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THE FISHES OF THE GENUS *BATHYLAGUS* OF THE SOUTHERN OCEAN

by

Ofer Gon

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ABSTRACT

In his revision of the genus *Bathylagus,* Norman (1930) recognized five species from the Southern Ocean. The taxonomic status of these species is re-evaluated by using morphometric data and the number of vertebrae, anal fin rays, gill-rakers, lateral scale series and pyloric caeca. Principle component analysis was carried out in support of species separation, using selected body proportions. Three species, namely *B. antarcticus, B. gracilis* and *B. tenuis,* are recognized here. *B. gracilis* and *B. euryops latifrons,* both described by Lönnberg, 1905, were found to be synonymous. A key to the species of *Bathylagus* in the Southern Ocean is provided.

INTRODUCTION

The genus *Bathylagus* was originally created by Günther (1878) for *B. antarcticus* and *B. atlanticus,* specimens of which were collected by the 'Challenger' expedition in the Antarctic Ocean and the South Atlantic Ocean respectively. In the beginning of the present century, a growing interest in Antarctica and the Southern Ocean sent a number of national expeditions to explore the Antarctic environment and biota. Three new species were described from specimens of *Bathylagus* that were collected during these expeditions. Lönnberg (1905a and b) described *B. euryops* var. *latifrons,* a supposed geographic variant of *B. euryops* (Goode & Bean, 1896) distinguished by its much wider interorbital space, and *B. gracilis* which he found to be distinctive by its long and slender body. Eight years later, Regan (1913) described *B. glacialis* from five specimens collected by the Scottish National Antarctic Expedition. He separated *B. glacialis* from *B. antarcticus* by the former's more graceful form and smaller number of anal fin rays, and from *B. gracilis* by the wider interorbital space and fewer scales on a longitudinal series. Norman (1930) based his revision of the genus *Bathylagus* on material collected in the Southern Hemisphere during 'Discovery' expeditions. In addition to the species mentioned above he recorded *B. euryops* from the Scotia Sea.

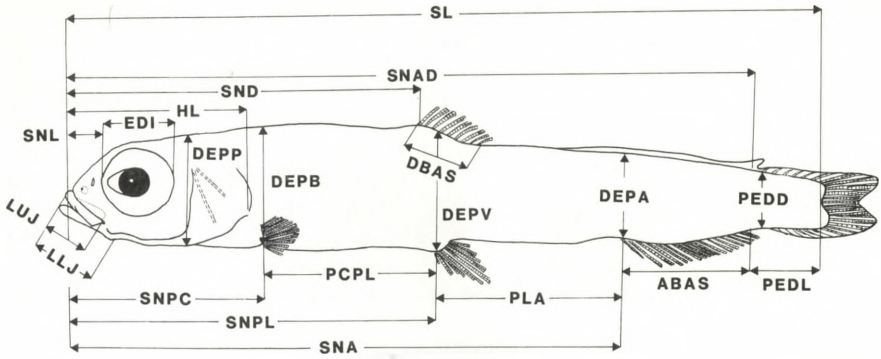

Figure 1. Measurements of *Bathylagus:* SL — standard length; DEPP — depth of head at level of preopercle; DEPB — body depth at level of pectoral fin base; DEPV — body depth at level of pelvic fin origin; DEPA — body depth at level of anal fin origin; HL — head length; SNL — snout length; EDI — eye diameter; LUJ — length of upper jaw; LLJ — length of lower jaw; DBAS — length of dorsal fin base; ABAS — length of anal fin base; PEDD — depth of caudal peduncle; PEDL — length of caudal peduncle; SND — snout to dorsal fin origin; SNAD — snout to adipose fin; SNA — snout to anal fin origin; SNPC — snout to pectoral fin base; SNPL — snout to pelvic fin origin; PCPL — pectoral fin base to pelvic origin; PLA — pelvic fin origin to anal fin origin.

Many specimens of *Bathylagus antarcticus* were collected by the R/V AFRICANA during the South African SIBEX II cruise to Prydz Bay area during February and March 1985. The specimens were taken in a single haul from about 500 meters to the surface, by a 15/41 Polish krill trawl. These were compared with the 'Discovery' material collected in the Southern Hemisphere as well as specimens collected during the international BIOMASS programme in the Southern Ocean.

METHODS

Measurements were taken to the nearest 0.1 mm. Morphological parameters were chosen for discrimination by body shape and to observe changes of body proportions in relation to size (Fig. 1). Fins were invariably damaged, thus not measured. Counts were made under a dissecting microscope with the aid of a high intensity fiber-optic light which proved invaluable especially for the fin-ray counts of small specimens. Gill-raker counts were made on the first gill arch of the left side and include rudiments. The gill-raker at the angle of the arch is smaller than the adjacent one on each side and included in the lower limb count. Fin rays of the

paired fins were counted on both sides of the fish. Scales were invariably missing and scale counts are an estimate based on scale pockets. Vertebral counts were obtained from radiographs made on photographic paper. All specimens were dissected for pyloric caeca count and for sex determination. In two or three specimens of each species the opercle on one side was cleaned by carefully scraping the skin off both sides of the bone. Due to the poor ossification of its lower edge, the opercle had to be detached from the sub and interopercle to allow the examination of the morphology of the entire bone. The opercles of all species were drawn using a camera lucida attachment on a dissecting microscope. Data analysis was done by computer, using the Statistical Package for Social Sciences (Nie *et al.*, 1975).

The specimens used in this work are deposited in the British Museum (Natural History) London (BMNH); Antarctic Division, Department of Science and Technology, Hobart, Australia (ADH); Institut für Seefischerei, Hamburg, West Germany (ISH); JLB Smith Institute of Ichthyology, (RUSI); Museum of Comparative Zoology, Cambridge, Massachusetts, USA (MCZ); Swedish Museum of Natural History, Stockholm, (SYD); United States National Museum, Washington DC, USA (USNM).

Abbreviations used for meristic characters: D — dorsal fin; A — anal fin; P — pectoral fin; V — pelvic fin; GR — gill-rakers; LSS — lateral scale series.

RESULTS

In my attempts to find distinguishing morphological characters and in order to detect allometric growth patterns, each of the measurements shown in Figure 1 was plotted against standard length for all three species. The measurements of snout length and interorbital width proved unreliable due to damaged head in most specimens and therefore were not used. Values of seven characters, DEPP, DEPB, DEPV, DEPA, PEDD, PEDL and PCPL, differed sufficiently to be of possible value in separating these species (Figs. 2-8). None of the characters chosen separated any one species from the rest without overlap. The smallest overlap was in PEDL (Fig. 7). On the other hand, when these characters were combined with the standard length by way of a principal component analysis, each character contributed to obtaining discrimination by shape and size (Fig. 9). Since at least one character, DEPV (Fig. 4) showed a distinct non-linear relationship to the standard length, all the data were transformed to their logarithm before the principal component analysis was carried out. In addition, in order to ascertain that characters other than the seven mentioned above have no discriminative value, the principal component analysis was performed twice. First with all the measurements shown in Figure 1 and secondly with the seven selected characters alone. Although separation between the species was evident in the first computer run, a much clearer picture was achieved in the second run by removing highly overlapping characters.

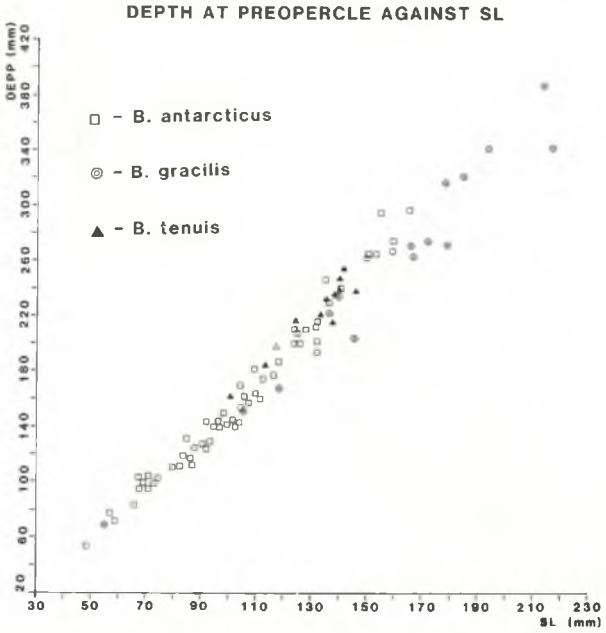

Figure 2. Depth of head at level of preopercle (DEPP) against SL in *Bathylagus* from the Southern Ocean.

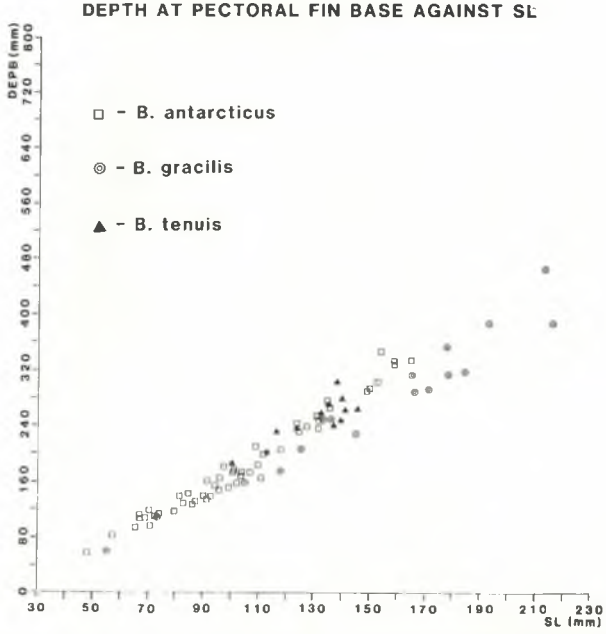

Figure 3. Depth of body at level of pectoral fin base (DEPB) against SL in *Bathylagus* from the Southern Ocean.

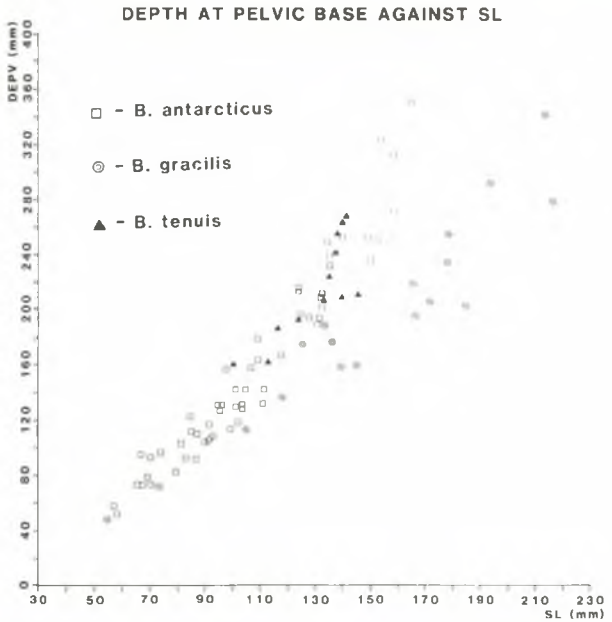

Figure 4. Depth of body at level of pelvic fin base (DEPV) against SL in *Bathylagus* from the Southern Ocean.

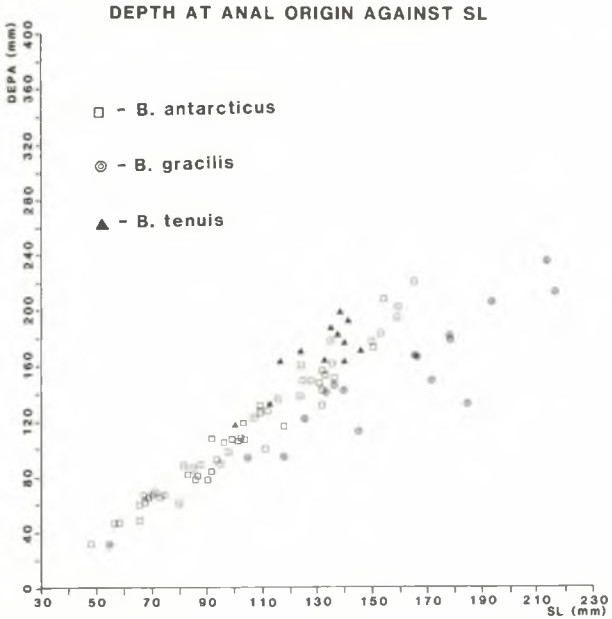

Figure 5. Depth of body at level of anal fin origin (DEPA) against SL in *Bathylagus* from the Southern Ocean.

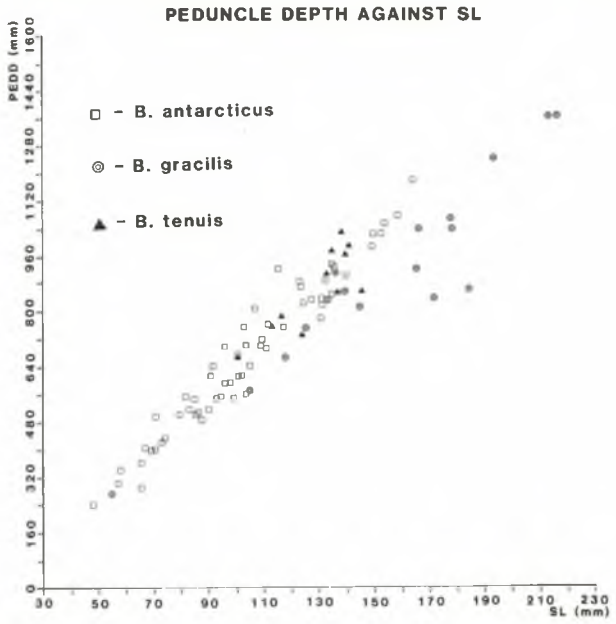

Figure 6. Caudal peduncle depth (PEDD) against SL in *Bathylagus* from the Southern Ocean.

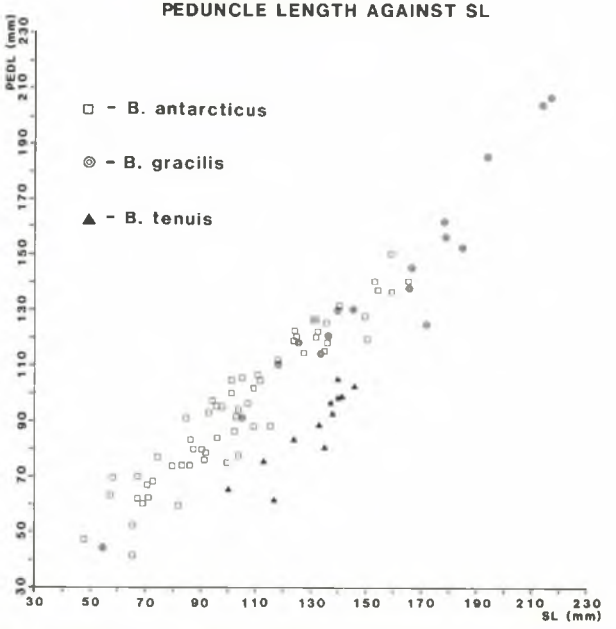

Figure 7. Caudal peduncle length (PEDL) against SL in *Bathylagus* from the Southern Ocean.

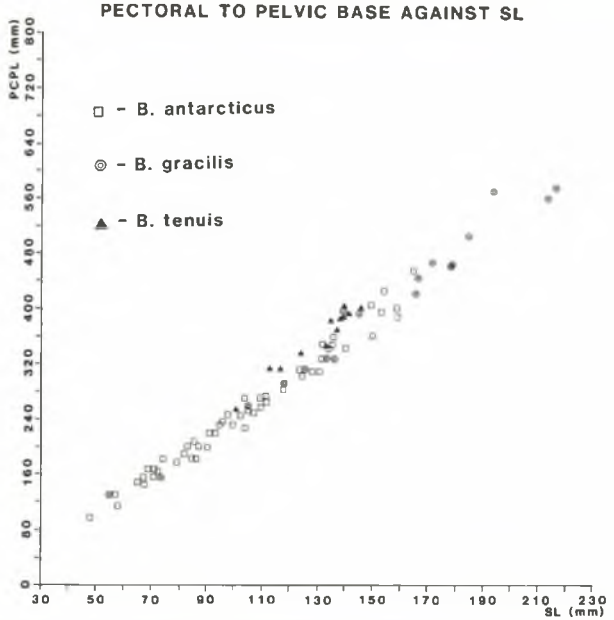

Figure 8. Distance from pectoral fin base to pelvic fin insertion (PCPL) against SL in *Bathylagus* from the Southern Ocean.

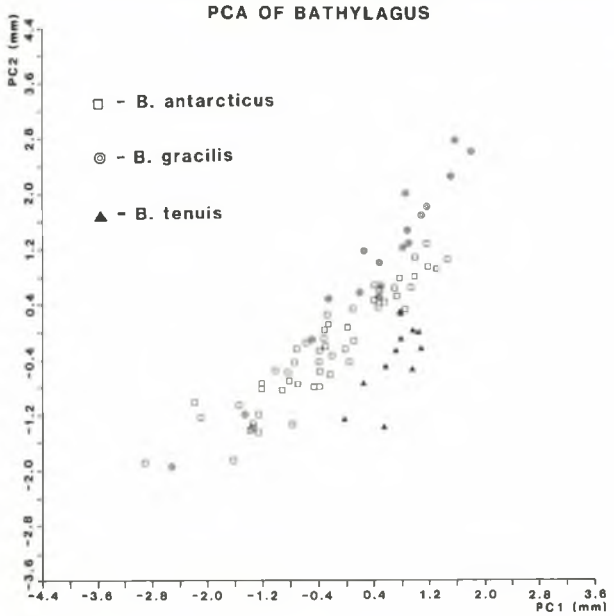

Figure 9. A plot of principal component analyses scores for *Bathylagus* from the Southern Ocean (principal component II against I) showing discrimination by shape and size.

Norman (1937) commented on the allometric growth of *B. antarcticus*. Although his material contained more than one species, he was correct in his observation. Such pattern of growth apparently exists in all three species of *Bathylagus* in the Southern Ocean. It is most evident from the relationships between DEPV and the standard length (Fig. 4), in which the change in the proportion is dramatic, and from the wide range of some proportions shown in the diagnoses below. Considering the large variation in counts and measurements exhibited by many, if not all, species of *Bathylagus*, a large sample of all sizes should ideally be used for morphometric studies. Unfortunately, a large enough sample was obtained only for *B. antarcticus*. The available collections of the other two species are small and consist mainly of large specimens. Therefore, the key below is designed for specimens larger than 110 mm SL.

In the diagnoses below the ranges of proportions refer to specimens larger than 100 mm SL and data in paraentheses refer to the whole sample; proportions are ratios of measurements divided into SL unless designated otherwise.

Key to species of *Bathylagus* in the Southern Ocean

(for specimens larger than 110 mm SL)

1a. Vertebrae 43-50; GR 24-30; LSS 37-43; eye diameter 2.0-2.8 in head length 2

1b. Vertebrae 48-52; GR 26-36; LSS 31-38; eye diameter 1.8-2.4 in head length; DEPA 7.4-11.1 in SL . . . . . *B. antarcticus*

2a. Vertebrae 43-47; A rays 15-20; PEDL 1.3-2.5 in anal fin base; PEDD 1.3-1.8 in PEDL; DEPA 9.0-14.0; PCPL 4.0-4.2 in SL . . . . . *B. gracilis*

2b. Vertebrae 46-50; A rays 20-24; PEDL 2.2-4.1 in anal fin base; PEDD 0.8-1.2 in PEDL; DEPA 6.9-8.6; PCPL 2.9-3.9 in SL . . . . . *B. tenuis*

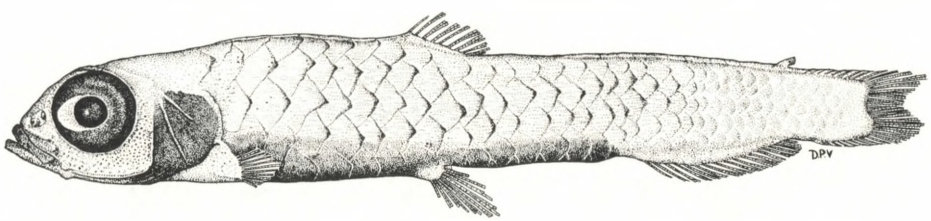

Figure 10. *Bathylagus antarcticus* RUSI 22662, 107.5 mm SL, male.

Bathylagus antarcticus Günther

Figs. 10 & 11

Bathylagus antarcticus Günther, 1878: 248 (type locality: 53°55'S, 108°35'E); 1887: 220; Regan, 1914: 38; Norman, 1930: 276; 1937: 81; Efremenko, 1979: 156; 1983: 5.

Bathylagus glacialis Regan, 1913: 231, pl. 9, fig. 2 (type localities: 68°25'S, 27°10'W; 68°32'S, 12°49'W; 71°50'S, 23°30'W; 71°22'S; 16°34'W; 71°32'S, 17°15'W); 1914: 38; Norman, 1930: 275; Andriashev, 1959: 4.

Bathylagus gracilis (non Lönnberg) Andriashev, 1959: 4.

Bathylagus sp. Krefft, 1958: 251; Kock, 1982: 98,108.

DIAGNOSIS: Counts are based on 100 specimens 48-168 mm; 59 specimens (48.1-165 mm) were measured. Frequency distributions of the counts are presented in Tables 1-5.

D 8-11; A 16-24; P 9-12; V 8-9; GR 26-36; LSS 31-38; pyloric caeca 3-5; vertebrae 48-52.

Body elongate and compressed, deep in front of dorsal fin and somewhat more slender behind its. DEPP 5.2-6.9 (5.2-8.9), DEPB 4.4-6.7 (4.4-8.6), DEPV 4.7-8.4 (4.7-12.8), DEPA 7.4-11.1 (7.4-15.5), head 4.0-5.6 (3.9-5.6); eye 1.8-2.4 (1.4-2.5) in HL.

Mouth small, maxilla reaching under anterior margin of eye; gill opening restricted to lower quarter or third of head. Dorsal fin originates anterior to or at about mid-body; SND 2.0—2.3 (2.0—2.3); DBAS 11.5—13.9 (10.6—14.7), ABAS 5.4—6.8 (4.2—7.0) PEDL 10.2—12.6 (8.4—15.9) PEDD 1.2—1.6 (1.0—2.0) in its length. Pelvic fins inserted closer to pectoral fin, in the middle between pectoral and anal fins or closer to the latter, depending on size of the specimen; PCPL 3.6—4.2 (3.6—5.1), PLA 3.8—4.7 (3.6—5.3).

Colour: In live fish — upper part of body and tail pale blue; lower half of body from opercle to anal fin origin dark, metallic blue to black, snout and jaws dark, but cheek paler; lining of lower half of orbit irridescent blue; rear margin of scale pockets dark; body, head and fins sometimes covered with small dark spots which may be larger on the cheek; fins dusky.

In alcohol — pattern remains the same; the general colour may change from yellow to brown, depending on period in preservative; dark blue areas turn to dark brown or black; intestine pale; peritoneum, mouth and gill chamber dark.

DISTRIBUTION: Circum-Antarctic and Southern Atlantic Indian and Pacific Oceans (Norman, 1937; Cohen, 1986). Specimens of *B. antarcticus* were caught between the surface and about 4 000 m.

REMARKS: *Bathylagus antarcticus* is closely related to *B. gracilis*. They differ in the numbers of pectoral fin rays (Table 1), vertebrae (Table 3), gill-rakers (Table 4) and lateral scale series (Table 5). *B. antarcticus* is somewhat more robust from the pelvic fins posteriorly (Figs. 4—6). In addition, *B. antarcticus* is a smaller species, the largest specimen I have examined was 167.7 mm SL. The largest specimen of *B. gracilis* was 217 mm SL.

B. antarcticus is also closely related to *B. pacificus* Gilbert, 1890. They differ in the number of pectoral fin rays (Table 1), and vertebrae (Table 3), but otherwise show a substantial overlap in meristic as well as morphometric characters (see also remarks for *B. gracilis).*

Norman's (1930) series of 'Discovery' specimens of *B. antarcticus* are of special interest. He reported seven specimens from three different stations. Of these, the specimen from Station 71 (BMNH 1930.1.12.36), labelled as *B. benedicti,* was originally identified as *B. antarcticus* (Wheeler, pers. comm.), but is here re-identified as *B. tenuis* (see below). The large specimen (BMNH 1930.1.12.37) and at least the largest of the three small ones (BMNH 1930.1.12.38) from Station 101 are probably *B. bericoides;* of the two specimens from Station 151 (BMNH 1930.1.12.39—40), one is *B. antarcticus* and the other was lost (Wheeler, pers. comm.); another specimen from this station (BMNH 1930.1.12.44), originally labelled as *B. benedicti,* was correctly re-identified possibly by Norman, as *B. antarcticus.* A specimen from Station 169 (BMNH 1930.1.12.48) was reported by Norman (1930) as *B. euryops,* but was redetermined as *B. antarcticus* at a later stage, possibly when he worked on the fishes of B.A.N.Z. expedition (Norman, 1937). In addition, in a footnote at the end of his account on *B. glacialis,* Norman (1930: 295) stated that of the two syntypes held in the British Museum collection one is *B. euryops.* I have examined these syntypes, both of which proved to be *B. antarcticus.* Norman (1930) apparently based his identification on the relatively low number of anal fin rays of the syntypes (17 and 18). However, both specimens have counts of 50 vertebrae and 31 gill-rakers, typical of *B. antarcticus,* whereas *B. euryops* has 44—48 vertebrae and 24—28 gill-rakers (pers. obs.).

The larvae of *B. antarcticus* were described by Efremenko (1979; 1983). Krefft (1958) collected a larva which he could not identify with certainty and stated that pigment is present only on the caudal end of the vertebral column and behind the anus. His specimen is most probably *B. antarcticus* since none of the other species appear south of 60°S. Kock (1982) collected larvae similar to those described by Efremenko (1979, 1983) but did not accept Efremenko's identification on the ground that more than one species of *Bathylagus* is known from the Scotia Sea. A larva collected in the Indian Ocean sector (60°59'55''S, 52°59'09''E) during the South African SIBEX II expedition (Fig. 11) generally agrees with Efremenko (1983). This specimen has a cluster of melanophores on the opercle and a short line of minute melanophores on the side of the brain which are not shown by Efremenko (1983); it appears that Efremenko's drawings of *Bathylagus* larvae are too generalized. The anal and dorsal fin primordia are shown with a dark margin, but this is white in my specimen. Efremenko (1979, 1983) does not mention such pigmentation in the description of the larvae and it is probably a result of the printing process. My acceptance of Efremenko's (1979, 1983) description of the larvae of *B. antarcticus* is based on the number of myotomes, 48—52, which can only be this species.

The sex ratio in the entire sample was 70 females: 29 males: 4 juveniles.

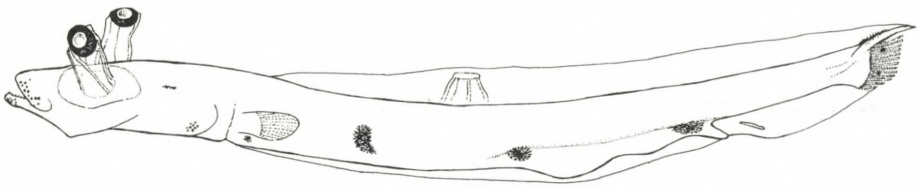

Figure 11. *Bathylagus antarcticus* larva, 25.0 mm SL.

Bathylagus gracilis

Fig. 12

Bathylagus gracilis Lönnberg, 1905a:762: 1905b: 68 (type locality: 49°56'S, 49°56'W).
Bathylagus euryops (non Goode & Bean) var. *latifrons* Lönnberg, 1905b: 67 (type locality: 49°56'S, 49°56'W)

DIAGNOSIS: Based on 18 specimens 55—217 mm, (3 fish less than 110 mm).

D 9—11; A 15—20; P 8—10; V 8—9; GR 24—29; LSS 38—43; pyloric caeca 3—6 (1 with 9); vertebrae 43—47.

Body elongate and compressed, the anterior half deep and robust and the posterior half considerably more slender, DEPP 5.5—7.1 (5.5—8.0), DEPB 4.6—6.8 (4.6—9.1), DEPV 6.3—9.1 (6.3—11.5), DEPA 9.1—14.0 (9.1—17.8); head 4.0—4.8 (4.0—4.8); eye 2.0—2.7 (2.0—2.7) in head length.

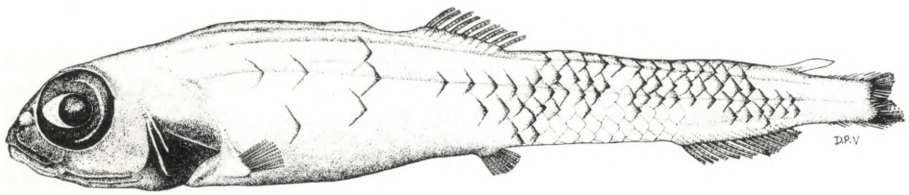

Figure 12. *Bathylagus gracilis* ISH 421/76, 217 mm SL, female.

Mouth small, maxilla reaching slightly beyond anterior margin of eye; gill opening restricted to lowest quarter of head. Dorsal fin inserted anterior to or at mid—body, SND 2.0—2.2 (2.0—2.3), DBAS 9.8—13.1 (9.6—13.1), ABAS 5.6—7.9 (5.1—7.9) PEDD 1.3—1.8 (1.3—1.8) in its length, and much shorter than anal fin base; PEDL 10.5—13.8 (10.5—13.8); pelvic fins inserted closer to anal fin origin than to pectoral fin base, PCPL 4.0—4.2 (4.0—4.7) PLA 4.0—5.0 (4.0—5.0).

Colour: In alcohol — generally brown, abdomen dark brown to black; body and head covered with diffuse pigment that sometimes forms minute dark spots; operculum and snout dark, cheek paler; mouth and gill chamber dark; fins dusky and sometimes spotted; peritoneum black; intestine pale. Colour in life not known.

DISTRIBUTION: Scotia Sea, south-west Atlantic Ocean and south-east Pacific Ocean. *B. gracilis* were caught at various depths between the surface and 2700 m.

REMARKS: *Bathylagus gracilis* is closely related to *B. antarcticus* (see remarks of the latter), but more so to *B. pacificus*. Counts (on 20 specimens) and measurements (on 8 specimens 73.8—163.3 mm) of *B. pacificus* from the North Pacific Ocean and Bering Sea, and the data published by Rass and Kashkina (1967) were compared to *B. gracilis*. Most of the counts for these two taxa were in complete agreement, except for a slightly wider range in *B. pacificus* for the dorsal fin rays (8—11), anal fin rays (15—21), pectoral and pelvic rays (7—10 for both), as well as a range of 37—42 lateral-line scales (Rass and Kashkina, 1967). The number of gill-rakers, however, has a much wider range in *B. pacificus* (25—34). The measurements were also in agreement between the two species. On one hand, the agreement in the measurements and most of the counts indicates a possible synonymy. On the other hand, the wider range of the gill-raker counts in *B. pacificus* (Table 4) as well as an apparent difference in the maximum size attained by these species opposes such synonymy. The maximum size I have measured was 217 mm SL for *B. gracilis* and 170 mm SL for *B. pacificus;* Rass and Kashkina (1967) measured a maximum of 171.6 mm for 209 *B. pacificus* but did not specify if it is standard length or total length. Other reports in the literature are estimates that cannot be relied on (Clemens and Wilby 1961; Fitch and Lavenberg, 1968). At present, a definite conclusion on the taxonomic status of *B. gracilis* cannot be reached due to the small sample size.

As in the case of *B. antarcticus,* Norman's (1930) 'Discovery' series of *B. gracilis* contained more than one species. The Southern Ocean specimens collected by the 'William Scoresby', Station 303 (BMNH 1930.1.12.34) and 307 (BMNH 1930.1.12.35) and at least one specimen from Station 151 (BMNH 1930.1.12.31—33) were re-identified as *B. antarcticus*. The specimens from Station 76 (BMNH 1930.1.12.29—30), outside the Southern Ocean, are provisionally regarded as *B. gracilis,* but also agree with *B. pacificus*.

It should be noted that Lönnberg (1905a and b) published two descriptions of *B. gracilis* n.sp. with conflicting locality data. However, in a footnote in the earlier, original description Lönnberg (1905a) stated that the locality data may have to be changed since the scientific account of the observations has not been completed yet. The corrected localities were included in the second description, in the complete report on the fishes collected during the Swedish South Polar expedition (Lönnberg, 1905b).

In a recent paper, Lisovenko *et al.* (1986) attempted to confirm the validity of *B. gracilis* as a separate species from *B. antarcticus*. Both works show that these species can be separated easily on the basis of meristic characters. My counts of anal fin rays, gill-rakers, vertebrae and pyloric caeca for *B. antarcticus, B. gracilis* and *B. tenuis* were compared with the data given by Lisovenko *et al.* (1986) for the former two species, and Kobyliansky (1986) for the latter species (Table 6); a major disagreement was immediately evident. My data for *B. antarcticus* agree with *B. gracilis* of Lisovenko *et al.* (1986). *B. antarcticus* of Lisovenko *et al.* (1986) seem to agree more with *B. tenuis* of the present study and Kobyliansky (1986) than with my *B. gracilis*. Since I have examined the type specimens of both *B. antarcticus* and *B. gracilis* (Tables 1—5), I can only conclude that Lisovenko *et al.* (1986), who apparently did not see these types, confused all three species. Consequently, their study of the reproduction of *B. gracilis* was actually performed on *B. antarcticus*.

The sex ratio in the Antarctic specimens of *B. gracilis* that I examined was 15 females: 2 males: 1 juvenile. The larva of this species is not known.

Bathylagus tenuis

Fig. 13

Bathylagus tenuis Kobyliansky, 1986: 40, fig. 20a (type locality: 40°17'S, 50°01'W).
Bathylagus antarcticus Norman, 1930: 276 (in part).

DIAGNOSIS: based on 12 specimens 100.5-146.0 mm. The proportions of the smallest specimen, the only one under 110 mm, fall within the range of proportions given below.

D 9-11; A 20-24; P 8-10; V 8-9; LSS 37-41; predorsal scales 9-10; GR 7-9 + 16-21 = 24-30; pyloric caeca 4-6; vertebrae 46-48.

Body relatively short and compressed, the depth decreasing gradually towards the tail. DEPP 5.5-6.4, DEPB 4.6-5.7, DEPV 5.3-7.0, DEPA 7.0-8.6; head 4.1-4.8 in SL; eye 2.1-2.5 in head length.

Mouth small, maxilla reaching under anterior margin of pupil; gill opening restricted to lower quarter of head. Dorsal fin origin on anterior half of body; SND 2.0-2.2, DBAS 9.1-11.3; ABAS 4.4-6.0. Caudal peduncle much shorter than anal fin base, PEDL 13.4-19.2; PEDD 0.8-1.2 in its

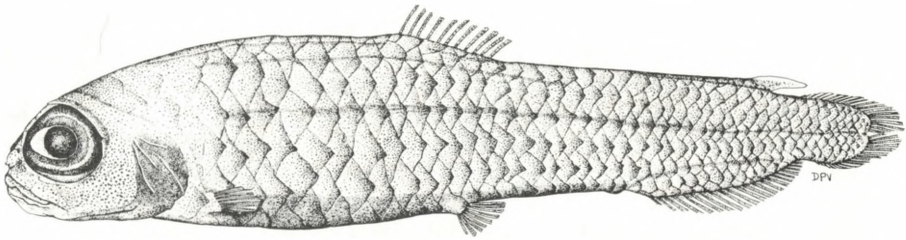

Figure 13. *Bathylagus tenuis* ISH 377/76, 138.5 mm SL, female.

length; pelvic fins inserted closer to anal fin origin than to pectoral fin base, PCPL 3.5-4.0, PLA 4.2-5.3.

Colour: In alcohol — generally brown; head and body covered with small, dark spots; snout and opercle dark, cheek pale; abdomen dark brown to black; fins dusky and spotted; scale pockets pale purple with dark rear edge; mouth cavity and gill chamber dark; gill arch and gill-rakers dusky; peritoneum black, intestine pale. Colour in life not known.

DISTRIBUTION: Scotia Sea, central South Pacific Ocean and southeast Atlantic Ocean. *B. tenuis* were caught at various depths between the surface and 2 600 m.

REMARKS: Despite the apparent similarity in shape, *Bathylagus tenuis* is not closely related to either *B. antarcticus* or *B. gracilis*. Nevertheless, the morphometric characters of *B. tenuis* show a higher degree of resemblance to *B. antarcticus*. Regressions of DEPP, DEPB, DEPV, DEPA and PEDD of both species closely follow each other, while *B. gracilis* shows a different growth pattern (Figs. 2, 4-6). The regression of PEDL for *B. tenuis* is separated from both other species (Fig. 7). The situation is reversed with regard to meristic characters. *B. tenuis* is closer to *B. gracilis* in its counts of vertebrae, pyloric caeca, gill-rakers and lateral scales series (Tables 2-5). In addition, a marked difference was observed in the shape of the opercle between *B. tenuis* and the other species (Fig. 14). A comparison of *B. tenuis* with the data given by Cohen (1964) for *B. euryops* Goode and Bean, 1896, suggests a close relationship between these species.

I have examined the holotype of *B. atlanticus Günther,* 1878 (in bad condition) as well as specimens of *B. euryops* from the north Atlantic Ocean. A similar opercle shape as well as a low number of vertebrae (44) and a relatively slender caudal peduncle (PEDD 1.4 in PEDL), indicate that *B. antlanticus* may be more closely related to *B. euryops* than to *B. tenuis*. Moreover, *B. atlanticus* has only 13 anal fin rays. An examination of its radiograph revealed no abnormalities of the axial skeleton or fins. This implies that associating *B. atlanticus* with *B. euryops* is reasonable since the

range of the number of anal fin rays of the latter (16-19) is lower than the range in *B. tenuis*. In addition I have examined a specimen (BMNH 1930.1.12.36) collected by 'Discovery', Station 71, currently labelled as *B. benedicti*. The specimen, originally identified by Norman (1930) as *B. antarcticus*, is recognized here as *B. tenuis*. It is possible that this specimen was renamed by Norman when he worked on the fishes of the B.A.N.Z. expedition (Norman, 1937).

The sex ratio of my sample was 8 females: 3 males.

DISCUSSION

The major taxonomic problem in the genus *Bathylagus* lies in the difficulty of distinguishing the species from one another. Frequently, the great morphological resemblance as well as the high degree of intraspecific variability and interspecific overlap of merisitic and morphometric characters make the task of identification virtually impossible. Furthermore, due to their delicate structure, specimens often get damaged in the trawl in parts of their body vital for identification. In addition, the results of this study indicate that the smaller the fishes the greater is the interspecific resemblance and overlap in important characters (Figs. 2-8). The allometric growth of *Bathylagus* seems to be expressed mostly in the vertical dimension of the body. The various depth characters (DEPB, DEPV, DEPA and PEDD) serve as good differentiating characters for separating *B. gracilis* from the other two species due to different growth rates in different species (Figs. 2-6). In the horizontal dimension the only character that is of value in separating the species is PEDL (Fig. 7). Lönnberg (1905b) erroneously used slenderness of the body as his main argument for separating *B. gracilis* from *B. euryops* var. *latifrons*. His three specimens, two of which were collected at the same station, differed greatly in size. Due to the non-linear relationship between various morphometric characters and standard length, comparisons of small specimens with large ones should be avoided. Furthermore, the condition of the fishes may also affect their dimensions. Most of the fat is stored in the front half of the body, under the skin and around visceral organs; since *Bathylagus* lacks a swim-bladder and its anterior part of the body carries most of its bulk, the positioning of stored fat is essential for buoyancy compensation.

Kobyliansky (1985) has shown the importance of the opercle morphology as a distinguishing character. The opercle morphology of the three Southern ocean species was compared with *B. pacificus* Gilbert, 1890 (Fig. 14). The similarity of the structure of *B. antarcticus*, *B. gracilis* and *B. pacificus* is a good indication of the close relationship of these three species. The opercle of *B. tenuis* is markedly different (Fig. 14c).

Lisovenko *et al.* (1986) apparently confused *B. antarcticus* with the other Southern Ocean species (see Remarks for *B. gracilis* above). Thus, I cannot consider their localities as reliable distribution records. At present, *Bathylagus antarcticus* is the only species found south of 60°S, and it has a circum-

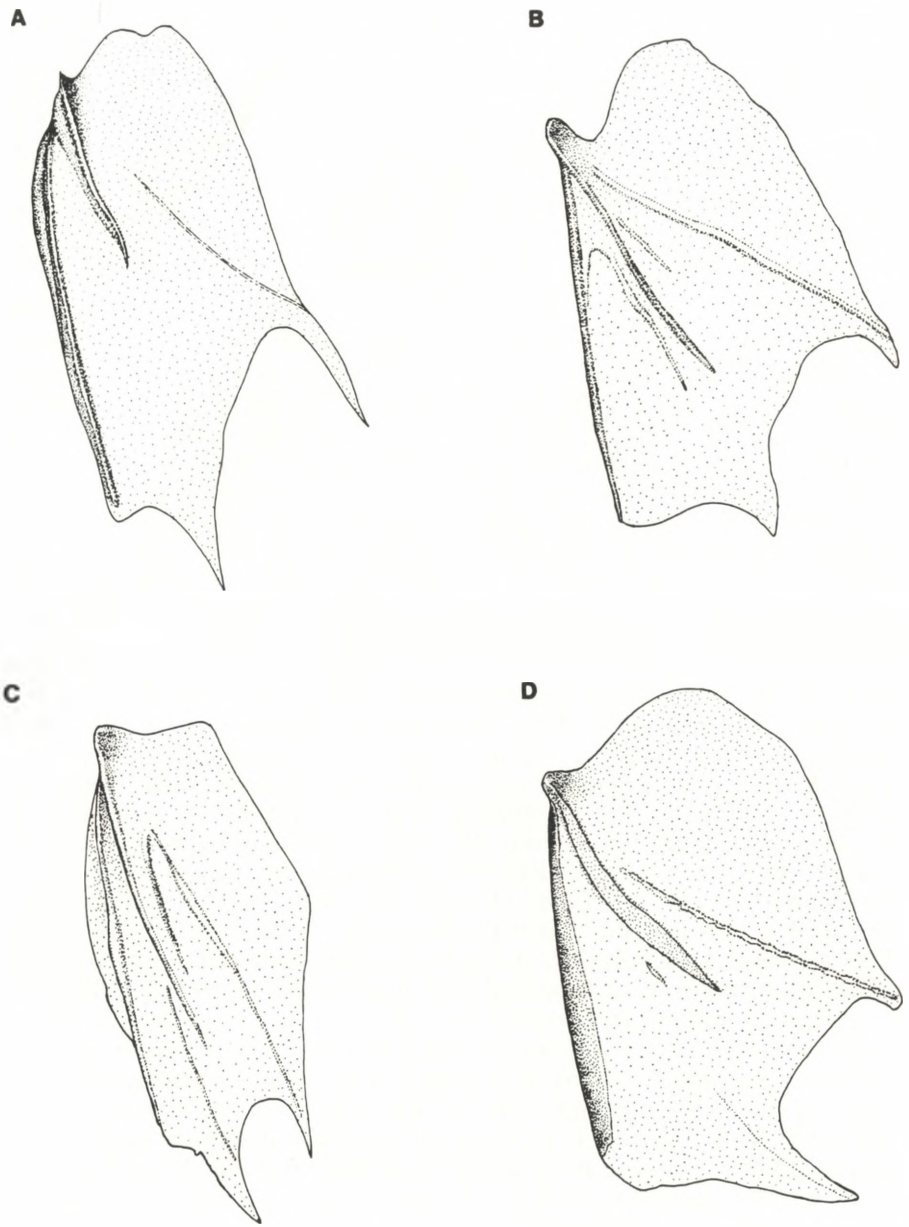

Figure 14. Opercular bones of some species of *Bathylagus:* A *B. antarcticus;* B *B. gracilis;* C *B. tenuis;* D *B. pacificus.*

Antarctic distribution. The wide range reported by Bussing (1965) for vertebrae (44-50) in *B. antarcticus* from Chile, indicates the presence of at least two species, one of which may be *B. gracilis*. *Bathylagus tenuis* is known from the south-east Atlantic Ocean and the central South Pacific Ocean, and will probably be found in other localities between the two and farther north.

It is virtually impossible to determine the vertical distribution of Southern Ocean *Bathylagus* since most works report on hauls from a certain depth, usually great depths, to the surface. A good example of such a haul is the collection off Mawson Station in the Indian Ocean sector during the South African SIBEX II expedition. The net was hauled from 500 m to the surface and contained hundreds of specimens of all sizes. It does provide evidence of schooling in these fishes, but there is no telling whether there is depth selection according to size.

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Table 1. Frequency distribution of dorsal, pectoral and pelvic fin rays in species of *Bathylagus* from the Southern Ocean (* = holotype). Data for the holotype of *B. tenuis* are taken from Kobylianski (1986).

	Dorsal rays				Pectoral rays					Pelvic rays		
	8	9	10	11	8	9	10	11	12	8	9	10
B. antarcticus	3	50	42*	5		10	67*	19	2	42*	51	1
B. tenuis		3	9*	1	2	4	7*			4	8	1*
B. gracilis		8	9*	1	3	12*	3			12	6*	
B. pacificus	1	16	2	1	1	16	3			15	4	

Table 2. Frequency distribution of anal fin rays and pyloric caeca in species of *Bathylagus* from the Southern Ocean (* = holotype). Data for the holotype of *B. tenuis* are taken from Kobylianski (1986).

	Anal fin rays											Pyloric caeca				
	15	16	17	18	19	20	21	22	23	24	25	3	4	5	6	9
B. antarcticus		2	3	17	31	23	16*	3	2	1	1	29	59*	7		
B. tenuis						3	4	5*	1				4	5*	3	
B. gracilis	2	3	3	5	4*	1						1	8	6	1	1
B. pacificus		1	1	4	3	8	1					4	11	5		

Table 3. Frequency distribution of vertebrae in species of *Bathylagus* from the Southern Ocean (* = holotype). Data for the holotype of *B. tenuis* are taken from Kobylianski (1986).

	Vertebrae									
	43	44	45	46	47	48	49	50	51	52
B. antarcticus						2	16*	36	34	11
B. tenuis				2	6	4	*			
B. gracilis	1	3*	5	7	2					
B. pacificus			2	10	5	2				

Table 4. Frequency distribution of gill-rakers in species of *Bathylagus* from the Southern Ocean (* = holotype).

	Number of gill-rakers													
	24	25	26	27	28	29	30	31	32	33	34	35	36	
B. antarcticus			1	2	9	17	17	24*	17	4	2	2	2	2
B. tenuis	1	2	3	1	3	1	1							
B. gracilis	3	3*	2	4	5	1								
B. pacificus		1	1	4	4	1	4	2	2	2		1		

Table 5. Frequency distribution of lateral scale series (LSS) in species of *Bathylagus* from the Southern Ocean based on approximate counts of scale pockets (* = holotype of *B. tenuis* from Kobylianski, 1986).

	Lateral Scale Series												
	31	32	33	34	35	36	37	38	39	40	41	42	43
B. antarcticus	2	6	3	6	6	3	2	1					
B. tenuis							1	2	2		1		1*
B. gracilis								1	2		3	1	1

Table 6. Comparison of some meristic characters of species of *Bathylagus* from the Southern Ocean based on the present study, Lisovenko *et al.* (1986) and Kobyliansky (1986). The first range for each species is based on specimens examined by the author.

	Anal rays	Vertebrae	Gill-rakers	Pyloric caeca
B. antarcticus	16-25	48-52	26-36	3-5
Lisovenko *et al.*	20-23	45-48	23-27	4-7
B. gracilis	15-20	43-47	24-29	3-5
Lisovenko *et al.*	16-21	49-52	27-33	3-5
B. tenuis	20-23	46-48	24-29	4-6
Kobyliansky	21-24	47-50	—	4-6

MATERIAL EXAMINED

(The number of specimens, if greater than 1, is followed by the size range in mm SL

Bathylagus antarcticus: BMNH 1887.12.7.230: holotype, 109.5 mm, female, 53°55'S, 108°35'E, 1950 fm, 'Challenger', Stn 157; BMNH 1912.7.1.63: syntype of *B. glacialis*, 79.8 mm, female, 68°25'S, 27°10'W, vertical net, 1000 fm, *'Scotia', Stn 398, 29 Feb. 1904; BMNH 1912.7.1.64: syntype of B. glacialis*, 90.3 mm, male, 71°50'S, 23°30'W, vertical net, 1000 fm, 'Scotia', Stn 414, 15 Mar. 1904; BMNH 1930.1.12.27-28: one of 2 specimens, 103.9 mm, female, 46°56'S, 46°03'W, 4.5 m net, 1050-1350 m, 'Discovery', Stn 239, 2 June 1927; BMNH 1930.1.12.31-33: 2 of 3 specimens, 32.9-33.8 mm, juveniles, 53°25'S, 35°15'W, 4.5 m net, 1025-1275 m, 'Discovery', Stn 151, 16 Jan. 1927; BMNH 1930.1.12.34: 48.1 mm, 45°51'24''S, 31°20'12''W, 0.7 m tow-net, 1000-750 m. 'William Scoresby' Stn 303, 6 Oct. 1928; BMNH 1930.1.12.35: 58.3 mm, female, 54°19'30''S, 30°31'30''W, 0.7 m tow-net, 1000-780 m, 'William Scoresby', Stn 307, 7 Oct. 1928; BMNH 1930.1.12.39-40: one of 2 specimens, 131.7 mm, female, 53°25'S, 35°15'W, 4.5 m net, 1025-1275 m, 'Discovery', Stn 151, 16 Jan. 1927; BMNH 1930.1.12.48: 70.8 mm, female, 60°48'50''S, 51°00'20''W, young-fish trawl, 1000-1100 m, 'Discovery', Stn 169, 22 Feb. 1927; BMNH 1937.9.21.160-161: 3, 57.2-150.2 mm, females, 65°10'S, 109°32'E, 2 m net, 710-0 m, B.A.N.Z., Stn 96, 26 Jan. 1931; ISH ex-388/76: one of 12 specimens, 103.9 mm, female, 54°12'S, 40°02'W, 2600 m, 'Walther Herwig', Cruise 388, Stn 97-11/76, 3 Jan. 1976; RUSI 22662: 107.3 mm, male, 62°01.7'S, 57°57.7'E, Bongo 500 net, 0-250 m, SIBEX I, SA 'Agulhas', Stn 23, 8 Apr. 1984; RUSI 22841: 30 of 238 specimens, 67.3-165.0 mm, 24 females and 6 males, off Mawson Station 66°20.38'S, 62°03.96'E, 15/40 Polish krill trawl, 0-500 m, SIBEX II, 'Africana', Stn 03-04, 7 Mar. 1985; USNM 274663: 41.0 mm, 69°03'S, 179°53'E, 500-1000 m, 'Eltanin', Cruise 27, Stn 1885, 1 Feb. 1967; USNM 274665: 45.1 mm, 68°05'S, 126°47'W, 250-500 m, 'ELtanin', Cruise 17, Stn 417, 7 Apr. 1965; USNM 274666: 108.0 mm, male, 63°04'S, 135°02'W, 250-500 m, 'Eltanin', Cruise 17, Stn 411, 1 Apr. 1965; USNM 274668: 115.6 mm, male, 60°15'S, 120°05'W, 825-975 m, 'Eltanin', Cruise 21, Stn 19, 27 Dec. 1965; USNM 274669: 5 of 7 specimens, 45.0-138.3 mm, 2 males and 3 females, 64°03'54''S, 149°57'42''E to 64°08'48''S, 150°11'36''E, 0-1500 m, 'Eltanin', Cruise 38, Stn 7 IK-2, 1 Apr. 1969; USNM 274670: 99.5 mm, male, 61°05'S, 120°15'W, 800-925 m, 'Eltanin', Cruise 21, Stn

20, 28 Dec. 1965; USNM 274672: 19, 37.1-126.4 mm, 6 males, 12 females and one juvenile, 58°30''S, 117°03'30''E to 58°37'S, 117°12'E, 750 m, 'Eltanin', Cruise 35, Stn 2297, 26 Sep. 1968; USNM 274695: one of 3 specimens, 48.8 mm, female, 64°05'S, 150°03'E to 64°11'18''S, 150°37'E, 0-750 m, 'Eltanin', Cruise 38, Stn 7 1K-1, 1 Apr. 1969; ADH S85184,387-88: 3, 113.0-167.7 mm, females, 64°59.7'S, 83°00.1'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 22 Jan. 1985; ADH S85069-70: 2, 87.3-150.5 mm, females, 63°00.4'S, 77°59.7'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 19 Jan. 1985; ADH S85284,86,88,90: 4, 57.1-159.4 mm, one female and 2 males. 62°59.9'S, 83°00.2'E, RMT 8, 0-1000 m, 'Nella Dan' SIBEX II, 22 Jan. 1985; ADH S85084,85,88: 3, 76.0-106.0 mm, one male and 2 females, 64°58.1'S, 87°58.1'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 25 Jan. 1985; ADH S85392: 98.2 mm, female, 66°00.1'S, 67°59.1'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 11 Jan. 1985; ADH S85405,15: 2, 88.1-95.1 mm, females, 63°00.4'S, 58°00.5'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 5 Jan. 1985; ADH S85298,300: 2, 76.5-104.5 mm, female and male, 62°59.9'S, 67°58.5'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX 11, 10 Jan. 1985; ADH S85248,52,54,57: 4, 64.2-120.0 mm, two males and 2 females, 62°59.9'S, 87°59.8'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 24 Jan. 1985; ADH S85195,201,211: 3, 48.3-90.2 mm, one juvenile and 2 females, 62°59.9'S, 62°59.9'E, RMT 8, 0-1000 m, 'Nella Dan', SIBEX II, 8 Jan. 1985.

Bathylagus tenuis: BMNH 1930.1.12.36: 146.0 mm, female, 43°20'S, 46°02'W, young-fish trawl, 2000—0 m, 'Discovery', Stn 71; ISH 377/76: 138.5 mm, female, 54°07'S, 39°59'W, midwater trawl, 650 m, 'Walther Herwig', cruise 377, Stn 97—1, 3 January 1976; ISH 997/76: 4, 113.3—141.5 mm, females, 54°12'S, 40°02'W, 0—2600 m, midwater trawl, 'Walther Herwig', cruise 388/76, Stn 97—II/76, 3 Jan. 1976; ISH 999/76: 140.0 mm, female, 53°18'S, 49°57'W, 700 m, midwater trawl,'Walther Herwig', cruise 252/76, Stn 12/76, 23 Nov. 1975; USNM 247671: 5, 100.7—135.3 mm, 2 females and 3 males, 56°10'S, 156°09'W to 56°13'S, 156G12'W, 200 m, 'Eltanin', cruise 25, Stn 362, 11 Nov. 1966.

Bathylagus gracilis: SYD 1902.265.4197: syntype, 55.3 mm, 49°56'S, 49°56'W, 2700 m, 27 June 1902; SYD 1902.265.3951: holotype of *B. euryops* var. *latifrons,* 194.0 mm, female, 49°56'S, 49°56'W, 2700 m, 27 June 1902; BMNH 1930.1.12.31—33: largest of the 3 specimens, 73.9 mm, female, 53°25'S, 35°15'W, 1025—1275 m, 'Discovery', Stn 152; BMNH 1930.1.12.29—30: 2, 52.6—85.5 mm, males, 39°50'30''S, 36G23'W, 1500—0 m, 'Discovery', Stn 76; ISH 252/76: 4 of 5 specimens, 105.6—185.0 mm, females, 53°18'S, 49°57'W, 700 m, 'Walther Herwig', Cruise 252, Stn 12/76, 23 Nov. 1975; ISH 998/76: 7 of 12 specimens, 126.0?—172.0 mm, 1 male (smallest) and 6 females, 54°12'S, 40G02'W, 2600 m, 'Walther Herwig', Cruise 388, Stn 97—II/76, 3 Jan. 1976; ISH 421/76: 4, 118.6—217.0 mm 1 male (smallest) and 3 females, 51°05.5'S, 39°56.5'W, 2300—2350 m, 'Walther Herwig', Cruise 421, Stn 99—II/76, 4 Jan. 1976.

Bathylagus pacificus: CAS 55061: 2 specimens, 159.6—170.0 mm, females, off Point Sur, 36°23'08''N, 122°14'06''W to 24°N, 122°14'06''W, 1200 m, 45 ft otter trawl, RV 'Cayuse', W. Wakefield and E. Anderson, 11 May 1984; USNM 228356: 141.5 mm, male, California coast, Monterey Bay, 'Tage', Stn 529B; USNM 274685: 4, 142.8—163.3 mm, females, Bering Sea, 54°40'40''N, 167°49'01''W, 1030—1040 m, 'Yakushi Maru', Cruise 21, Stn 296, D.M. Cohen, 15 June 1979; USNM 274688: 9, 113.5—156.4 mm, 2 males and 7 females, Bering Sea, 54°19'09''N, 166°40'38''W, 730—750 m, 'Yakushi Maru', Cruise 21, Stn 330, D.M. Cohen, 14 June 1979; USNM 274713: 3, 40.3—147.5 mm, one juvenile and 2 females, off California coast, 33°13.1'N, 123°16'W, 2234 m, IKMT, RV 'Horizon', Cruise H6204, Stn 80.90, 18 Mar. 1962.

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