

Aspects of the morphology and ecology of some unusual deep-sea eels (*Synaphobranchidae*, *Derichthyidae* and *Nettastomatidae*) from the eastern North Atlantic

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Specimens of *Haptenchelys texis* (9), *Ilyophis arx* (3), *I. brunneus* (36) (*Synaphobranchidae*), *Nessorhamphus ingolfianus* (5) (*Derichthyidae*), *Nettastoma melanurum* (9) and *Venefica proboscidea* (3) (*Nettastomatidae*) have been studied from collections in the eastern North Atlantic. An additional two *V. proboscidea* were also included from eastern South Atlantic material. The samples were used to augment the incomplete descriptions of these scantily known species, in order to allow further clarification of their taxonomic status. Data from the three synaphobranchid species have been used to clarify the sub-familial relationships and provide a preliminary family diagnosis. They have also been incorporated in an annotated key to the identification of the species found in the area. In addition, all the specimens have provided supplementary information on the ecology of the various species, in aspects of distribution, both horizontal and vertical, diet and reproduction.

I. INTRODUCTION

The Institute of Oceanographic Sciences (IOS) has, over the last decade or so, been investigating the ecology of deep-sea, bottom-living fishes in the eastern North Atlantic. Demersal trawling from RRS Challenger and RRS Discovery has been centred on the Porcupine Seabight (49°–52°N, 11°–14°W) and the continental slopes off northwest Africa (08°–27°N, 14°–30°W and 27°–34°N, 10°–14°W). Amongst these collections, held at IOS, deep-sea eels are represented mainly by the family *Synaphobranchidae*, in particular the slope-dwelling *Synaphobranchus kaupi* and the continental rise/abyssal-dwelling *Histiobranchus bathybius*. These are sufficiently abundant to warrant separate ecological consideration (Merrett & Marshall, 1981; Merrett & Domanski, 1985). Nevertheless, other synaphobranchids and representatives of the families *Derichthyidae* and *Nettastomatidae* have occurred in much smaller numbers in the catches. Their scarcity in collections generally merits study of a morphological/taxonomic nature on the one hand: on the other, these samples augment the sparse ecological knowledge of these species.

The new species of synaphobranchid, *Ilyophis blachei*, already described from the area (Saldanha & Merrett, 1982) will not be dealt with further here. Two other species, *Haptenchelys texis* (Robins & Martin, 1976) and *Ilyophis arx* (Robins, 1976) however, have had their known range extended by these collections, to the eastern north Atlantic in the case of *H. texis* and into the Atlantic Ocean itself in the case of *I. arx* (*H. texis*: Merrett & Marshall, 1981; *I. arx*:

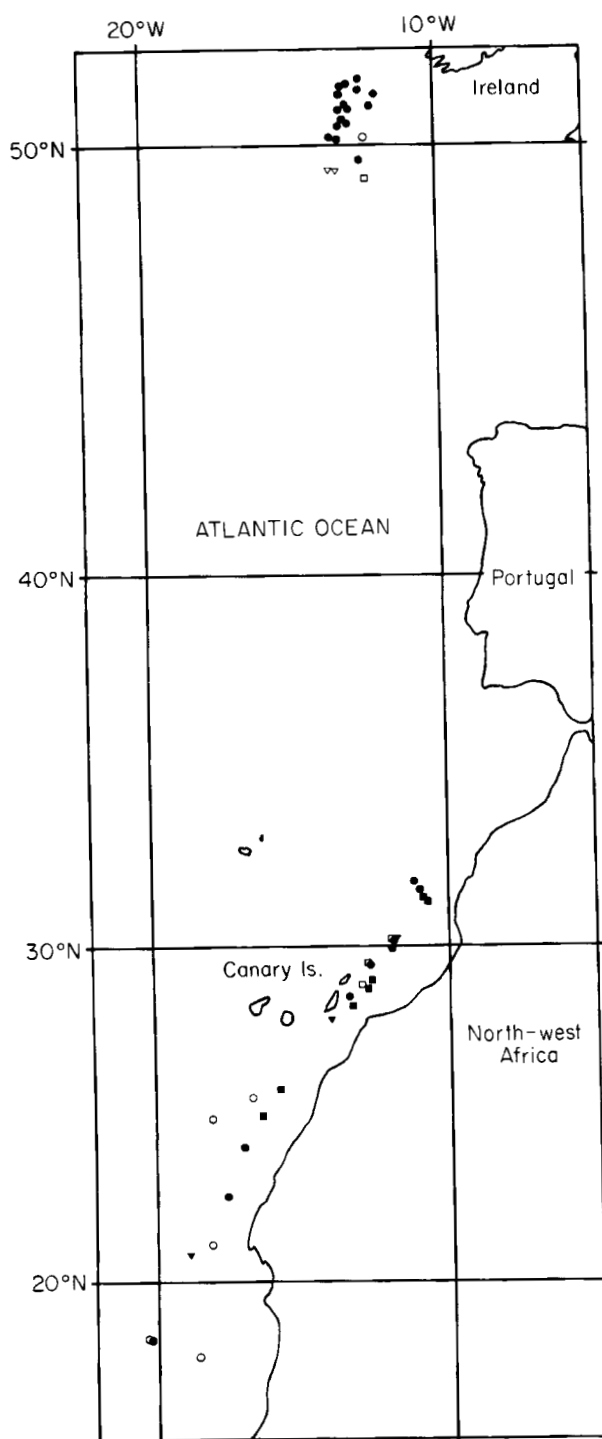


FIG. 1. Chart indicating the distribution of stations in the eastern North Atlantic at which the eels reported were collected. (No sampling was carried out between 32°N and 49°N.) ○, *Haptenchelys texis*; ▽, *Ilyophis arx*; ●, *I. brunneus*; □, *Nessorhamphus ingolfianus*; ■, *Nettastoma melanurum*; ▼, *Venefica proboscidea*.

TABLE I. Eel capture station data

| Station | Date | Position | | Gear | Sounding (m) | | Temp (°C) |
|---------|------------|----------|----------|---------|--------------|------------|--------------|
| | | °N | °W | | Range | (midpoint) | |
| 7851 | 25:III:72 | 25°43.6' | 15°47.9' | BN2.4 | 486-559 | (523) | — |
| 8001 | 24:VII:72 | 22°35.2' | 17°37.0' | BN2.4 | 1457-1460 | (1458) | — |
| 8519#7 | 23:VI:74 | 24°02.2' | 16°59.2' | BN1.5 | 997-1037 | (1017) | — |
| 8528#1 | 2:VII:74 | 17°38.7' | 18°35.8' | BN1.5 | 3150-3155 | (3153) | — |
| 8682#5 | 7:II:75 | 25°33.6' | 16°40.1' | BN1.5 | 3000-3000 | (3000) | — |
| 8930#1 | 30:X:75 | 25°00.5' | 16°22.6' | OTSB14 | 501-520 | (510) | — |
| 8933#3 | 1:XI:75 | 24°56.6' | 18°01.2' | OTSB14 | 2980-2990 | (2985) | — |
| 8966 | 2:VIII:76 | 31°21.0' | 10°41.5' | OTSB14 | 686-742 | (614) | — |
| 8968 | 3:VIII:76 | 31°35.0' | 11°02.2' | OTSB14 | 1767-1846 | (1800) | — |
| 8977 | 6:VIII:76 | 31°26.1' | 10°47.8' | OTSB14 | 947-1032 | (1003) | — |
| 9007 | 16:VIII:76 | 27°53.6' | 13°54.8' | OTSB14 | 1654-1699 | (1676) | — |
| 9009 | 17:VIII:76 | 28°18.6' | 13°29.2' | BN2.4 | 1238-1244 | (1241) | — |
| 9010 | 17:VIII:76 | 29°18.6' | 13°16.0' | BN2.4 | 1027-1029 | (1028) | — |
| 9012 | 17:VIII:76 | 28°49.3' | 13°02.2' | OTSB14 | 1045-1061 | (1053) | — |
| 9015 | 18:VIII:76 | 28°46.8' | 12°47.5' | BN2.4 | 610-637 | (624) | — |
| 9016 | 18:VIII:76 | 28°55.7' | 12°37.1' | BN2.4 | 873-895 | (884) | — |
| 9018 | 18:VIII:76 | 29°20.4' | 12°35.1' | OTSB14 | 1635-1658 | (1647) | — |
| 9020 | 19:VIII:76 | 29°53.7' | 11°58.4' | BN2.4 | 2017-2028 | (2023) | — |
| 9021 | 19:VIII:76 | 30°04.2' | 11°51.7' | OTSB14 | 2122-2173 | (2148) | — |
| 9030 | 21:VIII:76 | 31°44.2' | 11°12.5' | OTSB14 | 2516-2543 | (2529) | — |
| 9132#5 | 24:XI:76 | 20°50.1' | 18°55.5' | OTSB14 | 3089-3109 | (3100) | — |
| 9133#7 | 26:VI:76 | 21°09.1' | 18°08.8' | OTSB14 | 2130-2191 | (2161) | — |
| 9774#1 | 21:IV:78 | 51°04.4' | 11°59.3' | OTSB14 | 1494-1572 | (1533) | — |
| 50511 | 4:VI:79 | 50°32.4' | 13°01.4' | OTSB14 | 2435-2405 | (2420) | 3.0 |
| 50517 | 7:VI:79 | 49°30.1' | 13°19.9' | OTSB14 | 1794-1785 | (1790) | 3.8 |
| 50602#2 | 1:VII:79 | 51°01.0' | 13°05.9' | BN1.5 | 1955-1980 | (1968) | — |
| 10106#1 | 4:IX:79 | 50°41.7' | 12°50.7' | BN1.5 | 2300-2315 | (2308) | — |
| 50709 | 16:X:79 | 49°23.5' | 12°21.5' | GRANTON | 1260-1260 | (1260) | — |
| 50710 | 17:X:79 | 49°33.5' | 13°28.0' | OTSB14 | 1800-2000 | (1900) | 5.0-3.9 |
| 50715 | 21:X:79 | 51°19.5' | 12°57.0' | OTSB14 | 1635-1720 | (1678) | 4.2 |
| 50802 | 30:VII:80 | 49°39.5' | 12°36.9' | OTSB14 | 1857-1910 | (1884) | 3.5 |
| 50814 | 4:VIII:80 | 50°19.7' | 13°32.1' | OTSB14 | 3000-2715 | (2858) | — |
| 50822 | 7:VIII:80 | 50°56.7' | 13°11.6' | OTSB14 | 2095-2150 | (2123) | — |
| 50906 | 9:XI:80 | 50°26.2' | 13°20.8' | OTSB14 | 2585-2705 | (2545) | 2.7 |
| 51010 | 2:V:81 | 51°19.1' | 12°29.5' | OTSB14 | 1685-1700 | (1693) | 3.9 |
| 51011 | 3:V:81 | 50°44.6' | 12°14.8' | OTSB14 | 2180-2165 | (2173) | 3.2-3.4 |
| 51308 | 20:II:82 | 51°13.0' | 13°02.2' | OTSB14 | 1715-1770 | (1743) | 4.1 |
| 51411#1 | 29:III:82 | 50°27.2' | 12°59.1' | OTSB14 | 2470-2500 | (2485) | 3.0 |
| 51412 | 29:III:82 | 50°16.9' | 13°29.3' | BN1.5 | 2760-2790 | (2775) | — |
| 51611#1 | 21:VII:82 | 50°17.2' | 13°24.8' | OTSB14 | 2700-2640 | (2670) | 3.0 |
| 51613#1 | 21:VII:82 | 50°45.9' | 12°58.4' | OTSB14 | 2240-2200 | (2220) | 3.3 |
| 10884 | 12:VIII:83 | 18°08.6' | 20°11.7' | OTSB14 | 3120-3120 | (3120) | 2.7 |
| 51801 | 24:XI:83 | 51°20.8' | 21°31.4' | OTSB14 | 1740-1700 | (1720) | 3.9 |

Saldanha & Merrett, 1982). These specimens of both species provide novel information, as do those of *Ilyophis brunneus*. Such additions to the synphobranchid fauna of the area enhance the need for a key to the identification of species. This is provided, together with a preliminary family diagnosis. The derichthyid species *Nessorhamphus ingolfianus* and the nettastomatids *Nettastoma melanurum* and *Venefica proboscidea* are included with the aim of augmenting the existing descriptions of hitherto poorly described characters, as well as reporting such ecological information as the specimens allow.

II. MATERIAL AND METHODS

All IOS specimens were collected within the sounding range 510–3153 m and, with the exception of one, by either a mouth opening/closing epibenthic sledge (BN2.4 or BN1.5) or a semi-balloon shrimp trawl (OTSB14) the design and operation of which have been described elsewhere (Merrett & Marshall, 1981). The exception was caught in a Granton trawl described by Gordon & Duncan (1983). The relevant station data are given in Table I and the capture localities shown in Fig. 1. Two additional specimens of *Venefica proboscidea* have been used to augment the data for this species; these were a gift to one of us (L.S.) from Dr E. Karmovskaya (Institute of Oceanology, Moscow) and were obtained from the South Atlantic (31°08'S, 15°17'E; 11/XII/75; sounding 1200 m) by R. V. 'Evrika'.

In situ ambient temperature was measured during some OTSB14 hauls by an acoustic monitor mounted behind one trawl door and telemetered back to the ship at 2-s intervals during the course of the tow.

Fixation and initial preservation of the specimens was carried out on board in 10% saline buffered formalin. Ashore the fishes were transferred by stages to 40% isopropyl alcohol. Measurements were made, after transfer to isopropanol, by vernier caliper to the nearest 0.5 mm. The method of measuring followed Saldanha & Merrett (1982) (see also Fig. 2) except in the measurement of head length. In this case, the measurement taken, both in the synphobranchids with horizontal gill slits and in the remaining species in which they were oblique, was from the fleshy tip of the snout to the anterior margin of the gill slit. This in turn modified the measurement of the trunk length to be from the anterior, rather than the posterior, margin of the gill slit to the anus. In all cases gill slit length itself was taken as the distance between its extremities. Vertebral counts were made in accordance with Böhlke (1982) and were taken from X-radiographs.

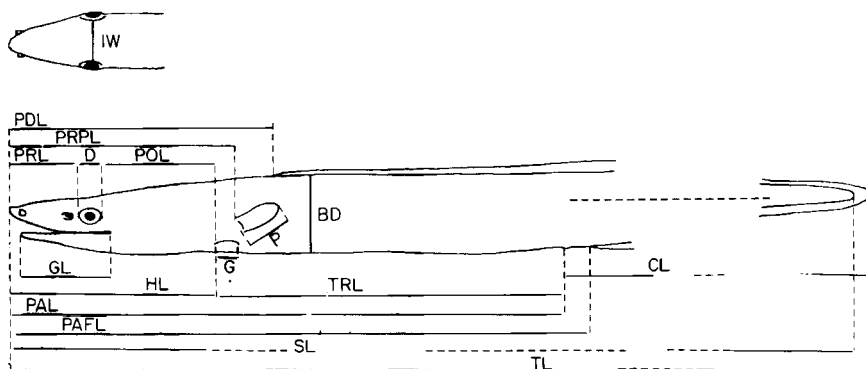


FIG. 2. Diagrammatic lateral view and dorsal view of the head of a specimen of *Haptenchelys* to indicate the measurements applied. BD, Body depth; CL, caudal length; D, horizontal eye diameter; G, gill slit length; GL, gape length of mouth; HL, head length; IW, interorbital width; PAFL, preanal fin length; PAL, preanal length; PDL, predorsal fin length; POL, postorbital length; POM, preoperculo-mandibular; PRL, preorbital length; PRPL, prepectoral fin length; SL, standard length; TL, total length; TRL, trunk length.

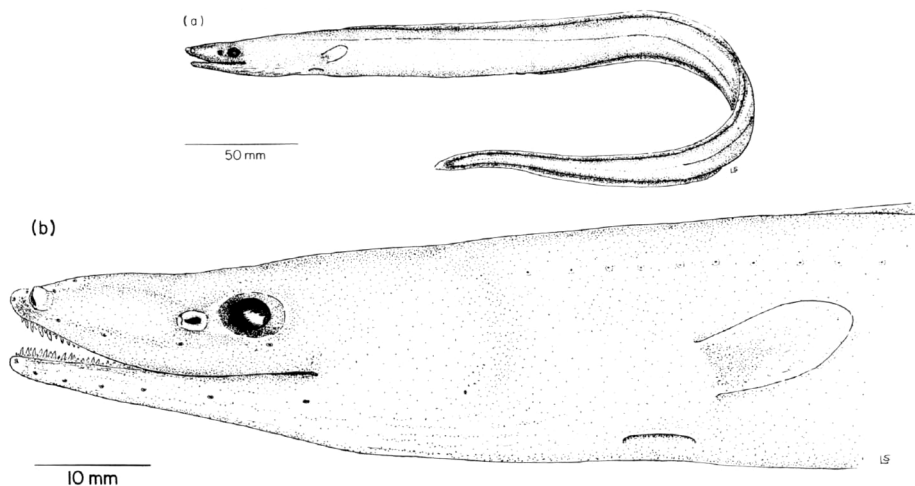


FIG. 3. *Haptenchelys texis* (450 mm TL) (a) Lateral view. (b) Head and cephalic lateralis system of the same specimen (the pores on the ascending branch of the infraorbital canal in this specimen are lacking).

Abbreviations used throughout are as follows:

ANSP, Academy of Natural Sciences, Philadelphia; BD, body depth; CL, caudal length; D, horizontal eye diameter; G, gill slit length; GL, gape length of mouth; HL, head length; IO, infraorbital; IW, interorbital width; PAFL, preanal fin length; PAL, preanal length; PDL, predorsal fin length; POL, postorbital length; POM, preoperculomandibular; PRL, preorbital length; PRPL, pectoral fin length; SL, standard length; SO, supraborbital; ST, supratemporal commissure; Stn, station; TL, total length; TRL, trunk length.

Comparative material examined: *Ilyophis arx* C. H. Robins, 1976 (paratype) ANSP catalogue No. 133809; 26–27 May 1966; 353 mm TL (now 350 mm TL); South Eastern Pacific Biological and Oceanographic Program; 01°48'S, 90°19'W in 3225 m by bottom longline.

III. RESULTS AND DISCUSSION

SYNAPHOBRANCHIDAE

Haptenchelys texis C. H. Robins & D. M. Martin, 1976 (Fig. 3 (a)).

Material examined: nine specimens.

Stn. 8528#1, 187 mm TL immature, 307 mm TL ♂; Stn. 8682#5, 338 mm TL ♂, 450 mm TL ♂; Stn. 8933#3, 465 mm TL ♂; Stn. 9133#7, 338 mm TL sex indet.; Stn. 51611#1, 283 mm TL ♂; Stn. 10884, 409 mm TL ♂; 445 mm TL ♀.

Morphology

In general there is good agreement between the morphometric characters of the above specimens and those of the type series given by C. H. Robins & D. M. Martin (in Robins & Robins, 1976). The possible exception is the rather shorter jaw relative to the head length (attributable perhaps to differences in the measuring technique) (Table II).

Head. In some of these specimens the gape extends slightly more than the half diameter of the eye behind the eye that was found in the type series. Likewise, the cutaneous crease of the gape extends a diameter and a half posterior to the eye.

TABLE II. Morphometric and meristic characters of (a) *Haptenchelys texis* (187–465 mm TL) and (b) *Ilyopis bruneus* (217–479 mm TL) (Synbranchidae)

| Morphometric characters (<i>n</i> = 9) | (a) <i>Haptenchelys texis</i> | | | | (b) <i>Ilyophis bruneus</i> | | | | |
|---|-------------------------------|-----------|-----------|-----------|-----------------------------|-----------|-----------|-----------|-----------|
| | %TL | %HL | %TRL | %PAL | (<i>n</i> = 36) | %TL | %HL | %TRL | %PAL |
| Standard length | 96.2-98.9 | | | | | 97.3-99.3 | | | |
| Head length | 10.6-12.7 | | | | | 7.4-10.6 | | | |
| Trunk length | 20.0-25.2 | | 44.7-57.8 | 31.5-36.6 | | 18.3-22.5 | | 33.0-54.9 | 24.8-35.4 |
| Caudal length | 63.9-74.8 | | | 63.4-70.5 | | 68.4-72.6 | | | 64.6-76.8 |
| Prepectoral length | 12.4-14.8 | | | | | 9.3-12.4 | | | |
| Predorsal length | 13.4-16.4 | | | 35.9-41.6 | | 10.5-14.8 | | | 31.9-38.4 |
| Preanal length | 31.4-36.1 | | | 39.0-47.2 | | 27.4-31.6 | | | 37.2-45.6 |
| Preanal fin length | 31.8-39.1 | | | | | 29.0-33.9 | | | |
| Preorbital length (snout) | 3.2-4.7 | 33.3-37.4 | | | | 3.1-4.1 | 34.2-44.0 | | |
| Postorbital length | 5.7-6.7 | 50.9-58.8 | | | | 3.2-5.9 | 42.9-56.7 | | |
| Eye diameter (horizontal) | 0.3-1.6 | 7.8-13.0 | | | | 0.8-1.3 | 7.7-14.3 | | |
| Interorbital width | 2.1-2.7 | 17.4-23.1 | | | | 0.9-2.2 | 10.0-24.0 | | |
| Gape length | 5.2-6.2 | 45.1-56.7 | | | | 3.7-6.1 | 38.1-63.3 | | |
| Gill slit length | 1.1-1.7 | 9.3-15.1 | | | | 0.6-1.8 | 5.8-20.0 | | |
| Pectoral fin length | 1.6-3.3 | 13.0-26.9 | | | | 0.9-2.2 | 9.5-24.0 | | |

| | | | | | | |
|--|--|------------|-----------|--|------------|----------|
| Depth of body—gill slit level | 3·9–5·4 | 34·8–46·7 | 11·0–15·9 | 2·5–4·4 | 26·1–44·0 | 8·3–15·2 |
| —mid caudal region | 3·2–3·9 | | | 2·8–4·3 | | |
| —anus level | 2·8–5·4 | | | 2·5–4·5 | | |
| —anterior caudal region | 2·8–5·0 | | | 2·5–4·5 | | |
| —maximum | 4·3–7·4 | 37·7–63·0* | 12·9–20·5 | 2·9–5·4 | 30·4–62·5* | 9·7–18·1 |
| Meristic characters (frequency in parentheses) | | | | | | |
| No. pectoral rays | 12–14 ($\frac{2}{12}, \frac{3}{13}, \frac{2}{14}$) $n=7$ | | | 11–15 ($\frac{3}{11}, \frac{11}{12}, \frac{1}{13}, \frac{1}{14}, \frac{0}{15}$) $n=16$ | | |
| No. vertebrae—total | 125–132 ($\frac{1}{125}, \frac{1}{126}, \frac{1}{127}, \frac{3}{128}, \frac{0}{129}, \frac{2}{130}, \frac{0}{131}, \frac{1}{132}$) | | | 139–148 ($\frac{1}{139}, \frac{2}{140}, \frac{3}{141}, \frac{7}{142}, \frac{6}{143}, \frac{6}{144}, \frac{6}{145}, \frac{3}{146}, \frac{1}{147}, \frac{1}{148}$) | | |
| | $n=9$ | | | $n=36$ | | |
| —predorsal | 8–12 ($\frac{1}{8}, \frac{3}{9}, \frac{3}{10}, \frac{1}{11}, \frac{1}{12}$) $n=9$ | | | 6–10 ($\frac{1}{6}, \frac{3}{7}, \frac{14}{8}, \frac{13}{9}, \frac{4}{10}$) $n=35$ | | |
| —preanal | 36–39 ($\frac{5}{36}, \frac{3}{37}, \frac{0}{38}, \frac{1}{39}$) $n=9$ | | | 35–40 ($\frac{8}{35}, \frac{6}{36}, \frac{10}{37}, \frac{10}{38}, \frac{1}{39}, \frac{1}{40}$) $n=36$ | | |

Body proportions given in percentages of the total length (TL), head length (HL), Trunk length (TRL) and preanal length (PAL). *Belly distended with contents.

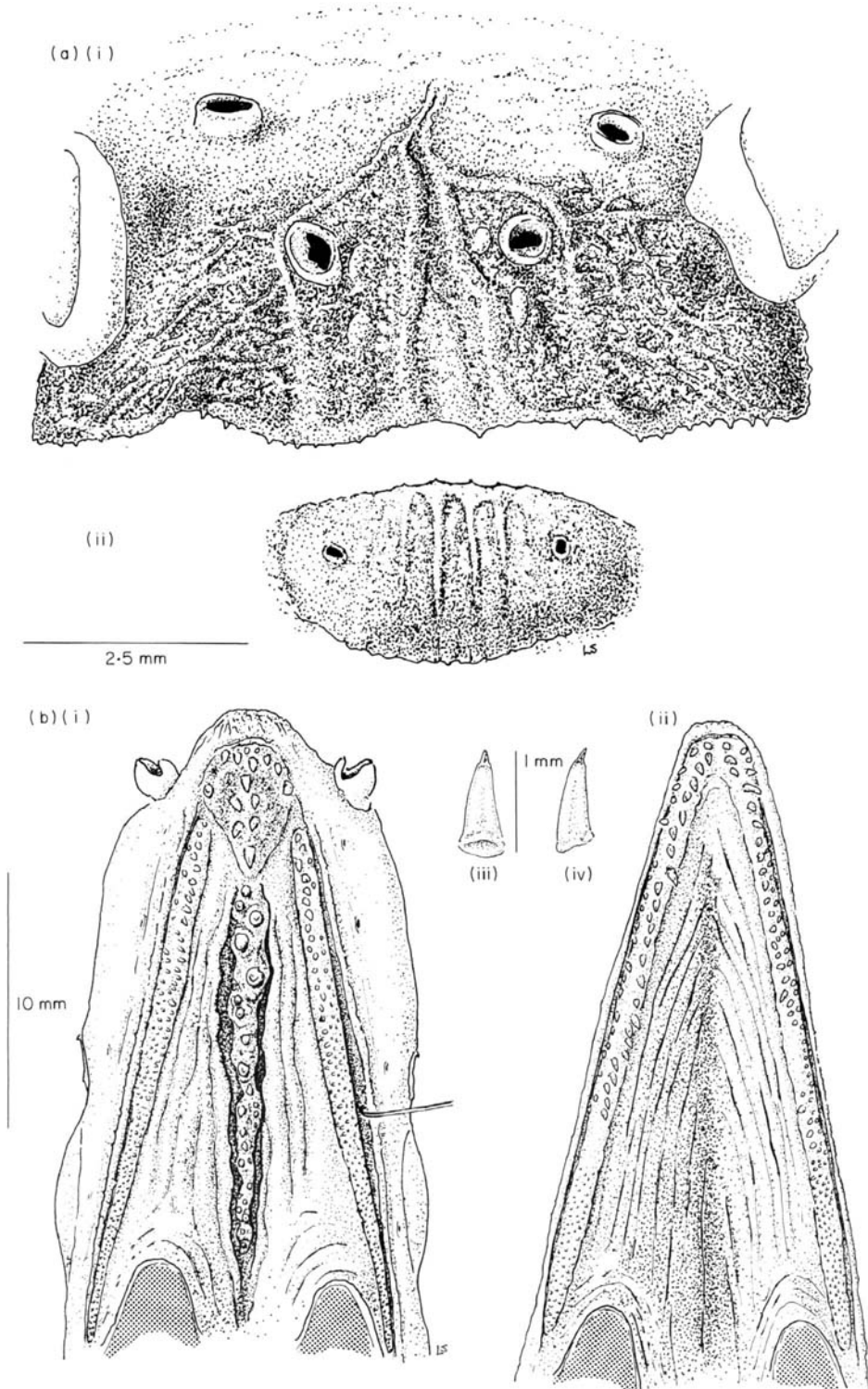


FIG. 4. *Haptenchelys texis* (450 mm TL). (a) Snout (i) and jaw (ii) tip ornamentation. (b) Dentition; (i) upper jaw (ii) lower jaw, (iii) and (iv) posterior and lateral view of a premaxillary tooth.

The snout is slightly longer than the lower jaw with less complex ornamentation than occurs in *Ilyophis* species. The ornamentation consists of a network of poorly developed, thin plicae [Fig. 4(a)]. The most conspicuous are those bordering the mid-line, between the two anterior supraorbital pores. These plicae are branched dorsally and the lateral sections embrace the two anterior supraorbital pores and then merge into the network of smaller plicae. All these ridges bear inconspicuous acute papillae. (Described mainly from a specimen of 450 mm TL). The gill slits conform with those described by C. H. Robins & D. M. Martin (in Robins & Robins, 1976) and, in addition, their posterior insertions are perpendicular, or slightly anterior, to the pectoral base.

Nostrils. The anterior nostrils are tubular, directed forwards, with anterior crescentic margins that form partially hooded openings. The posterior nostrils have rims only.

Dentition. Tooth pattern and shape are in general agreement with the type material. Minor variations observed were some 10–16 teeth on the premaxillary, arranged in a roughly triangular pattern, with 10–25 vomerine teeth. The variability of the latter results from an obscuring cover of skin in some specimens. The vomerine teeth are mostly uniserial with an occasional paired arrangement.

The maxillary teeth are in bands, one to two deep in the anterior portion, three to five centrally and c. two to three deep posteriorly. The dentary teeth are in one to two bands anteriorly, two to five at the mid-length and some three to six posteriorly. Teeth anteriorly placed and on the inner rows are largest. In shape they are acute and very slightly recurved posteriorly, with sharp spine-like tips. Those on the anterior part of the vomer are the most broadly based [Fig. 4(b)].

Lateralis system. The open pores of the lateral line in all the specimens terminate half to three-quarters of the way along the total length of the body. There are four to six pores anterior to the pectoral fin four(1), five(6), six(2) and 31–35 before the anus.

The cephalic sensory canals are arranged in the pattern described by C. H. Robins & D. M. Martin (in Robins & Robins, 1976), although the number of pores in the infraorbital and preoperculomandibular canals do differ somewhat [Fig. 3(b)]. These authors describe six to eight pores in the infraorbital series; our material reveals five to seven pores. The specimen with seven pores bears two behind the eye, with one clearly in the ascending branch of this canal in common with the type material. The four specimens with five infraorbital pores lack the two posterior to the eye (one in the ascending branch). The remaining three specimens bear six infraorbital pores, including one posterior to the eye. The preoperculomandibular series in the type material typically bears eight pores (seven to nine) 'located from the tip of the jaw to just behind the gape' (C. H. Robins & D. M. Martin in Robins & Robins, 1976). Similar counts prevailed in the eastern North Atlantic material, although one specimen bore 10 preoperculomandibular pores. Generally, an extra pore was found located in an opercular position, to give an overall range of eight to ten pores. The supraorbital canal pores (three) were found to be the same as the type material. All these cephalic pores were structurally similar with a more or less conspicuous rim.

Fins. The origin of the dorsal fin in the type material is said to be vertically above the base of the pectoral fin. In our specimens the dorsal origin relative to

the pectoral fin is variable, placed over the posterior one third of the pectoral fin to slightly behind it (at a distance of 0.3–1.0% TL).

Squamation. Scales are absent in all but one specimen. In the exception, scales occur sparsely in a position dorsal and posterior to the pectoral fin and even more so over the belly. The remaining surface of the body is naked. (The significance of this is that it provides additional evidence for our claim that squamation is very variable within the genera in a transitional position between the Synphobranchinae and the Dysommidae (cf. Robins & Robins, 1976) and cannot be relied upon as a constant feature for diagnostic purposes (see below).

Coloration. The brown colour described for the type series persists in two specimens, the others are faded. In all, the nostrils and lateral line pores are white.

Ecology

Distribution. Previously the species has been recorded from the western central Atlantic, Caribbean and Gulf of Mexico (09°–25°N, 74°–95°W) from 2350–4086 m soundings (C. H. Robins & D. M. Martin in Robins & Robins, 1976). The captures reported here extend the known range to the eastern North Atlantic (17°–50°N, 13°–20°W; Fig. 1). There, again *H. texis* is a continental rise dweller, being taken from soundings of 2130–3150 m. *In situ* temperature measured at 2670 m (Stn 51611#1; Table I) was 3.0° C and at 3120 m (Stn 10884) was 2.7° C.

Diet. Only three fish had stomach contents and each was almost empty, with residual material only. These remains, however, suggest that *H. texis* is an active

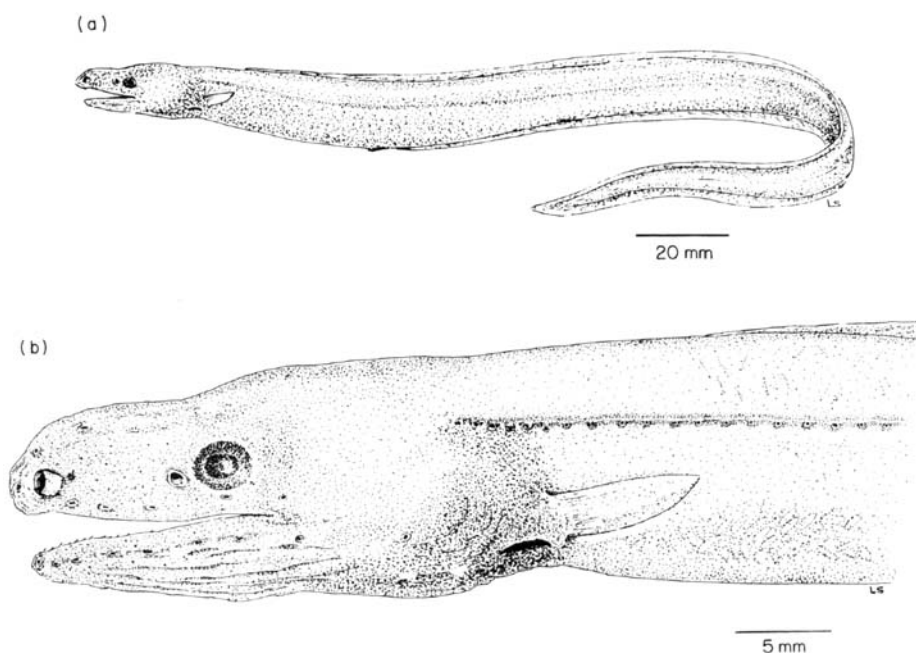


FIG. 5. *Ilyophis arx* (237 mm TL) (a) Lateral view. (b) Head and cephalic lateral line system of the same specimen.

TABLE III. Morphometric and meristic characters of *Ilyophis arx* (237–271 mm TL) (Synphobranchidae) from (a) eastern North Atlantic material and (b) paratype ANSP 133809

| Morphometric characters ($n=3$) | (a) Eastern North Atlantic material | | | | (b) Paratype ANSP 133809 (Pacific) | | | |
|--|--|-----------|-----------|-----------|------------------------------------|------|------|------|
| | %TL | %HL | %TRL | %PAL | %TL | %HL | %TRL | %PAL |
| Standard length | 97.5–98.2 | | | | 97.7 | | | |
| Head length | 10.3–12.2 | | 56.0–76.3 | 35.9–43.3 | 10.6 | | 49.3 | 33.0 |
| Trunk length | 16.0–18.5 | | | 56.7–64.1 | 21.4 | | | 67.0 |
| Caudal length | 70.7–73.0 | | | | 68.0 | | | |
| Prepectoral length | 12.2–13.3 | | | 42.3–45.2 | 12.3 | | | 38.4 |
| Predorsal length | 13.9–15.3 | | | 49.3–52.6 | 15.1 | | | 47.3 |
| Prealal length | 28.3–29.3 | | | | 32.0 | | | |
| Prealal fin length | 31.0–31.7 | | | | 33.4 | | | |
| Preorbital length (snout) | 3.8–5.2 | 31.0–44.8 | | | 3.7 | 35.1 | | |
| Postorbital length | 4.8–7.2 | 44.8–56.6 | | | 6.3 | 59.5 | | |
| Eye diameter (horizontal) | 1.2–1.5 | 10.3–14.3 | | | 1.1 | 10.8 | | |
| Interorbital width | 2.1–2.8 | 17.2–24.1 | | | 1.7 | | | |
| Gape length | 4.6–5.2 | 37.9–46.4 | | | 5.4 | | | |
| Gill slit length | 1.3–2.0 | 10.3–17.9 | | | 0.9 | 8.1 | | |
| Pectoral fin length | 3.2–3.7 | 27.6–35.7 | | | 2.9 | 27.0 | | |
| Depth of body—gill slit level | 4.2–5.2 | 34.5–50.0 | | 14.9–17.9 | 4.9 | 45.9 | 15.2 | |
| —midcaudal region | 4.4–5.2 | | | | 4.3 | | | |
| —anus level | 4.8–6.3 | | | | 4.9 | | | |
| —anterior caudal region | 4.8–7.2 | | | | 4.6 | | | |
| —maximum | 5.6–7.2 | 48.3–58.6 | | 19.2–25.4 | 4.9 | 45.9 | | 15.2 |
| Meristic characters (frequency in parenthesis) | | | | | | | | |
| No. pectoral rays | 15 $n=3$ | | | | 15 | | | |
| No. vertebrae—total | 131–134 ($\frac{1}{131}, \frac{1}{132}, \frac{1}{133}, \frac{1}{134}$) $n=3$ | | | | (131–135—type collection) | | | |
| —predorsal | 8–9 ($\frac{2}{8}, \frac{1}{9}$) $n=3$ | | | | — | | | |
| —preanal | 31–32 ($\frac{2}{31}, \frac{1}{32}$) $n=3$ | | | | — | | | |

Body proportions given in percentages of total length (TL), head length (HL), trunk length (TRL) and preanal length (PAL).

predator. The largest fish (408 mm TL) had evidently regurgitated: it was very distended but contained only a sizeable portion of crustacean antenna. Another (307 mm TL) contained three fish bones, among which was an elongate jaw (c. 50 mm) of ? *Nessorhamphus*, and one squid lens (2 mm diameter). The smallest (187 mm TL) held three lenses, two from squid (c. 2 mm diameter) and one from a fish (c. 1 mm diameter).

Reproduction. One female in the late growth phase of ovarian maturation (445 mm TL) was caught in August. Two ripe males (338, 450 mm TL) were caught in February and one (409 mm TL) in August. Beyond this, the specimens were either immature of indeterminate sex (187, 338 mm TL) or male (307 mm TL). A single ovigerous female was reported by C. H. Robins & D. M. Martin (in Robins & Robins, 1976) which was caught in July.

Ilyophis arx C. H. Robins, 1976 [Fig. 5(a)]

Material examined: three specimens.

Stn. 50517, 237 mm TL ♀; Stn 50710, 249 mm TL ♂; 271 mm TL ♂.

(Comparative material: ANSP 133809, 353 mm TL (now 350 mm TL)).

Morphology

Despite certain differences, discussed below, the balance of morphological similarities of the specimens to hand with *I. arx* evidently identifies them with this species. The 350 mm TL paratype of *I. arx* was examined to substantiate this view and the detailed measurements compared with those of the Discovery Collection material (Table III and cf. Robins & Robins (1976: Table I, p. 254)). Morphometric characters are in general agreement although variation does occur in some. Individual variation, known to be extensive among anguilliform fishes, may account for this in part, but allometric differences between the small specimens of these North Atlantic collections and the larger fish of the type series could also be responsible. Hence, in body proportions at least, there is no reason to consider our specimens different from those described by Robins & Robins (1976).

Head. The gape extends at most to the level of the posterior half of the eye and the cutaneous crease somewhat farther (i.e., half eye diameter or less behind the eye).

Snout ornamentation. The snout is plicate, with a somewhat variable degree of development. Generally there are three main plicae on each side of the mid-line, with the outermost one least developed. The most anterior supraorbital pore is located between the first and second plicae. The outer margins of the first and second plicae bear some four and eight papillae respectively, and other minute, acute papillae occur along all the plical ridges. The tip of the lower jaw is also plicate [Fig. 6(a)]. (Described mainly from a specimen of 249 mm TL.)

Nostrils. The anterior nostrils are tubular or more or less hooded and anteriorly directed, but are not always hooded as reported by Robins & Robins (1976) (but not illustrated—see their Fig. 4). We found no such hood in the 350 mm TL paratype. Hence, it appears that little taxonomic value can be attached to this character.

Dentition. The teeth are in general conical and acute, sharp-edged distally and variable in size according to position (Fig. 6(b)). They are arranged in bands

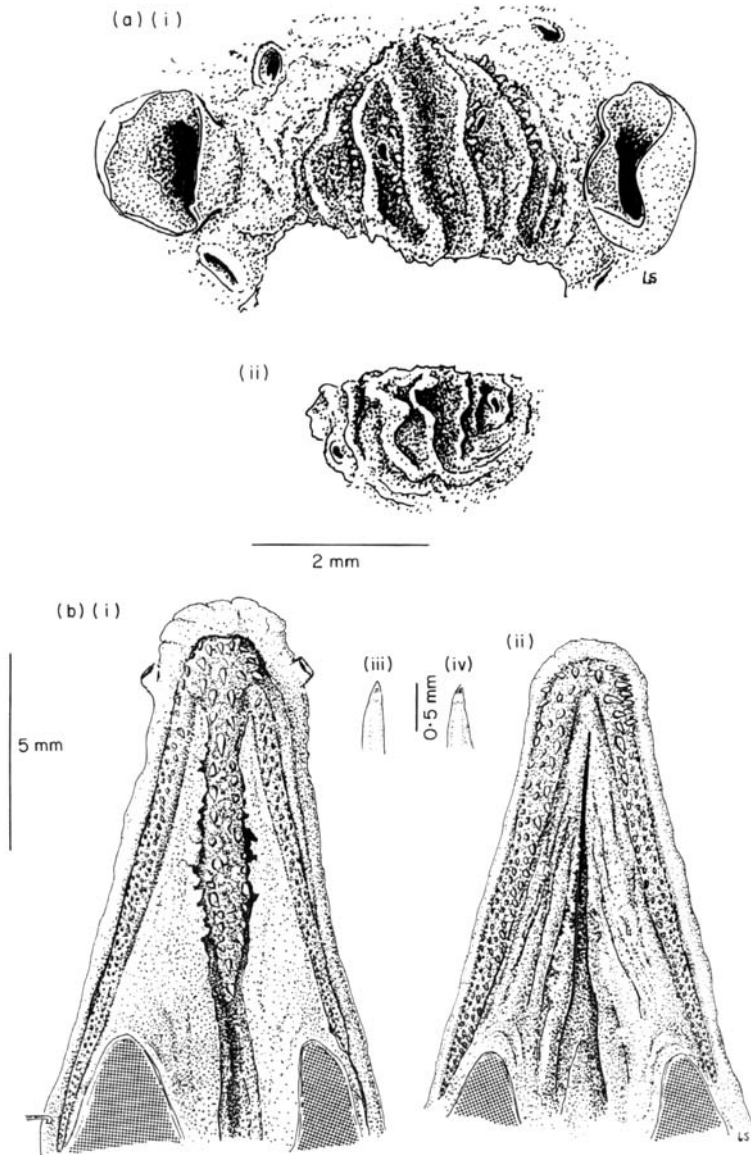


FIG. 6. *Ilyophis arx*. (a) Snout (i) and jaw (ii) tip ornamentation of 249 mm TL specimen. (b) Dentition of the 237 mm TL specimen; (i) upper jaw, (ii) lower jaw and (iii) and (iv) frontal and lateral view of a premaxillary tooth.

along the length of the maxillary and dentary. Maxillary teeth are disposed in a gradation of one to four (medially) to one irregular row, with anterior teeth somewhat enlarged. There are roughly three to five series of teeth on the dentary, again with anterior ones (in two rows) the largest. On the premaxillary patch there are around 16–18 strong, concentrically arranged teeth abutting the vomerine series, which are in two rows anteriorly (with some 11 teeth each) and converging into a single row posteriorly (with two to three teeth). The vomerine teeth, as the premaxillaries, are strong and surrounded by papillae. These

papillae, both in the Discovery Collection material and in the paratype examined, do not attain the degree of development observed in the congener *I. blachei* (Saldanha & Merrett, 1982) and thus can no longer be considered diagnostic for *I. arx* as proposed by Robins & Robins (1976). Indeed, in reporting two *I. arx* from the Caribbean, M. E. Anderson (pers. comm.; Anderson *et al.*, in press) comments on his inability to detect any differences in the size of palatal papillae between his specimens and 15 *I. brunneus* from the north-west Atlantic.

Lateralis system. The lateral line observed from the type collection (Robins & Robins, 1976) is short, with open pores confined to the anterior half of the body. In the Discovery Collection material, pores are present in the lateral line to more than two-thirds the length of the body. Three to six pores occur anterior to the pectoral fin (variable on either side of the same specimen, e.g. three to four, four to six). In the paratype examined there are four pre-pectoral and 32 pre-anus pores. There are 26–30 pores anterior to the anus in the Discovery Collection specimens. The cephalic pores [Fig. 5(b)] are similar in structure, being rimmed, and in general arrangement to the type series (Robins & Robins, 1976). There are three supraorbital pores, six infraorbital (including the pore set at the base of the anterior nostril on the anterior ascending branch of the infraorbital) and eight to nine preoperculomandibular. In this last series there are seven to eight pores along the jaw and the eighth or ninth is placed in a preopercular position. Only seven pores are present in the preoperculomandibular series of the type collection and all are mandibular in position, none preopercular (Robins & Robins, 1976). Also, there are five infraorbital pores in the type series while in the Discovery Collection specimens a sixth pore is placed behind the level of the posterior margin of the eye.

Fins. The insertion of the dorsal fin in our specimens is somewhat variable in position, arising from between the level of the posterior half of the pectoral fin and its tip. The dorsal and anal fins in the paratype examined and in the illustration given by Robins & Robins (1976) are proportionally higher than in the Discovery Collection specimens. In all specimens the left pectoral fin bears 15 rays.

Squamation. None of the four specimens studied by Robins & Robins (1976) was scaled, a feature they took to be diagnostic. The three Discovery Collection fish, however, are scaled, representing the most trenchant deviation from this diagnosis. They are scaled all over the body, except the head. The scales are arranged broadly in the classic basket-weave pattern (Fig. 7 (a)), yet their number, shape and disposition are very variable. The scales are generally elongate in shape, but their length may vary between twice the scale width [type A scales—Fig. 7 (b) (i)] and 15 or more times the scale width [type B scales—Fig. 7 (b) (ii–iv)]. The disposition of these scale types is variable between specimens and not necessarily bilaterally symmetrical on an individual. Type A scales are present in only one of the specimens [Fig. 7 (a)]. Here they are present in one patch on the left side on the belly posterior to the left pectoral fin and two patches on the right side, one between the lateral line and the dorsal profile, posterior to the right pectoral fin, and the other on the beginning of the caudal region between the lateral line and the ventral profile. Scales of type B are most common and are present on all three specimens. They occur all over the body from the level of the pectoral fin. The density of these scales is variable, both anteroposteriorly and bilaterally.

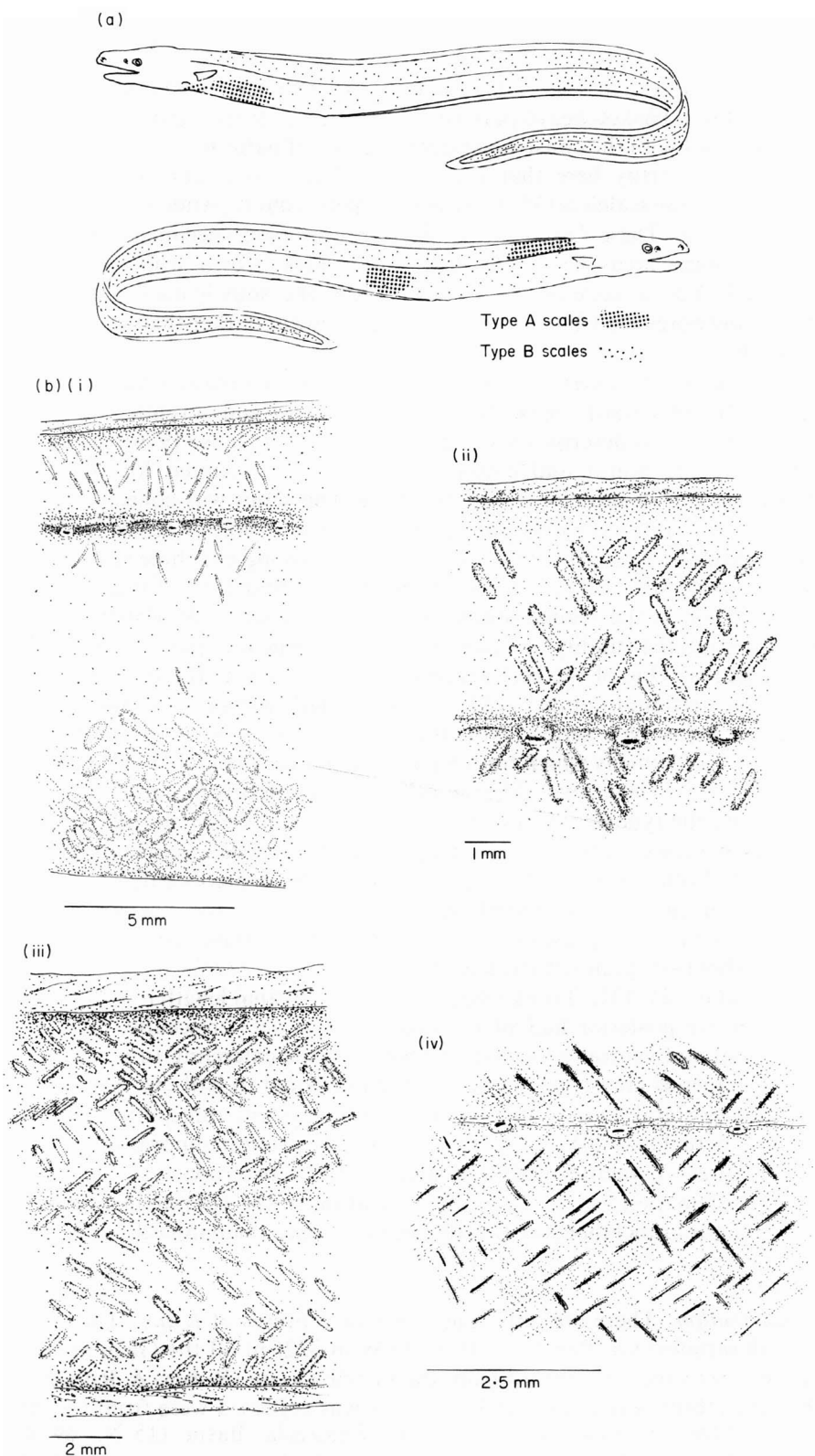


FIG. 7. *Ilyophis arx*. (a) Distribution of type A and B squamation on each side of a 237 mm TL specimen. (b) Detail of the squamation from the areas indicated in (a), (i) trunk region (scales of type A ventrally), (ii) anal region (scales of type B), (iii) region of end of caudal (scales of type B), (iv) caudal region of 249 mm TL specimen (scales of type B).

There are zones, in the caudal region for instance, where they are densely arranged in a basket-weave pattern [Fig. 7 (b) (iii) & (iv)] and others where they are dispersed with the consequent derangement of pattern.

It is noteworthy here that the two specimens of *I. arx* collected from the Caribbean were scaleless (M. E. Anderson, pers. comm.; Anderson *et al.*, in press).

Coloration. These Discovery Collection preserved specimens are variable in colour. Some areas have remained a dull dark brown while others are discoloured. Yet, in general, the throat is dark, the anus is dark rimmed and the lateral line pores are whitish. The belly is somewhat darker than the remainder of the body.

Conclusion and diagnosis. Some of the morphological characters of these eastern North Atlantic specimens, the fifth, sixth and seventh reported, differ from the original description given by Robins & Robins (1976). Most of these differences are minor and could reasonably be accounted for by individual, allometric and geographic variation. (The type series was collected in the East Pacific.) The most obvious difference is the possession of scales in the eastern North Atlantic eels. The individual variation among the three specimens, however, coupled with the similar observation of a gradation of nakedness to variously scaled in the related species *I. blachei* (Saldanha & Merrett, 1982) calls into question the validity of squamation as a diagnostic character among species of the genus. One of the best arguments for identifying these specimens with *I. arx* is the vertebral number (131–134) which falls within the range (131–135) of the Galapagos type series. Nonetheless, this does not hold true for the two Caribbean specimens which both have vertebral counts of 124 (M. E. Anderson, pers. comm.). These, two, differ in other minor respects, but not in their nakedness, from the type description, yet give overall confidence in their identity as *I. arx*. Such a conservative approach is prudent until more specimens become available from both oceans to delineate the variability more exactly and so indicate whether or not specific variation is involved. For the present, a modified diagnosis of *I. arx* is presented here based upon the above and the characteristics of the other two species of *Ilyophis* (*I. brunneus* and *I. blachei*):

Vertebrae 124–135. Trunk long, $c. \frac{1}{3} - \frac{1}{6}$ TL. Preanal length $c. \frac{1}{3}$ TL. Dorsal fin origin above posterior half of pectoral fin. Gill slits crescentic, approximately horizontal and ventrally located on throat. Gape extending to posterior half of eye. Cutaneous crease extending less than or equal to half eye diameter behind eye. Supraorbital pores of the cephalic lateralis system, three; infraorbital, five to six; preoperculomandibular, seven to nine. No supratemporal or supraorbital commissures. Vomerine teeth arranged roughly in two rows.

The systematic position of *I. arx* in relation to the subfamilies Dysommidae and Synphobranchinae has already been discussed (Saldanha & Merrett, 1982).

Ecology

Distribution. There are only four reported captures of *I. arx*. The type series were all sampled together from 01°S, 90°W in 3225 m off the Galapagos Islands and represent the only record from the Pacific Ocean (Robins & Robins, 1976). The other three occasions on which *I. arx* was collected were from the Atlantic Ocean. One of these was from the Venezuela Basin (15°N, 69°W and 3977–4047 m soundings (temperature 3.4° C), (Anderson, pers. comm.; Anderson

et al., in press)). The other two were from the Porcupine Seabight [49°N, 13°W and 1794–1785 m soundings (3.8° C) (Saldanha & Merrett, 1982) and 1800–2000 m soundings (3.9–5.0° C) (Fig. 1)].

Diet. In the absence of evidence from stomach contents, it must be assumed that *I. arx* is a predatory eel, because the capture of the type series was on a bottom longline.

Reproduction. Sexual maturity in *I. arx* is attained by 237 mm TL, as the smallest specimen known is of this size and was found to be ovulating; evidently few if any eggs had been shed and the total fecundity was 1979 eggs. This eel was sampled in June (Stn. 50517).

***Ilyophis brunneus* Gilbert, 1891**

Material examined: 36 specimens.

Stn 8001, 436 mm TL ♀; Stn 8519#7, 479 mm TL ♂; Stn 8968, 278 mm TL ♀; Stn 9009, 315 mm TL ♂; Stn 9018, 217 mm TL ♂, 244 mm TL ♂, 247 mm TL ♂, 264 mm TL ♀, 273 mm TL ♂, 310 mm TL ♀, 314 mm TL ♀; Stn 9020, 247 mm TL immature; 265 mm TL ♂; Stn 9021, 310 mm TL ♀; Stn 9030, 420 mm TL ♀; Stn 9774#1, 465 mm TL ♀; Stn 50511, 400 mm TL ♀; Stn 50602#2, 432 mm TL ♀; Stn 10106#1, 324 mm TL ♂, 332 mm TL ♂, 400 mm TL ♀; Stn 50715, 335 mm TL ♀; Stn 50802, 396 mm TL ♂; Stn 50814, 346 mm TL ♂; Stn 50822, 416 mm TL ♂; Stn 50906, 408 mm TL ♀; Stn 51010, 368 mm TL ♀, 420 mm TL ♀; Stn 51011, 432 mm TL ♀; Stn 51308, 432 mm TL ♀; Stn 51411#1, 439 mm TL ♀; Stn 51412, 400 mm

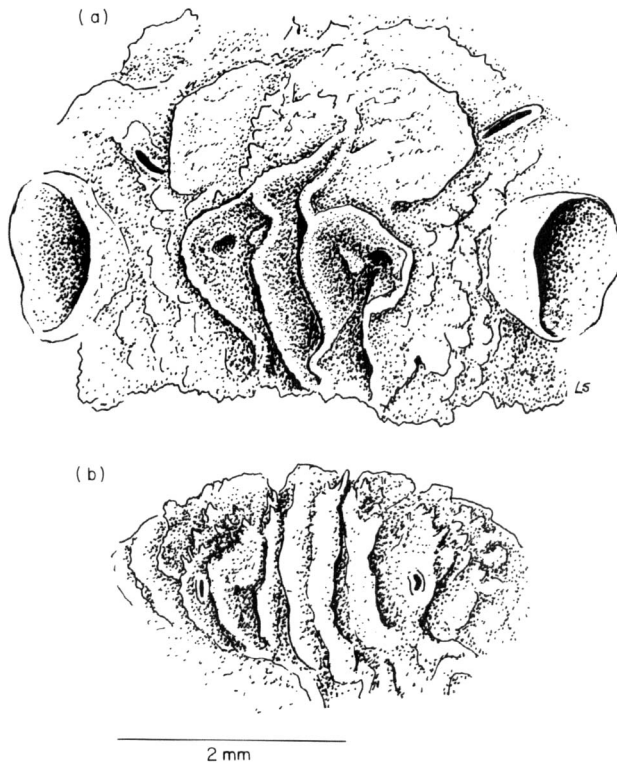


FIG. 8 (a) Snout and (b) jaw tip ornamentation of *Ilyophis brunneus* (436 mm TL).

TL♀; Stn 51613#1, 271 mm TL♀; Stn 10884, 284 mm TL♀, 313 mm TL♂; 51801, 415 mm TL♀.

Morphology

The specimens conform with previous descriptions (Castle, 1964; Robins, 1971; Karrer, 1982) and a summary of the morphometric and meristic characters is given in Table II. The following notes are provided to augment the information given by these authors.

Head. The gape extends to the level of the posterior margin of the eye and the cutaneous crease to about one eye diameter behind the eye.

Snout ornamentation. Dorsally, the snout bears four very conspicuous median plicae, the outermost encircling the anterior supraorbital pores (Fig. 8). Contiguous with the dorsal origin of these plicae, two other, more horizontally arranged, plicae are present on each side of the mid-line. The snout itself is bulbous in the area between the anterior nostrils and the medial plicae. Very minute and acute papillae commonly cover the ridges of the plicae. The tip of the lower jaw is conspicuously plicate also. (Described mainly from a specimen of 436 mm TL).

Nostrils. The anterior nostrils are tubular and slightly hooded in some specimens (cf. *H. texis* above). The posterior nostril bears a thickened rim.

Dentition. The tooth pattern conforms with the descriptions by Castle (1964) and Karrer (1982).

Lateralis system. The lateral line is long (80.3–92.0% TL in eight specimens measured) with drop-shaped pores as in the other synphobranchids discussed here, somewhat paler than the surrounding skin (see *Coloration*), with four to six anterior to the pectoral fin base and 33–36 before the anus. The distribution of cephalic pores is consistent with earlier descriptions (Robins, 1971; Karrer, 1982), i.e. three supraorbital pores, five to six infraorbital and nine to ten preoperculomandibular (eight to nine mandibular and one opercular). In one of the specimens there are only four infraorbital pores on the left side of the head, lacking the second labial pore from the snout tip, i.e., that placed between the first at the base of the anterior nostril and the third set close to the anterior part of the posterior nostril. Those specimens with only five infraorbital pores lack that placed posteriorly to the orbit (cf. Karrer, 1982). One specimen bore an extra supraorbital pore (on the right side) located near the posterior nostril.

Fins. The pectoral fins bear 11–15 rays (Table IV). In our material they are relatively smaller than those of *Ilyophis arx* (45.7–108.7 in TL; 4.2–10.5 in HL) and somewhat triangular in shape. In the Discovery Collection specimens the dorsal origin is generally close to the pectoral tip, ranging from the mid-length of the pectoral fins to 1.5% TL posterior to it. Castle (1964) and Karrer (1982) reported that the dorsal insertion was at the level of the pectoral base or slightly posterior to it, so the current observations extend this range. Considerable variation has been observed in the same character in *Synphobranchus kaupi* and *S. affinis* Günther, 1877 by Matsubara & Ochiai (1951).

Squamation. Generally, the specimens are scaled in typical basket-weave pattern. The head is mostly naked and squamation commences around the pectoral fin level.

Coloration. All but one of the specimens are beige coloured in isopropanol and that is a dark brown hue. The lateral line pores are whitish.

TABLE IV. Morphometric and meristic characters of (a) *Nessorhamphus ingolfianus* (189–502 mm TL) (Derichthyidae) and (b) *Nettastoma melanurum* (190–685 mm TL) (Nettastomatidae)

[illegible]

Body proportions given in percentages of total length (TL), head length (HL), trunk length (TRL) and preanal length (PAL).

Ecology

Distribution. Castle (1964, 1968) gave the range of *I. brunneus* as the central Atlantic, Straits of Malacca and the central East and South-west Pacific. Subsequent extensions to this distribution are the equatorial western Indian Ocean (Mozambique Channel; Karrer, 1982), western North Atlantic (36°–40°N; Markle & Musick, 1974), sub-tropical East Atlantic (22°–24°N; Merrett & Marshall, 1981) and the eastern North Atlantic (49°–51°N; Saldanha & Merrett, 1982). Additional records to those reported from the central and northern East Atlantic now augment the known occurrence in the area 22°–51°N, 11°–17°W (Fig. 1). Blache, Bauchot & Saldanha (1973) give the depth distribution of this species as deep abyssal to 2668 m. Its sounding range is shallower, however, in the Straits of Florida and parts of the Carribean (644–1283 m; Robins, 1971), but off the Bahama Is. it is found from 1239 to 3032 m (K. J. Sulak, pers. comm.). On the western North Atlantic slope it occurs in 900–2745 m soundings (Markle & Musick, 1974; K. J. Sulak, pers. comm.), while in the Mozambique Channel its reported sounding range is 990–1600 m (Karrer, 1982). The specimens currently reported were trawled from 1017–3120 m soundings. *In situ* temperatures were recorded from 11 of the 25 stations at which *I. brunneus* was captured, within the range 4.2° C (1678 m at 51°N)—2.7° C (2545 m at 50°N and 3120 m at 18°N).

Diet. Stomach contents were found in 14 *I. brunneus* which revealed a diet of a variety of crustaceans and annelid worms. Identifiable crustaceans were the natant decapod *Heterocarpus grimaldii* A. Milne Edwards & Bouvier, 1900 (one stomach), the amphipod *Procyphocaris induratus* (Barnard, 1925) (three stomachs) and the euphausiid *Thysanopoda cornuta* Illig, 1905 (one stomach). Both *H. grimaldii* and *P. induratus* are known only from benthic collections, while *T. cornuta* adults are bathypelagic organisms which may impinge on the slope as this cuts its depth distribution (c. 1250–2000 m). Annelid remains occurred in seven specimens and this evidence together with the above suggests that *I. brunneus* has a demersal feeding pattern. The known vertical ranges of these prey organisms all lie within the sounding span of *I. brunneus*. One additional prey, however, a specimen of the amphipod *Hyale* sp. (♀) from the stomach of an eel trawled from 2148 m soundings, is known to be strictly littoral in distribution. Such a range appears totally inconsistent with the habitual diet of a mid-slope/abyssal-dwelling eel. Members of the genus *Hyale* are generally associated with seaweed. It is possible, therefore, that this specimen was eaten from a moribund piece of drift weed which had sunk to slope levels. As it was well into the stomach, albeit in an undigested state, it seems unlikely to have been subject to net feeding.

Reproduction. The sex ratio within this collection of *I. brunneus* was 13♂ : 22♀. One specimen only was found to be too small for sex determination. Of the remainder, the majority of females possessed ovaries that were either imature or in the initial stages of yolk formation. Seven females, however, were in the growth phase of egg maturation and five of these were sufficiently close to ovulation for fecundity estimates to be made. These ranged from 2316–9852 eggs (278 mm TL–2316 eggs; 310–3337; 310–6524; 314–5330; 420–9852). The mean diameter of a sample of the alcohol-preserved eggs in the ovary of the 420 mm TL specimen was found to be 0.8 mm. All these females in advanced state of ovarian maturity were caught in sub-tropical latitudes (29°–31°N) during the month of

August. Only two other specimens approached this degree of ripeness, albeit in a much earlier stage of the post chorion formation growth phase, and these were sampled from 50°N during March and April. Noteworthy also is the small size of the sub-tropical specimens in relation to their ovarian maturity. Evidence from the 14 females collected around 50°N suggests that there the onset of yolk and chorion formation occurs at about 400 mm TL. Immature females up to 432 mm TL were found, while the smallest specimen with yolk and chorion formation in train was 408 mm TL and the two in the following growth phase of maturation were 445 and 465 mm TL respectively. Thus, if this evidence is representative, onset of ovarian maturation occurs at 130+ mm smaller size around 30°N than around 50°N. While the temperature regime in both habitats is similar such a variation may result from biological factors such as food supply, and infers a degree of stock separation.

RELATIONSHIPS WITHIN THE SYNAPHOBANCHIDAE

Earlier Saldanha & Merrett (1982) questioned the separation of the Synphobranchinae and Dysommidae as sub-families of the family Synphobranchidae on the basis of intermediate characters displayed by the genus *Ilyophis*. Hitherto this had been considered a dysommidae synphobranchid (Robins & Robins, 1976) but the variability of squamation in *I. blachei* stressed again the transitional situation between the two sub-families. The specimens of *I. arx*, studied above, were scaled, although the species was hitherto known only to be naked (Robins & Robins, 1976). Similarly, one specimen of *H. taxis* bore a few scales near the pectoral area. Moreover, there is a wide variation in location of scales, when present, in both *I. blachei* and *I. arx* (see above (Fig. 7) and cf. Saldanha & Merrett, 1982, Fig. 5). The evidence presented here, therefore, serves to confirm the intermediate position of the genus *Ilyophis* between the two existing sub-families which, together with the observation of scales in *H. taxis*, further weakens the case for such a separation. In addition it demonstrates the unreliability of squamation as a diagnostic character within the Synphobranchidae.

Preliminary family diagnosis and key to the species of Synphobranchidae known to occur in the eastern North Atlantic

The recent addition of *I. blachei* to the synphobranchid fauna of the region (Saldanha & Merrett, 1982), together with the current addition of *I. arx* and *H. taxis*, cause a need for a key to the identification of adults represented in the area. To facilitate its use a family diagnosis is also required. The family now includes species that formerly were included in different families and later incorporated into the sub-families Simenchelyinae, Dysommidae and Synphobranchinae (Robins & Robins, 1970, 1976). These representatives display broad morphological variation (e.g., in the size and shape of the mouth, the shape and degree of ornamentation of the snout, the presence or absence of pectoral fins and scales) which severely complicates a comprehensive diagnosis. For practical (field) purposes, therefore, a preliminary version is given below based upon external characters only. (The omission of larval and osteological features is tacitly accepted as beyond the scope of the present study.)

Body anguilliform, trunk short (generally) or long. Head, blunt with small,

circular, terminal mouth, or cylindro-conical (usually) with large mouth cleft to the level of the eye or beyond. Snout generally moderate in size (c. 18–45% HL), depressed or compressed, bluntish or sharp, sometimes ornamented with ridges and papillae (that may be very conspicuous); fleshy tip sometimes overhanging tip of lower jaw. Eyes variable in size (c. 4–20% HL). Gill slits inserted ventrally or ventro-laterally, generally at level of pectoral fins or slightly anteriorly, horizontal or oblique, linear or crescentic in shape; confluent anteriorly or contiguous over much of their length and placed in a common ventral groove, or totally separate.

Anterior nostrils tube-like, anteriorly directed, inserted at base of tip of snout. Posterior nostrils round openings, often rimmed, placed near anterior margin of eye.

Teeth in general caniniform, in bands, or with cutting edge in one row in both jaws; vomerine series largest and sometimes compound; cutaneous papillae often present among premaxillary and vomerine teeth.

Lateral line extending whole length of body or reduced; number of pores in cephalic lateralis system often reduced.

Dorsal and anal fins confluent with caudal; dorsal origin anterior to, or at level of pectoral fin (when present) or posteriorly inserted behind level of anus; anal fin origin usually contiguous with anus; pectoral fins present (usually) or absent.

Scales present or absent, when present usually arranged in a basket-weave pattern.

Habitat bathyal to abyssal, benthopelagic.

Annotated key to the species of Synphobranchidae found in the eastern North Atlantic

- 1(a) Pectoral fins absent.. .. *Dysomma brevirostre* (Facciola, 1887)
(Snout with conspicuous bulbous tip adorned with well developed fleshy tabs, ridges and papillae. Vomer with single median row of widely spaced truncate teeth. Vertebrae: 190–205. Sounding range: 350–600 m)
- 1(b) Pectoral fins present 2(a)
- 2(a) Head blunt, mouth small, terminal and circular *Simenchelys parasitica* (Gill, MS) Goode & Bean, 1879
(Anus close to mid-length of body, PAL 40–45% TL. Anterior nostril placed frontally. Teeth forming a single cutting edge in both jaws. Vertebrae: 116–125. Sounding range: 880–3000 m)
- 2(b) Head conico-cylindrical, mouth large, sub-terminal and cleft to level of eye or beyond. 3(a)
- 3(a) Dorsal origin posterior to anus (rarely level with it).. .. *Synphobranchus kaupi* Johnson, 1862
(Trunk short, 15–21% TL. Rictus behind posterior margin of eye. Teeth conical and recurved, one to two rows on vomer. Gill slits united below. Vertebrae: 142–152. Sounding range: 400–2550 m)
- 3(b) Dorsal origin well anterior to anus, over or close to pectoral fins, when laid back. 4(a)
- 4(a) Gape extending more than twice diameter of eye behind eye. *Histiobranchus bathybius* (Günther, 1877)
(Trunk long, 30–40% TL. Teeth sharp, conical and recurved; two to

- three rows on vomer. Gill slits only slightly divergent, almost confluent anteriorly. Vertebrae: 126–146. Sounding range: 1780–4800(+) m)
- 4(b) Gape extending only to posterior margin of eye or beyond to about one eye diameter behind it. 5(a)
- 5(a) Distance between posterior margin of eye and base of pectoral twice pre-orbital length *Haptenchelys texis* Robins & Martin, 1976 (Snout elongate, height about twice length. Dorsal origin above or slightly behind pectoral fin when laid back. Gill slits horizontal, ventrally placed and well separated. Teeth acute and slightly recurved, conspicuous externally anteriorwards in both jaws. Most vomerine teeth uniserial, broad based medially. Vertebrae: 125–131 (Pre-anal 36–39). Sounding range 2130–3150 m)
- 5(b) Distance between posterior margin of eye and base of pectoral less than twice postorbital length 6(a)
- 6(a) Gill slits ventrolateral, strongly oblique so that postero-dorsal margins extend to pectoral base *Ilyophis blachei* Saldanha & Merrett, 1982 (Gape extending to level of posterior margin of eye or beyond by distance less than half eye diameter. Cutaneous crease reaching half to the one eye diameter behind eye. Posterior nostril with roughly triangular flap. Dorsal origin about half snout length posterior to tip of pectoral when laid back. Vomerine teeth biserial, bluntish and caniniform. Vertebrae: 179–188; Sounding range: 1250–1800 m)
- 6(b) Gill slits broadly horizontal, ventral but well separated, postero-dorsal margins separated vertically from pectoral base by about one eye diameter 7(a)
- 7(a) Pectoral fins minute, 4.2–10.5 in head length. Snout pointed in profile. Cutaneous crease reaching about one eye diameter behind eye. *Ilyophis brunneus* Gilbert, 1982 (Gape reaching posterior margin of eye. Dorsal origin over pectoral fin, when laid back roughly horizontal. Vomerine teeth irregularly uniserial, conical, acute and slightly recurved. Vertebrae: 132–152 (Pre-anal 35–40). Sounding range: 1010–3120 m)
- 7(b) Pectoral fin moderate in size, 2.8–3.6 in head length. Snout blunt in profile and short, length about 1.5 times height. Cutaneous crease reaching up to half eye diameter behind eye *Ilyophis arx* Robins, 1976 (Gape reaching level of posterior half of eye. Dorsal origin level with posterior half of pectoral fin, when laid back. Vomerine teeth roughly biserial anteriorly, converging posteriorly, conical and acute. Vertebrae: (124) 131–135 (Pre-anal 31–32) Sounding range: 1790–2000 m)

DERICHTHYIDAE

Nessorhamphus ingolfianus (Schmidt, 1912)

Material examined: five specimens.

Stn 9012, 230 mm TL immature; Stn 9018, 326 mm TL ♂; Stn 9021, 189 mm TL immature; Stn 50709, 405 mm TL ♀, 502 mm TL ♀.

Morphology

There is no extensive formal description of *N. ingolfianus*, but Schmidt (1912)

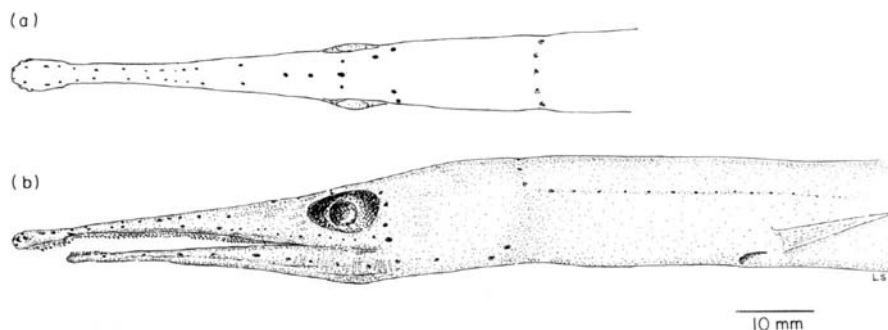


FIG. 9. Head and cephalic lateralis system of *Nessorhamphus ingolfianus* (326 mm TL); (a) dorsal and (b) lateral view.

and Beebe (1935) provided sufficient data to characterise this species with the long and spatulate snout. Such a feature immediately distinguishes the genus from other anguilliform fishes. Morphometric and meristic data for the specimens examined here are given in Table IV.

Nostrils. (Fig. 9) The two pairs of nostrils are inserted near the tip of the snout, in its fleshy part, on each side at the level of the premaxillary tooth patch. (The exact position is difficult to observe in the largest specimens owing to the shrunkenness of the snout tip.) In the smallest specimen the nostrils are placed somewhat ventrally, the anterior ones near the tip and the posterior ones laterally behind them at a slightly higher level.

Dentition. (Fig. 10) The teeth are conical and recurved on the premaxillary patch and in bands of three irregular rows on the maxillaries. The vomer has one-five-one irregular rows anteriorly to posteriorly. The dentary bears two to three irregular rows.

Lateralis system. Anterior to the pectoral there are eight to ten pores in the lateral line (eight(1), nine(1), ten(3)) and 73 before the anus (observable in only one specimen).

The pores of the cephalic lateralis system (Fig. 9) were also obscure in this material, but the most reliable counts are, with the number of specimens in parentheses: SO, 14 (1); IO, 20 + 4 (ascending branch) (1), 24 + 5 (1), 19 + 4 (1); POM, (left side) 13 (4), (right side) 11 (2) 13 (2), (two pores are placed in an opercular position); ST three (4). In addition to these pores, all the specimens bore a series of sagittal pores, mainly in the posterior part of the snout and extending over the eye region. They may form a supraorbital commissure. They varied as two to six in number and were placed approximately between the supraorbital pores of the eye region. In one case a smaller extra sagittal pore was present on the right side.

Fins. The dorsal and anal fins are confluent with the caudal. The caudal is damaged in these specimens but its shape—truncated and emarginate (cf. Schmidt, 1912)—can be guessed. The outer rays are more robust than the inner ones.

Coloration. These specimens are dark brown with a paler part on the anterior extremity of the head.

Ecology

Distribution. According to Schmidt (1930) *N. ingolfianus* is distributed in the 'warmer parts of all oceans' and Blache, Bauchot & Saldanha (1973) consider it

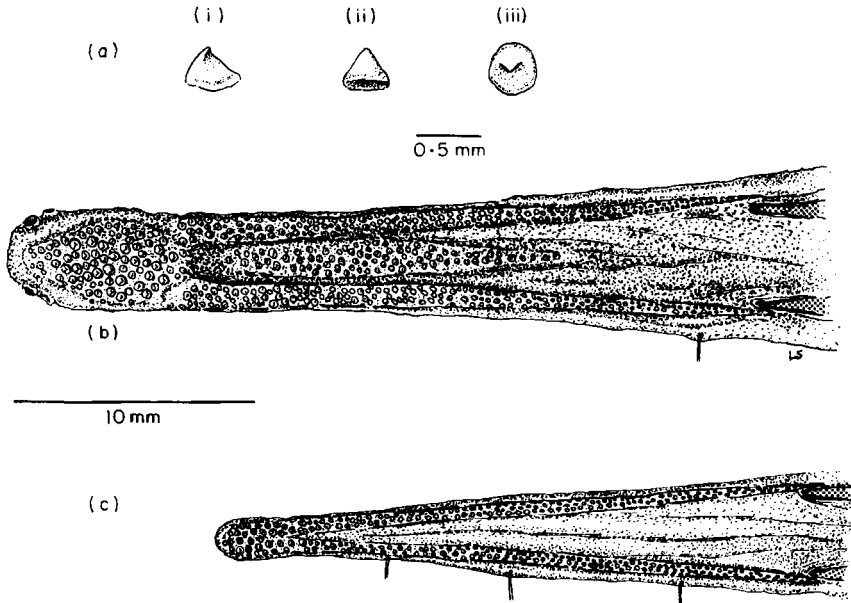


FIG. 10. Dentition of *N. ingolfianus*; (a) premaxillary tooth, (i) lateral (ii) posterior, (iii) dorsal view; (b) upper jaw; (c) lower jaw.

common and its distribution cosmopolitan in the eastern North Atlantic. The specimens reported here were from the area 28–49°N, 11–13°W and from soundings of 1045–2173 m (Fig. 1). The specimen from the ostensibly greatest depth was close to the southerly position where the bottom temperature would be around 4.5° C (Fuglister, 1960), while the bottom temperature at 1045 m 49°N is approximately 8° C (I.O.S. unpubl.). According to Blache, Bauchot & Saldanha (1973), however, this species is epi- and meso-pelagic. Unpublished (I.O.S.) data from mouth opening/closing midwater trawl (RMT 1 + 8) samples collected in the eastern North Atlantic tend to confirm this view, with various stages of juveniles being shown to occur in the upper 1000 m. The two specimens collected from greater depth (1200–1500 m) were larger (350–575 mm TL). This may imply an ontogenetic descent with growth, with larger specimens impinging on the sea-floor as the continental slope cuts across their pelagic living space.

Diet. Two specimens had stomach contents and both contained crustacean remains.

Reproduction. While the larval stages of *N. ingolfianus* are known (for references see Blache, Bauchot & Saldanha, 1973) there is no information on the breeding biology. While the single male represented was ripening at 326 mm TL in August, both the females (405 and 502 mm TL) evidently were sexually immature.

NETTASTOMATIDAE

Nettastoma melanurum Rafinesque, 1810

Material examined: nine specimens

Stn 7851, 376 mm TL ♀; Stn 8930#1, 405 mm TL ♂; Stn 8966, 572 mm TL ♀,

695 mm TL ♀; Stn 8977, 554 mm TL ♂, 677 mm TL ♀; Stn 9010, 504 mm TL ♀; Stn 9015, 193 mm TL immature; Stn 9016, 653 mm TL ♂.

Nettastoma melanurum is collected relatively often in the eastern North Atlantic and consequently is the best known species considered here.

Morphology

Smith *et al.* (1981) reviewed the genus *Nettastoma* and provided a detailed diagnosis of *N. melanurum* with which our observations broadly concur (Table IV).

Dentition. This is in agreement with the pattern described (cf. Saldanha, 1965; Smith *et al.*, 1981).

Lateralis system. There are 45–48 pores anterior to the anus in the two specimens at hand. The following pores are present in their cephalic lateralis system: SO 4–5; IO, 12–15 (of which one is at the base of the anterior nostril in a semi-dorsal position and three are in the ascending post-orbital canal); POM, 18–21; ST, 3.

The SO 5 pore is lacking in eight of the nine specimens examined, which evidently commonly occurs (cf. Smith *et al.*, 1981). The one SO 5 pore found has a flattened elliptical shape.

Vertebrae. Counts from the above specimens extend the known range to 186–206.

Colour. (in preservation)—whitish overall.

Ecology

Distribution. The species is widely distributed on both sides of the Atlantic, from Portugal and the Mediterranean to the Gulf of Guinea and from the northern Gulf of Mexico and east coast of Florida through the Caribbean to the Guianas (Saldanha, 1965, 1982; Smith *et al.*, 1981). It is a shelf/slope-dweller (37–1647 m—Smith *et al.*, 1981) and so the specimens reported here were collected well within the known range (25–31°N, 10–16°W in 486–1029 m soundings—Fig. 1). The probable temperature at these soundings is around 11°C (Fuglister, 1960).

Diet. Minimal remains in the stomachs of three specimens suggests that they feed to some extent on crustaceans.

Reproduction. In that leptocephali of *N. melanurum* are widespread in occurrence, virtually covering the known adult range (Smith & Castle, 1982), breeding is unlikely to be restricted in locality. Our male specimen was ripe (in October) while three females were in the early growth phase of ovarian maturation in August.

Venefica proboscidea (Vaillant, 1888)

Material examined: five specimens.

Stn 9007, 600 + mm ♀; Stn 9021, 740 + mm ♂; Stn 9132#5, 890 + mm ♂; 'Evrika' specimens, 880 + mm ♂, 906 + mm ♂.

Morphology

The morphological characters of these specimens in general agree with those described (Table V) (cf. Karrer, 1982). Each specimen lacks part of the tail, allowing proportions to be expressed only as percentages of head, trunk and

TABLE V. Selected size ranges of morphometric and meristic characters of *Venefica proboscidea* (Nettastomatidae)

| Morphometric characters ($n=5$) | %HL | %TRL | %PAL |
|--|-----------|--|-----------|
| Length* 600 + - 906 + mm | | | |
| Preanal length 233-345 mm | | | |
| Head length 63-95 mm | | | |
| Head length | | 27.9-39.1 | 21.8-28.1 |
| Trunk length | | | 71.9-79.4 |
| Predorsal length | | | 23.9-30.6 |
| Preorbital length (snout) | 44.2-50.7 | | |
| Postorbital length | 44.0-50.5 | | |
| Eye diameter | 4.8-5.6 | | |
| Nose filament | 23.3-30.6 | | |
| Interorbital width | 2.6-4.0 | | |
| Gape length | 39.7-48.6 | | |
| Depth of body-gill slit level | 11.1-15.3 | | |
| —maximum (anterior half of tail) | | | 5.2-7.5 |
| Meristic characters (frequency in parentheses) | | | |
| No. vertebrae—total | — | | |
| —predorsal | 6-10 | $(\frac{1}{6}, \frac{3}{7}, \frac{0}{8}, \frac{0}{9}, \frac{1}{10}) n=5$ | |
| —preanal | 54-58 | $(\frac{1}{54}, \dots, \frac{1}{57}, \frac{3}{58}) n=5$ | |

Body proportions given in percentages of head length (HL), trunk (TRL) and preanal length (PAL).

*All specimens are incomplete, with the ends of their tails missing.

preanal length. The trunk length and maximum body depth in percentage of preanal length are higher than Karrer's (1982) values for Indian Ocean specimens.

Dentition. The teeth are cardiform on the premaxillary, maxillary, vomer and dentary, with the inner rows somewhat enlarged. In the broader part of the vomer there are four to five irregular rows. The premaxillary teeth are in a somewhat triangular patch and rather bigger than the rest. There are some six irregular rows on the median portion of the maxillary and around five in the dentary, although this number does vary with size. These observations are in close agreement with the careful description given by Karrer (1982).

Lateralis system. The maximum number of pores in the lateral line (left side) of two specimens was 59 and 60 pores anterior to the anus. Damage on both sides of the other fish prevented this count from being corroborated. Similar skin damage complicated observation of the details of the cephalic lateralis system. Counts that were possible are: SO; 9-10 (including those on the fleshy tip of the snout); IO 16-17 (1+12-13+3 ascending branch); POM, 18-19 (13-14 mandibular+5 opercular); ST 3. The pores in the supraorbital canals are not always paired, sometimes they have a staggered arrangement (e.g. one specimen bore a single unpaired pore between the eyes).

Vertebrae. While damage to the tails of these specimens preclude total vertebral counts (225+ maximum), the range of predorsal vertebrae was 6-10 and preanal 57-58 in I.O.S. specimens and 7 and 54-58 in the 'Evrika' eels.

Coloration. The preserved specimens are uniformly light brown.

Ecology

Distribution. *Venefica* is widely distributed. According to Smith & Castle (1982) adults occur in the eastern and western Atlantic, the eastern Pacific and the Indo-West Pacific Oceans. The North Atlantic specimens reported here (20–30°N, 11–18°W—Fig. 1) are thus within the known range and the sounding range of capture (1654–3109 m) and corroborate the view of Smith & Castle (1982) that it lives in deeper water than other nettastomatids. According to Fuglister (1960) the temperature range consistent with these soundings and latitudinal ranges in the North Atlantic is c. 2.5–5.0°C. The South Atlantic ('Evrika') specimens were collected from 1200 m which, again according to Fuglister (1960), in this area lies within the same 2.5–3.0°C temperature range.

Diet. A single large natant decapod crustacean was found in each of the 'Evrika' specimens. One of these was 13% of the total length of the predator, the other 8%. Some red pigment in the digested remains in the stomach of one of the North Atlantic specimens suggested that similar food had been taken.

Reproduction. *Venefica leptocephali* are unknown (Smith & Castle, 1982) as is other evidence of breeding biology. All male specimens here were mature but the female was immature.

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