and the shortest 4.7-10.5 % of the standard length. All of the caeca end in front of the tip of the stomach. The major part of the digestion apparently takes place in the stomach and caeca. The liver is small, ending at the anterior caeca. The gallbladder is very conspicious. A swimbladder is not developed.

Gonads:

Two of the 11 *B. nigricans* specimens (No. 7 and the holotype of *M. gymnos*) are juveniles without developed gonads, four specimens (Nos. 3, 4, 9 and 10) are females and the remaining five are males.

Females. The maximum egg diameter varies in the four specimens between 1.0 and 2.7 mm. Eggs with

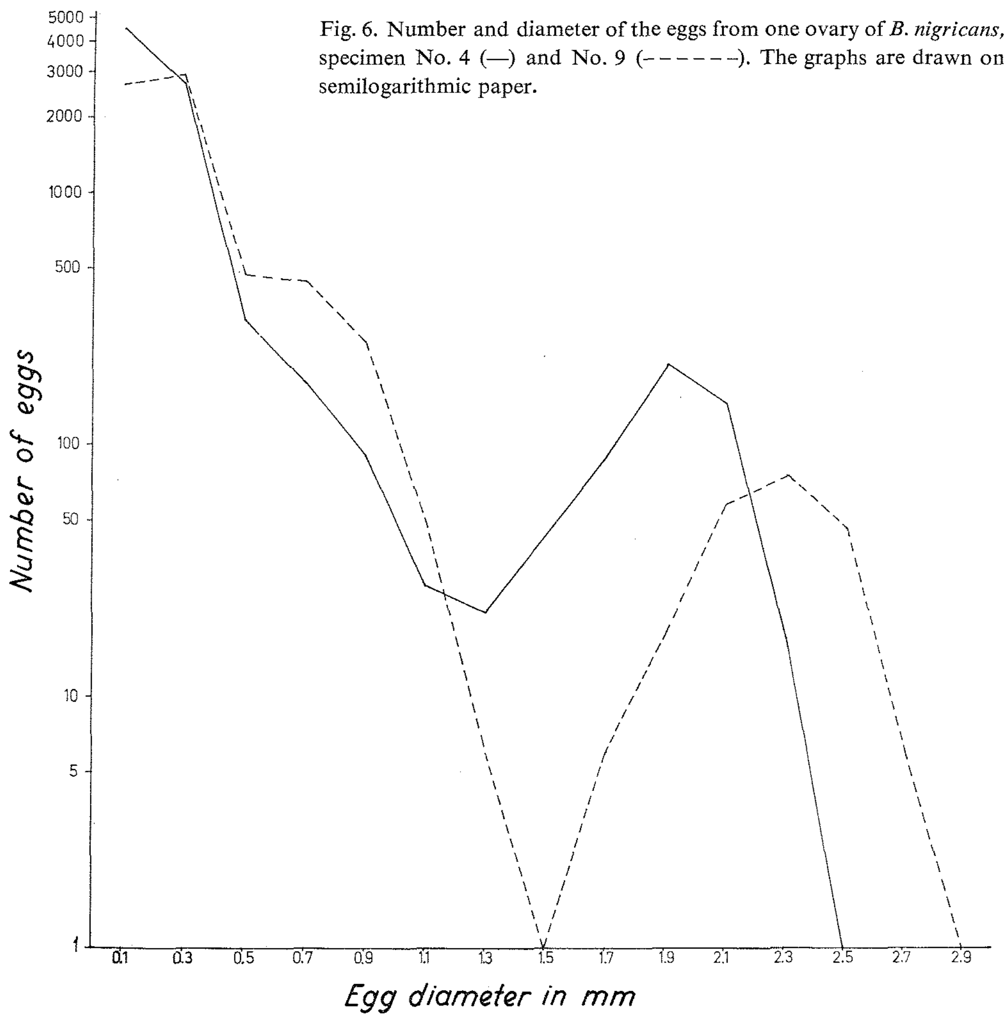


Fig. 6. Number and diameter of the eggs from one ovary of *B. nigricans*, specimen No. 4 (—) and No. 9 (------). The graphs are drawn on semilogarithmic paper.

a diameter less than 0.1 mm were not included in the examination. Pl. XIV, Fig. 1, shows a part of one of the ovaries (egg diameter 0.1-2.4 mm) of specimen No. 4. In No. 3 the ovaries contain relatively few eggs (diameter 0.1-1.1 mm), but a counting and measuring of the eggs would be very approximate since it was extremely difficult to distinguish between small eggs and oildrops. Also, the relatively voluminous ovaries indicate that No. 3 most probably is a newly spent specimen. Fig. 6 gives the number and diameter of the eggs from one of the ovaries of specimens Nos. 4 and 9. The eggs from one fourth of the ovary were measured, counted and the total number estimated. There are a little more than 7000 eggs in one ovary of No. 9 and about 8500 in one ovary of No. 4. Fig. 6 shows that the eggs fall in two groups: one with a diameter of 0.1 to approx. 1 mm, comprising the great majority of the eggs, and a much smaller group, containing only 3-6 % of the eggs, with a diameter of about 1.5-2.7 mm. The latter group most probably forms the coming clutch. Presuming that the right and left ovary contain eggs of the same size and number the clutch for specimens Nos. 4 and 9 is approx. 1000 and 450, respectively. The difference in the number of eggs from the estimated clutches corresponds to the difference in the standard lengths. The ovaries of No. 10 are in an intermediate state of development and have not been further examined. The ovaries are very long, varying from 33-40 % of the standard length in the four specimens. None of the eggs seem to be fertilized. The larger eggs are light-brown and the smaller ones whitish.

Males. The testes of all the five male specimens were examined macroscopically. They are of almost the same relative length, forming 43-46 % of the standard length. However, according to the form, the testes fall into two (or three) groups (cf. Pl. XIII, Figs. 1 and 2):

1. Each testis consists of 14-18 rather thin, overlapping lobes of somewhat varying sizes. The

bulk of the lobes are completely free from the neighbouring ones except for the connection through the dorsal duct. (Specimens Nos. 1 and 6; Pl. XIII, Fig. 1).

2. Each testis consists of approx. 35 rather thin, non-overlapping lobes. In two specimens (Nos. 2 and 5) most of the lobes are completely connected to the following ones via a thinner piece of tissue, but the ventral part of the lobes is free. In another specimen (No. 8), all lobes are grown together and also the ventral edge of the lobes are connected, forming a straight line. (Pl. XIII, Fig. 2).

In order to check whether the testes were in different stages of development, 8 μ sections were prepared of a cleared and stained portion from each of the two (or three) testis forms. The examination showed that all the three testes are in the same stage, containing many spermatids in the lumen and in the dorsal duct, but relatively few spermatogonids and spermatocytes in the rather thin seminiferous ampoules. It seems as if there are spermatozoa in specimen No. 8, but the tails are very indistinct and the heads are circular, like that of a spermatid, and not oval as a typical spermatozoon.

The conclusion is that spermatogenesis has stopped and all three testes were ready to spawn or were in the process of spawning. It seems impossible to explain, at least on the basis of the present material, why the outer morphology of the testes differs so much among specimens in the same developmental stage and of the same standard length.

Biology and reproduction:

B. nigricans may be characterized as a meso- and/or bathypelagic species (cf. the vertical distribution below). No photophores were observed as it turned out that the organs indicated by PARR (1948) had nothing to do with light production (cf. p. 234-35). Judging from the very large mouth cleft, the numerous strong pointed teeth, the rather small gill rakers and the well-developed eyes provided with an evident aphakic aperture, this powerful fish is likely to be a fast swimming predator. Identifiable stomach contents were not found in any of the 10 specimens examined.

The large number of eggs in the second peak of the graphs in Fig. 6 shows that *B. nigricans* most probably occurs in water masses relatively rich in food items, i.e., in the upper layers. On the other hand, the fact that the ventral part of the fish is black, like the rest of the fish, involves that it would be very risky for it to live epipelagically as it would be easily seen against the light surface. Also, the lack of a swimbladder and the poorly ossified skeleton is a combination of characters typical for a deep occurring pelagic fish (cf., i.a., MARSHALL 1955, p. 325). The fact that only one specimen was caught on each occasion and that so few specimens are known of a species occurring at depths where much fishing takes place must mainly be ascribed to the rapidity, but probably also to the rarity, of the fish.

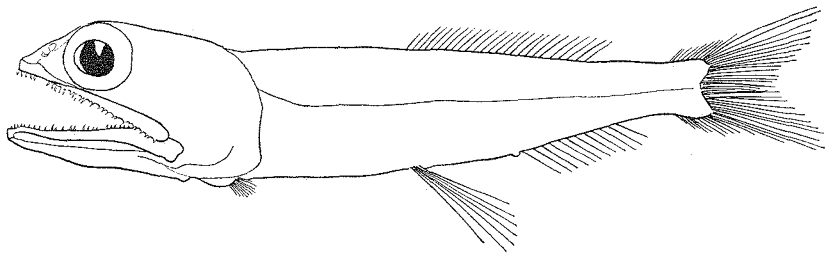
Sections were made of the gonads of three specimens and no traces of hermaphroditism were found. It is most probably an oviparous species, as embryos were not observed in any of the four females. All the females were taken in the same area (Northern Indian Ocean) but no correlation could be shown between the degree of gonad development and the date for the capture of the specimens. This might indicate that the breeding period is independent of a yearly season.

Distribution:

Horizontal distribution. Fig. 1 shows that *B. nigricans* is found in all oceans, but only in the tropical and subtropical parts. All the specimens were caught close to land masses, a pattern which cannot be explained solely by the fact that relatively many hauls have been made in these areas. It is probably connected with the amount of food available.

Vertical distribution. Because of the pelagic occurrence there is no depth-indication on Fig. 1. The gear used had fished pelagically with a combined depth-variation of 0-2000 m at seven out of the 11 localities where *B. nigricans* was caught. However, in five of the seven hauls the depth was 1200 m at a maximum. These captures include the two fishes found in the stomach of the two *Aphanopus carbo* specimens, a species which is taken on hook and line on a depth of 800-1200 m off Madeira. Specimen No. 3 shows the most shallow occurrence as it was caught between 450 and 750 m. In the four cases where *Bathylaco* was taken by a bottom trawl the depths varied between 1900 and 4376 m. (The two "Galathea" bottom hauls all contained pelagic as well as benthic fishes). The general appearence of *B. nigricans* indicates that it is not an epipelagic fish and according to the above-mentioned information the lower limit for the distribution is apparently 1500-2000 m. This means that *Bathylaco* has a meso- and/or bathypelagic occurrence (BRUUN 1957).

Fig. 7. Holotype of *Macromastax gymnos* (std. l. 35 mm). From BEEBE (1933).



Macromastax gymnos Beebe, 1933
(Fig. 7)

PARR (1948) considered, with a question-mark, *M. gymnos* to be synonymous with *B. nigricans*. Table 1 column 13 gives some of the characters of the only known specimen of *M. gymnos*. They partly derive from BEEBE's description and partly from an examination of the holotype, kindly made by R. H. GIBBS, JR., in the U. S. National Museum. The specimen is in a very bad shape. No skin and fins remain and it has once dried out. Radiographs showed neither vertebrae nor fins, so it is impossible to check BEEBE's counts and measurements.

Judging from the length of the specimen there is no doubt that it is juvenile. Except for a rather high number of dorsal fin-rays and low number of gill rakers on the anterior arch, Table 1 shows much similarity between *M. gymnos* and *B. nigricans* (the gill rakers were counted while the specimen was in the present, bad condition). The morphometric characters are somewhat more divergent. However, many of the disagreements can most probably be explained as due to allometric growth, as it turns out that by far the best agreement is found when *M. gymnos* is compared to the smallest *B. nigricans* (No. 7) (Fig. 2).

We therefore find it justifiable to consider *M. gymnos* Beebe, 1933, a junior synonym of *B. nigricans* Goode & Bean, 1896.

Bathylaco macrophthalmus n. sp.
(Pl. XV, Fig. 2)

Material (1 specimen):

Holotype (std. l. 203 mm, ♂); "Galathea" St. 716, Gulf of Panama (9°23'N, 89°32'W); 3570 m; herring otter trawl. 6. May 1952. 11^{45} a.m.

The holotype, fixed in formaldehyde and preserved in alcohol, is kept in the Zoological Museum, Copenhagen (Cat. No. P 1784).

Diagnosis and relationships:

Below are mentioned some of the characters in which *B. macrophthalmus* differs from the only other described *Bathylaco* species, *B. nigricans* Goode & Bean, 1896. (The characters of the latter species are placed in the parentheses):

Number of dorsal fin-rays 17 (18-22), anal fin-rays 17 (11-12), pectoral fin-rays 4 (6-11); horizontal diameter of pigmented eye 7.4 % (3.8-5.9 % in adult specimens) (see Fig. 2), base of dorsal fin 17.0 (20.5-28.0). No well-developed rakers in the inner row of the first and second gill arches (four of eight specimens with normal rakers in the inner row of the anterior arch, and six with well-developed rakers in the inner row of the second gill arch). The dentigerous part of the palatines more narrow than in *B. nigricans*. Some pyloric caeca end posterior to the tip of the stomach (all pyloric caeca end anterior to the tip of the stomach) (cf. Pl. XIII). – If only the holotypes of *B. nigricans* and *B. macrophthalmus* were compared the presence or absence of teeth on the pterygoids would seem to be a valuable specific character. However, as it appears from Table 2, only four of the 11 known specimens of *B. nigricans* (including the holotype) have dentigerous pterygoids.

Condition of the holotype:

Like most of the *B. nigricans* specimens, also *B. macrophthalmus* is in a rather poor condition owing to the fragility of the fish. The skin and fin-rays are much damaged and the premaxillaries and parts of the gill-covers are lost. (Cf. Pl. XV, Fig. 2).

Description:

Most of the meristic and morphometric characters are mentioned in Table 1, column 14.

The body is rather elongate and compressed. Much of the skin is lost. Various areas have scale-pockets, but only a few of the cycloid scales remain, all of which are found close to the pectoral fin and the gill slit where they apparently are better protected. The lateral line runs along the midline of the body. All the lateral line scales are lost. The dorsal fin is placed far back, beginning a little behind a

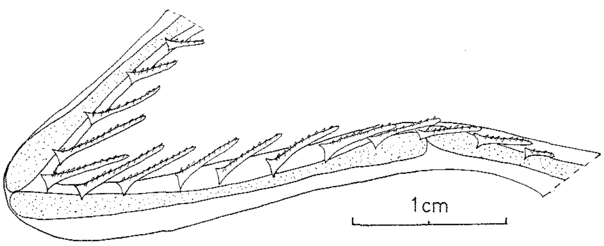


Fig. 8. Anterior right gill arch from the holotype of *B. macrophthalmus*.

vertical plane through the ventrals and ending above the anterior part of the anal fin. The caudal fin is provided with 10 + 9 principal rays. The small pectorals are inserted rather low. The head has probably been provided with scales, at least dorsally. The eyes are very large, the diameter is longer than the snout, with the upper edge at the dorsal profile. There is a distinct rostral aphakic aperture like that in *B. nigricans* (Fig. 3). Probably due to the damaged snout, there is no comma-shaped lid fold in front of the eyes. The nasal organ is relatively large and is placed closer to the eye than to the snout. The skin around and the septum between the two openings is lost. The branchiostegal rays are very much damaged, but the upper ones are definitely broadened like those in *B. nigricans*. The long, slightly curved maxillaries end well behind the eyes. A supramaxillary is developed over the posterior part of the maxillary. The skin is so incomplete that it is impossible to reconstruct the pattern of the sensory papillae. Otoliths are not developed.

Dentition. The maxillaries are provided with numerous thin, pointed teeth arranged in two irregular rows. A minor part of the teeth, mainly in the inner row, are twice as long as the rest, being slightly inward curved. The dentaries have 3-4 irregular rows anteriorly and 1-2 posteriorly, formed like those on the maxillaries. The lower jaw symphysis is edentate. The palatines have about 10 pointed teeth in 1-2 rows. The premaxillaries are lost and there are no teeth on the vomer, the pterygoids, the basihyal and on the basibranchials. The pharyngeal tooth-plates are similar to those of *B. nigricans* (cf. Fig. 4).

Gill cavity. Fig. 8 shows the anterior right gill arch of *B. macrophthalmus*. There is a gradual transition between the long and short rakers which are all more or less elongated and dentigerous. There is a total of 14-15 rakers in the outer row, with one placed in the angle between the epi- and ceratobranchiale, four rakers on the former and 7-8 on the latter of these bones and finally two on the hypobranchiale. Except for 1-2 extremely small knobs (0.3 mm in diameter), one of which is provided with a few teeth, the inner row of rakers are not developed on the anterior arch. The second arch has a few more, but shorter, rakers in the outer row than the first arch. The inner row consists of 3-4 knobs equal to those in the inner row of the anterior arch. Two of the knobs are dentigerous. The inner row of the third arch is quite normal, being provided with knob-formed, dentigerous rakers in a number equal to that found in the outer row. The rakers in the inner row are the shortest. On the fourth arch the outer and inner row of rakers are almost uniform.

Below is given a survey of the number of rakers in the outer row from both sides:

1st gill arch 4 + 1 (3.1 %) + 9-10
2nd gill arch 5 + 1 (2.3 %) + 11-12
3rd gill arch 4 + 1 (1.8 %) + 9
4th gill arch 2 + 1 (0.9 %) + 9
5th gill arch 1 + 1 (0.5 %) + 7

The percentage in the parentheses indicates the length of the angle-raker expressed as a percentage of the standard length. There are 2-3 more rakers in the outer rows on the second arch than on the first arch.

The anterior arch is provided with approximately 75 pairs of narrow, simply built gill filaments. The length is equal to the diameter of the lens. The second arch has approximately 100 pairs of laminae.

The pseudobranch is provided with ten filaments.

Vertebral column and caudal skeleton. The following information is based on radiographs. Reference is made to the general remarks under *B. nigricans* on p. 228. The two species show only minor disagreements:

There are 27 precaudal and 19 caudal vertebrae, all very poorly ossified. The spine of the first preural vertebra is very short. Epineural and epipleural ribs are developed on the 2nd-3rd caudal and on all the precaudal vertebrae. The rest of the characters are either difficult to observe with certainty or they agree with those of *B. nigricans*.

Colour. Only small parts of the dark brown skin are left, so the colour of the specimen is due to the yellow-brown muscle tissue. The iris is dark blue and the lens is light brown.

Viscera. In most respects the viscera in the two *Bathylaco* species are developed in the same way. Therefore, only the differences are mentioned here (cf. *B. nigricans* p. 228):

There are seven pyloric caeca, varying in length from 7.8-18.5 % of the std. l. In addition, a very small caecum is found dorsally on the intestine, somewhat removed from the other ones. A few of the larger caeca end posterior to the tip of the stomach. The stomach ends somewhat in front of the ventral fins (Pl. XIII, Fig. 3).

Gonads. The length of the testes forms about 45 % of the standard length. Each testis holds 16-17 rather thick, partly over-lapping lobes. Almost all of the lobes are broadly connected to the neighbouring ones by a piece of relatively thin tissue (Pl. XIII, Fig. 3). Sectioning of a part of one of the testes showed that the seminiferous ampoules contain all stages of spermatogonids and spermatocytes. Spermatids are numerous in the lumen. The testes are thus not ready for spawning yet, but are in active spermatogenesis.

Biology and reproduction:

The specimen, a male, was taken in a bottom trawl, which worked in a depth of 3570 m. It was, however, most probably caught when the trawl was brought up as it is known that several definite pelagic species were taken together with benthic ones at that particular station (see also the remarks about *B. nigricans,* p. 230).

Distribution:

B. macrophthalmus is only known from the type locality in the Gulf of Panama (Fig. 1).

GENERAL REMARKS

Resumé of opinions:

GOODE & BEAN (1896, p. 57) referred their new genus, *Bathylaco,* to the family Synodontidae, i.e., to the order Iniomi.

JORDAN & EVERMAN (1896, p. 540), JORDAN (1920, p. 467 and 1923, p. 154), and JORDAN, EVERMAN & CLARK (1930, p. 164) also placed it in the Synodontidae.

BEEBE (1933, p. 161) described *Macromastax gymnos* which was considered a probable synonym of *B. nigricans* by PARR (1948), MAUL (1959) and BIGELOW (1964). This suggestion is further supported by the present examination (p. 231) where new and smaller specimens of *B. nigricans* have become available, giving information about the allometric growth. BEEBE (1933 and 1933a) placed *Macromastax* in the family Alepocephalidae (order Isospondyli).

PARR (1937, p. 6) mentioned *Macromastax* in the "Tentative synopsis of the genera of the Alepocephalidae".

PARR (1948, p. 48) gave a detailed description of *Bathylaco nigricans* based on the holotype and on the specimen from the "Dana" Expedition. He established the family Bathylaconidae which was "tentatively placed among the Isospondyli in spite of rather strong, but unfortunately incomplete, indications that a new order, which might be called the Bathylaconi, would be more appropriate". PARR concluded (p. 51) after a discussion of the taxonomy that owing to the luminous organs and the absence of a mesocoracoid "the reasons for regarding the Bathylaconidae as a possible intermediate between the Isospondyli and the Iniomi become plain". – PARR used the following characters in the discussion whether *Bathylaco* is most closely related to the Alepocephalidae or to the Synodontidae: upper jaw structure (Isospondyli-like); stomach and pyloric appendages (Alepocephalidae- and Iniomi-like); shape of upper branchiostegal rays (Isospondyli-like); absence of mesocoracoid (Iniomi-like); luminous organs (Alepocephalidae- and Iniomi-like). However, the present re-examination shows that *Bathylaco* does have a mesocoracoid (cf. Pl. XV, Fig. 3), in spite of fig. 2D in PARR's paper (1948) and that neither the preorbital luminous organ (MUNK 1968) nor the organs on the top of the gill cover are photophores (cf. p. 234). Consequently, PARR's main arguments indicating relationship to the Iniomi have to be cancelled, leaving no doubt about *Bathylaco* being an isospondylous genus.

GREY (1956, p. 127) mentioned the Bathylaconidae without giving it an ordinal position.

BERTIN & ARAMBOURG (1958, p. 2259) placed *Bathylaco* in a separate suborder, Bathylaconoidei, within the Clupeiformes between the suborders Stomiatoidei and Esocoidei, removed from the Alepocephaloidei. Their argumentation is that *Bathylaco* has large, dentigerous maxillaries like the Stomiatoidei and lacks the mesocoracoid as do the Esocoidei. It differs from both these suborders in the broadened upper branchiostegal rays, which they considered a very archaic character. However, the mesocoracoid is developed and *Bathylaco* is not the only clupeiform fish with broadened upper branchiostegal rays (cf. p. 234).

GOSLINE (1960, p. 358) did not discuss the Bathylaconidae in his classification of the modern isospondylous fishes, but left them *incertae sedis.*

PARR (1960, p. 3) stated that the species hitherto referred to the Alepocephalidae belong to at least three families: Alepocephalidae (s. str.), Searsidae and the somewhat isolated Bathylaconidae. Compared to PARR's earlier paper (1948) it appears as if he has revised his opinion about the systematic position of the Bathylaconidae.

BIGELOW (1964, p. 561) placed the Bathylaconidae in a separate suborder, the Bathylaconoidea. The main reason for this separation is the development of the branchiostegal rays. He is thus following BERTIN & ARAMBOURG's opinion (1958).

BERRY & PERKINS (1966, p. 654) placed the Bathylaconidae in the Isospondyli.

GREENWOOD, ROSEN, WEITZMAN & MYERS (1966, p. 394) have ranked the Bathylaconidae in the suborder Bathylaconoidei within the order Salmoniformes and superorder Protacanthopterygii, division III.

NORMAN (1966, p. 126) placed *Bathylaco,* with some reservation, in the iniomous family, Synodontidae.

MCALLISTER (1967a, p. 539) arranged the bioluminescent fishes, to which he referred *Bathylaco,* according to his new classification (MCALLISTER 1967b) which is based on the evolution of the branchiostegals and the gular, opercular and hyoid bones. He places the Bathylaconidae in the suborder Bathylaconoidei (Clupeiformes) while the Alepocephalidae and the Searsidae are found in the suborder Clupeoidei.

Characters of ordinal and familiar significance:

Branchiostegal rays. PARR (1948) remarked that "the stage of evolution of the upper branchiostegal rays of *Bathylaco* is very primitive even for the Isospondyli and far removed from the condition among the Iniomi". The upper one is a broad and exposed lamella with its upper edge joining the lower contours of the sub- and inter-operculum; it participates in the formation of the gill cover. The second and third rays are also more or less broadened. BERTIN & ARAMBOURG (1958) payed so much attention to the broad branchiostegal rays that they even established a new suborder for *B. nigricans.* BIGELOW (1964) remarked that "the union of the branchiostegal rays with the opercular bones" and "their plate-like nature" justify a separate suborder.

However, perusal of various papers on isospondylous anatomy shows that broadening of the upper branchiostegal rays is not so unique a character as stressed by the above-mentioned authors. For instance, HUBBS (1920, p. 63) wrote that "the branchiostegals of the typical Isospondyli (at least the upper ones), persist as thin wide plates. The uppermost and widest ray (...) is attached closely to the inner margin of the sub- and interoperculum". PARR (1960, fig. 39) figured the searsid genus *Searsia koefoedi* Parr, 1937, showing that the upper branchiostegal rays are broad. MONOD (1961, figs. 63 and 64) demonstrated that the upper branchiostegal rays are broad in *Ethmalosa fimbriata* (Bowdich, 1825) and in *Brevoortia tyrannus* (Latrobe, 1802) (both Clupeidae). KREFFT (1967, p. 1) mentioned in the description of a new searsid genus, *Paraholtbyrnia,* that the upper three branchiostegal rays are broad.

Lateralis system. There is no connection between the two supraorbital canals behind the eyes, which is typical for isospondylous fishes, while this connection exists in the order Iniomi (GOSLINE, MARSHALL & MEAD 1966, p. 3). A comparison between the lateral line canals on the head of *B. nigricans* and of some alepocephalid species (*Rouleina danae* Parr, 1951 and *Nematobathytroctes bifurcatus* Parr, 1951) and searsid species (*Normichthys operosa operosa* Parr, 1951 and *Mirorictus taningi* Parr, 1947) shows almost exactly the same pattern in the five species concerned. *Bathyprion danae* Marshall, 1966, demonstrates a rather similar pattern, with the exception of the infraorbital canal which bifurcates just posterior to the eye, while it is unbranched in the above-mentioned species.

Mesocoracoid. Most isospondylous fishes are provided with a mesocoracoid. This bone is only visible from the inner side of the pectoral girdle. PARR (1948, fig. 2D) stated that no mesocoracoid was present in *B. nigricans,* which suggests that the latter is an iniomous species as the absence of this bone is typical for all members of this order (GOSLINE, MARSHALL & MEAD 1966, p. 2). However, as shown by Pl. XV, Fig. 3, a distinct mesocoracoid is developed in *B. nigricans.*

Upper jaw. In agreement with the Isospondyli, the upper jaw of *B. nigricans* consists of premaxillary and maxillary, both being dentigerous, while in iniomous fishes the upper jaw is solely made of the premaxillary.

Photophores. According to PARR's description (1948), *B. nigricans* is provided with a large "comma-shaped preorbital luminous organ similar to that of many stomiatoids and myctophids, rather than the small circular organs sometimes found in this position among alepocephalids". As shown by MUNK (1968), this structure actually is the rostral part of

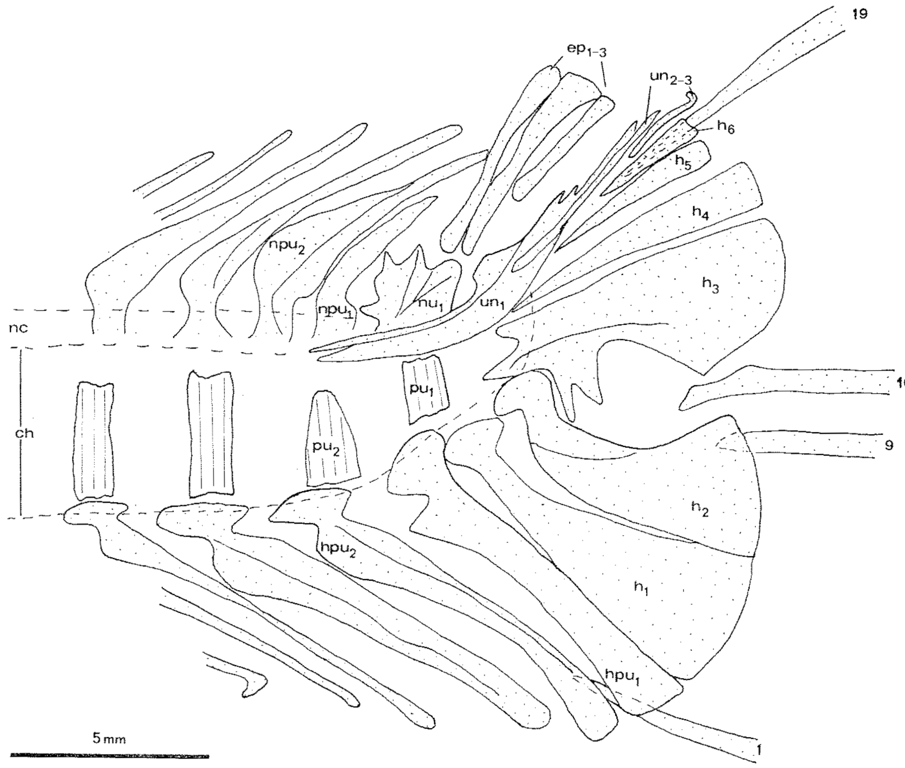


Fig. 9. Caudal skeleton of *B. nigricans* (trypsin-alizarin stained, No. 5, std. l. 220 mm). ch: chorda, ep_{1-3}: epurals, h_{1-6}: hypurals, hpu_{1-2}: haemal spine and arch of 1st-2nd preural vertebra, nc: neural canal, npu_{1-2}: neural spine and arch of 1st-2nd preural vertebra, nu_1: neural process of 1st ural element, pu_{1-2}: 1st and 2nd preural vertebra, un_{1-3}: 1st-3rd uroneural, 1-9-10-19: principal caudal fin-rays; Nos. 1 and 19 are unbranched. (Drawn by NIELS BONDE).

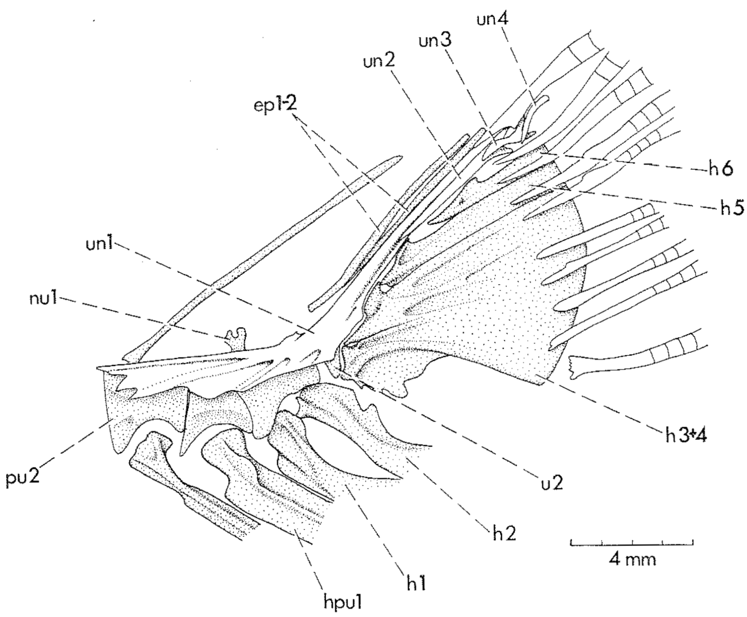


Fig. 10. Caudal skeleton of *Alepocephalus rostratus* (std. l. 26 cm). From PATTERSON (in press). npu_1 is broken. For abbreviations see Fig. 9.

the palpebral fold (= lid fold). PARR also mentioned some scattered groups of minute club-shaped organs, particularly in the region at the top of the gill cover, which presumably are luminous. Some of these organs were sectioned and they proved to belong to the lateral line system. Also MCALLISTER (1967a) mentioned the two luminous organs, even though he characterized those above the gill opening as questionable.

Caudal skeleton. GOSLINE (1960, fig. 1) published a drawing of the caudal skeleton of *Alepocephalus rostratus* Risso, 1820, which is rather similar to *B. nigricans,* but may have better ossified centra. However, the caudal skeleton of the same specimen is figured by PATTERSON (in press, fig. 12), who has interpreted the elements in a different way than GOSLINE did. According to PATTERSON, *A. rostratus* has hypural 3 and 4 fused, only two epurals, very

Table 4. Comparison between the alepocephaliform families.

	Bathylaconidae	Alepocephalidae	Bathyprionidae	Leptochilichthyidae	Searsidae
Dorsal and anal fin opposing each other	+	+	+	—	+
Ventral fins on rear half of abdomen	+	+	—	+	+
Number of pectoral fin-rays	4–11	7–18	10	11	14–28
Number of branchiostegal rays	9–10	5–8	12	13	4–8
Eyes with a rostral aphakic aperture[1]	+	+	—	—	+
Number of supramaxillaries	1	1–2	2	1	1–2
Teeth in the upper jaw	+	+	+	—	+
Photophores	—	+	—	—	+
Shoulder organ	—	—	—	—	+

+ = present; — = absent.

1. Not all Alepocephalidae and Searsidae show this character.

little development of the neural arch and spine on the anterior ural centrum, and four uroneurals on one side, the anterior being very large and probably of composite origin.

A. rostratus is apparently the only alepocephalid species of which the caudal skeleton has been examined. Figs. 9 and 10 show so many similarities that the two species must be rather closely related.

Eye. According to MUNK (1968, p. 217) there are several structural features common for *B. nigricans* and the searsid *Platytroctegen mirus* Lloyd, 1909, indicating a close relationship.

The systematic position of the family Bathylaconidae:

MARSHALL (1966) described a new genus and species, *Bathyprion danae,* for which he made a new family. He found that it belonged to a suborder of the Isospondyli, the Clupeoidea, which among other things consists of the families Alepocephalidae, Searsidae and Leptochilichthyidae, of which the latter was established in the same paper. MARSHALL made a thorough comparison between *Bathyprion* and these three families, showing that it has similarities with all of them, but still was so divergent that it needed a special family, the Bathyprionidae. Finally, in the discussion he concluded that the Bathyprionidae could be placed together with the three above-mentioned families in the division Alepocephaliformes, suborder Clupeoidea (MARSHALL 1962, p. 265), or maybe as an even better solution, in the family Alepocephalidae, which in that case should comprise four subfamilies (MARSHALL 1966, p. 9).

MARSHALL did not, however, mention the Bathylaconidae, but in Table 4 (above) this family is compared to the other alepocephaliform families. The comparison is mainly based on information from the following papers: GARMAN (1899), MARSHALL (1966) and PARR (1951, 1952, 1960). Information about the Alepocephalidae is difficult to obtain since no synopsis of this family exists.

Table 4 shows that the Bathylaconidae are most closely related to the Alepocephalidae, but are not far removed from the remaining families. The high number of branchiostegal rays, combined with the long jaws, corresponds to the conditions found in Bathyprionidae and Leptochilichthyidae (MARSHALL 1966, p. 8).

The diagnostic characters of the division Alepocephaliformes Marshall, 1962, are as follows: swimbladder absent. Small pectoral fins placed low down on the shoulders. Tendency for the loss of scales on the head. Origin of the dorsal fin nearly always behind the mid-standard length, overlapping or opposing the anal fin. Normally 7-9 branchiostegal rays. The Bathylaconidae fulfils all of these requirements.

There are divergent opinions as to whether the five families in the Alepocephaliformes should remain in the suborder Clupeoidea or form their own suborder. MARSHALL (1966) arranged the division Alepocephaliformes and BERG (1958, p. 170) and GOSLINE (1960, p. 357) the superfamilies, Alepocephaloidae and Clupeoidae, in the suborder Clupeoidea or -oidei. On the other hand, BERTIN & ARAMBOURG (1958, p. 2259), BIGELOW (1964, p. 561) and MCALLISTER (1967b, p. 540) placed the family Bathylaconidae in a separate suborder, Bathylaconoidea or -oidei, mainly based on the broad, upper branchiostegal rays. WHITEHEAD (1962, p. 745) preferred, because of the absence of a swimbladder, not to include the Alepocephalidae in the Clupeoidei. GREENWOOD *et al.* (1966, p. 394) arranged the suborders Alepocephaloidei and Bathylaconoidei in division III and the Clupeoidei in division I. They based this separation on, among other things, differences in the caudal skeleton and the vertebral column, referring to GOSLINE (1960).

The conclusion of the discussion is that we arrange the Bathylaconidae in the division Alepocephaliformes within the suborder Clupeoidea, order Isospondyli, following MARSHALL (1966). However, when the family Alepocephalidae has become better known it might turn out that the genus *Bathylaco* can be placed in this family.

SUMMARY

A redescription of the circumtropical, meso- and/or bathypelagic genus, *Bathylaco,* is made, based on 12 specimens. One of these, caught in the Gulf of Panama, represents a new species, *B. macrophthalmus,* which differs mainly from the type species, *B. nigricans* Goode & Bean, 1896, by having larger eyes and more anal fin-rays. Examination of the gonads gave, among other things, information about the size of the clutch and showed furthermore that *Bathylaco* is oviparous and dioecious. Finally, the systematic position of the monogenetic family Bathylaconidae is discussed. It is closely related to the Alepocephalidae and is therefore arranged in the division Alepocephaliformes, suborder Clupeoidea, Isospondyli.

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