รายงานผลการวิจัย
ทุนวิจัยรัชดาภิเษกสมโภช

เรื่อง

การศึกษาสัณฐานวิทยา กายวิภาคศาสตร์ และนิเวศน์วิทยา ของปลาปากกลมน้ำลึก เพื่อเสนอชื่อเป็นชนิดใหม่ของโลก จากทะเลอันดามัน

โดย

ทศพร วงศ์รัตน์

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จุฬาลงกรณ์มหาวิทยาลัย

ทุนวิจัยรัชดาภิเษกสมโภช

รายงานผลการวิจัย

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พฤศจิกายน ๒๕๒๖

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ของปลาปากกลมน้ำลึก เพื่อเสนอชื่อเป็นชนิดใหม่ของโลก
จากทะเลอันดามัน

ชื่อผู้วิจัย นายทศพร วงศ์รัตน์

เดือนและปีที่ทำการวิจัยเสร็จ พฤศจิกายน ๒๕๒๖

บทคัดย่อ

Eptatretus indrambaryai n.sp. เป็นชื่อวิทยาศาสตร์ที่เสนอขึ้นสำหรับปลาปากกลมที่พบเป็นชนิดใหม่ของโลก จากผลการศึกษาตัวอย่างรวม ๑๐ ตัว ที่รวบรวมได้จากสองบริเวณในทะเลอันดามัน ที่ระดับความลึกระหว่าง ๒๖๗ ถึง ๔๐๐ เมตร และมีอุณหภูมิที่ระดับนั้นประมาณ ๙.๐–๑๒.๒ องศาเซลเซียส ปลาปากกลมชนิดนี้ มีช่องเหงือก ๘ คู่ จึงจัดได้ว่าใกล้ชิดเพียงกับ ๒ ชนิดที่เคยรู้จักกันคือ E. okinoseanus Dean, 1904 จากเขตน่านน้ำประเทศญี่ปุ่น และ E. octotrema Barnard, 1923 จากเขตน่านน้ำประเทศอัฟริกาใต้ แต่อย่างไรก็ตาม โดยอาศัยลักษณะ อนุกรมวิธานที่ยอมรับกันตลอดมา ปลาปากกลมชนิดใหม่นี้ แตกต่างกับอีกสองชนิดดังกล่าว ตรงที่มีช่วงลำตัวสั้นกว่า คือเพียง ๕๑.๗–๕๗.๐ เปอร์เซ็นต์ของความยาวตลอด มีช่องเหงือกยาวกว่าคือเป็น ๘.๖–๑๐.๖ เปอร์เซ็นต์ของความยาวตลอด มีลำตัว (ไม่นับส่วนครีบ) กว้างกว่า คือเป็น ๘.๓–๑๐.๓ เปอร์เซ็นต์ของความยาวตลอด มีช่องเหงือกรวมเพียง ๑๑–๑๒ ช่อง และมีซี่ฟันบนแผงฟัน รวม ๔๕–๔๘ ซี่ ซึ่งแตกต่างกับสองชนิดนั้น

Project Title Studies on morphology, anatomy and ecology of a new species of deep-sea hagfish from the Andaman Sea

Name of the Investigator Associate Professor Dr. Thosaporn Wongratana

Year November 1983

Abstract

Eptatretus indrambaryai n.sp. is described from ten specimens from two different localities in the Andaman Sea, at depths of about 267–400m where the temperature was about 11.0–12.2°C. The fish appears to be allied to *E. okinoseanus* Dean, 1904 from Japan, and *E. octotrema* Barnard, 1923 from South Africa in having eight gill apertures. It differs, however, from them mainly in having shorter trunk length (51.7–57.0% TL), slightly longer branchial region (8.6–10.6% TL), a thicker body (greatest depth of body excluding finfold 8.3–10.3% TL), fewer slime pores (total 77–82), and a different total cusp count of teeth (45–48).

CONTENTS

Introduction

Nothing is known of the species of Myxinidae from Thailand, most of the Indian Ocean and the South China Sea, chiefly because hagfishes are not represented in ordinary commercial fish catches of the countries surrounding these areas. In tropical seas the very few records of myxinids from the Carribean Sea, French Guiana, Gulf of Mexico, Florida (Fernholm & Hubbs, 1981) and Philippines (Fernholm, unpubl. data) were taken only from cold deep waters of 8.9–11.5^{0}C. Fishing at great depths is uncommon for local fishermen of Thailand and neighbouring countries.

From 1 to 14 November 1981, I was invited to join the R.V. Nagasaki-maru (587 tonnes) of Nagasaki University, Japan, for a cruise in the Andaman Sea whose purpose was to conduct trials with several types of fishing gear. These included 19 trials with shallow, middle, and deep-sea trawls, 3 trials with deep-sea shrimp traps, and 5 trials with vertical squid automatic anglings, in addition to taking oceanographical records. This enabled me to selectively collect and bring back to Chulalongkorn University nearly 1000 specimens of fishes comprising 257 species of 91 families (Wongratana, 1982). Among 9 unidentified species were 4 specimens of a deep-sea hagfish, each individual of which was captured from a different trap of a series of about 50 units from the depths of about 267–400 m. in early morning on 10 November 1981. Each trap was baited with about 8–10 half-rotten sardines, Sardinella gibbosa, of about 100–130 mmSL, wrapped in a sack made from a piece of netting.

No hagfishes were caught in other of deep-sea shrimp traps, nor in any of the three deep-sea trawls made. This could be due to many factors such as shallower water depths, different gear operations, varying mesh size of the nets, type of bottom, temperature and current. Throughout the Gulf of Thailand, where the greatest depth is not more than 80 m and temperature is about 24-29°C, no hagfish has been captured in any survey since extensive trawling was introduced with the Naga Expedition by R.V. Stranger in 1959-1961. Hagfishes are absent also from the fishes taken in surveys by R.V. Pramong 2 in the Gulf of Thailand and off the east coast of the Malay Peninsula during February 1966 to April 1967 (Wongratana, 1968).

Upon searching the collection of the Division of Exploratory Fishing, Department of Fisheries, which has conducted several deep-sea shrimp trawls at depths of 200-500m on R.V. Exploratory 2 in the Andaman Sea. I was able to find 7 unlabelled specimens of hagfish. Locality data and other details (including a penciled note, "eel-like fish", in Thai), appear on the original cruise records, including the important record of bottom temperatures as 11.38°C. I have assumed that these environmental data belong to the specimens. However, when Manprasit (1976, in Thai) published a list of deep-sea fauna secured from that survey, no hagfish was mentioned under any name in his work but he stated that there was about ten further species not yet identified.

All specimens of hagfishes from the two were found to be of the same species. They belong to the 8 gilled-hagfishes of the genus *Eptatretus* Cloquet, 1819, but do not appear to belong in any currently recognized species. The specimens are compared to the previously known 8 gilled species, *E. okinoseanus* from Japan and *E. octotrema* from South Africa, and are described as new to science as follows.

Methods and abbreviations

Many characters were difficult to measure with accuracy on the soft wrinkled body parts, because of great variation in condition of the specimens due to differences in handling, preservation and quantity of gut contents, as well as injuries sustained during capture.

In this work data was taken as outlined by Fernholm and Hubbs (1981) and Hubbs and McMillan (unpublished data), with some additions, there are: promucous pore length from extreme tip of rostrum to anteriormost slime pore; preventral finfold length from extreme tip of rostrum to origin of midventral finfold; interspace between first gill aperture; interspace between last gill apertures; distance between origin of midventral finfold to a line drawn between the posterior edges of the last gill apertures.

Measurements are all straight-line distances taken with dividers to the nearest 0.1 mm. They were made on the left side of all specimens. All the measurements are expressed as percentage of total length (TL). The countings, however, were made on both right (R) and left (L) sides of each specimen. Weight is not reported for badly damaged individual missing tissues. Mature specimens were sexed by examination at gonads, through a cut in the lateral right side of body wall anterior to the cloaca. Sometimes sex determination was not possible. Eggs of ripe females could be detected externally by feeling the abdominal region.

Slime pores could usually be counted even if the skin was torn apart, as their openings on the muscle could be seen. Slime glands are pinkish-brown even after long preservation.

The teeth of the specimens only partially everted. The examination and counting of lingual teeth and hyoid or palatine teeth are made possible by making a longitudinal dissection right at the midventral line starting at the lower edge of the oral cavity, and continuing down the pharynx until the two parts can be freely turned outward to either side. There was no difficulty in differentiating the teeth at the posterior end of the row from cartilage which may protude at the tip of the tooth plate, because the former are sharp, strong, smooth with shining enamel, and the cartilage is whitish, rough and soft. The position of the base of tongue muscle was examined by making a longitudinal slit in ventral region between the anterior gill apertures and the skin was pushed aside to uncover the muscles.

The specimens of the new species studied, and specimens of _Eptatretus okinoseanus_ and _E. octotrema_, are in the following repositories: AMS - Australian Museum, Sydney; BMNH - British Museum (Natural History), London; CUMZ - Chulalongkorn University Museum of Zoology, Bangkok; DEF - Division of Exploratory Fishing, Department of Fisheries, Samutprakarn, Thailand; KUMF - Kasetsart University Museum of Fisheries, Bangkok.

Eptatretus indrambaryai n.sp.

(Figure 1, Table 1)

Holotype: CUMZ (uncat.) 296 mmTL, from Nagasaki-maru, station deep-sea shrimp trap 3, lat.07° 37' 02"N, long. 97° 52' 00" E, depth 267-400m, 1700 h of 9 November 1981 -0630 h of 10 November 1981, coll. T. Wongratana.

Paratypes: (9 fishes); AMS 123661-001 (1 fish) 193 mmTL, same data as the holotype, but from another trap; BMNH 1983.3.24.1 (1 fish) 188 mmTL, same data as the holotype, but from yet another trap; DEF (uncat.) (7 fishes) 198-437 mmTL, from R.V. Exploratory 2, cruise 1/1975, station 0284, lat. 10° 53' 00"N, long. 97° 03' 00"E, depth 300-308m, 8 March 1975, 0730-0830 h, coll. T. Panniam and U. Manprasit.

Other specimen: KUMF (uncat.) (1 fish) about 262 mmTL, same data as the holotype, but from another trap, coll. S. Sontirat.

Diagnosis: A medium-sized hagfish, the only species known from the Andaman Sea, of the genus *Eptatretus*. This is most similar to *E. okinoseanus* of Japan and *E. octotrema* of South Africa in having eight gill apertures (rarely 7), but differs chiefly in a combination of the following characters: trunk length 51.7-57.0%TL, branchial length 8.6-10.6%TL, greatest depth of body (excluding finfold) 8.3-10.3%TL, total slime pores 77-82, with three and two cusps on multicuspids of outer and inner row in teeth, and with total cusp count 45-48.

Description: Based on the 10 syntypes, 188-437 mmTL. The general body form and positions of finfolds may be seen in Figure 1. Body proportions in percent of total length and counts of other characters are broadly given in Table 1. Figures in parentheses in the following description apply to paratypes when different from the holotype.

This is a stout species of Eptatratus. The biggest studied fish is a female with fully riped eggs 20.8mm in length and 9.1mm in width. The total number of eggs of this specimen was unknown because most of them were lost through a large hole at the middle part of the body; because of its poor condition the anchor filaments of both ends of the eggs could not be counted.

The body is essentially subcylindrical in the vicinity of the head and branchial apertures. It is slightly deeper than broad at the middle and increasingly compressed posterior to the strongly compressed tail, which has a margin of somewhat irregular shape or bluntly rounded. The dorsal finfold is well developed, restricted to the region of the tail and confluent with the caudal finfold. Its origin is usually vertically above the front corner of cloacal slit. The length from the beginning of upper finfold to the posterior-most margin of the caudal finfold is 15.81 (14.4-17.6) %TL. There are (BEF uncat. 414mmTL) 54 elements supporting the entire dorsal part of tail fin, and 46 elements supporting the ventral lobe of the caudal finfold. Almost all the elements are bifurcated and some are trifurcated, the posterior ones with deep incisions. The cloacal aperture is a longitudinal slit of about

2.6 (2.4–3.3) %TL. surrounded by lateral body wall-like labia.

The midventral finfold originates well behind the branchial region and extends backward to the cloaca where it appears to split, forming the labia of the cloaca, and unite posteriorly, becoming the caudal finfold. There are some variations in the original position of the midventral finfold (Table 1). It seems likely that the fold is proportionally deeper in younger individuals than in larger ones, particularly at middle part of its length.

The mouth is a small aperture concealed by the heavy fold lip. The naris is prominent and guarded above by a thin membranous hood which terminates in a round margin. There are three pairs of barbbels flanking both nostrils and mouth. They are round in cross-section and taper evenly to a point, the nasal barbels being slightly shorter than the second pair, and the posterior barbels longest.

Eight pairs (seven in one paratype, DEF 360.0 mmTL) of branchial apertures open ventrolaterally in a regular row, but the interspaces between pairs narrow posteriorly (Figure 18). The posteriormost left efferent duct of the gill confluents with pharyngo-cutaneous duct and forming the largest branchial aperture.

Each side of the body has a ventral series of slime pores or mucous pores, exteding from a short distance behind the rostrum rearward to a point slightly behind anterior half of the tail. In the prebranchial region the line of slime pores is situated about 2/3 down the side of the body, but at about the middle of the trunk the line is located on the side about 2/3 of body depth in smaller fish to 3/4 in larger fish. Just before the clocal slit the slime pores are placed about 1/5 of the depth from below. Branchial slime pores are variously situated in the region between the ventroposterior and ventral to (rarely behind) each gill aperture. Sometimes, one or more of the posterior gill apertures (particularly the last one) have no associated slime pores; however, in such cases an extraslime pore may appear behind the normal one of the preceding gill aperture. The abdominal series continuously extends from the posterior end of the branchial region to a place just in front and above the anterior corner of the cloacal slit. Horizontally above the level of the last abdominal pore, there are 3, rarely 2 or 4, slime pores above cloacal slit followed by 8-9, rarely 7 or 10, pores above the ventral lobe of the caudal finfold.

The lingual tooth plates bear 9 (9-10) teeth in an outer row and 9 (8-10) in an inner row. The bases of the anterior-most 3 teeth of the outer row are fused together as are those of the anterior-most two of the inner row (Figure 10). The anterior teeth of each row are more or less compressed, the posterior ones cylindrical in shape, and generally all taper to a sharp point, especially the posterior ones. A single hyoid tooth is present and of about the same size but sharper than other teeth. It lies at the middle of the roof of mouth, just above the front profile of the lingual toothed series.

The slime glands are bulb-like and conspicuous. The tongue muscle is stout and cylindrical in shape with a rounded base, and slender anteriorly. Its base typically lies above the space between the second and third gill pouches. The ventral aorta branches at the level of the last gill pouch (Figure 1C). Eggs are 13 in number (from DEF 414 mmTL, unripe, averaging 23.1 x 5.9 mm in size). A large egg from DEF 437 mmTL measured 26.9 x 9.1 mm.

In examination for the sensory canals of the head no trace of the organs was found.

Colouration: When fresh, the Nagasaki-maru specimens had shiny dark violet colouration, each gill aperture and eye region being paler or whitish. When the body was pressed near the slime pores a tiny white substance exceded from each pore (this facilitated counting the number of pores). In good preserved specimens the skin in most places is a uniform shiny purplish-brown, but dull brownish-grey in other specimens. That snout or rostral part and the area around mouth are whitish in most large specimens, possibly due to their highly active boring. All barbels, especially those of smaller fish, are coloured the same as body parts, but they are usually much paler in larger fish. All teeth are light brownish. Slime glands are pinkish-brown (observed from several injured specimens when the glands were exposed).

Ethymology: The new species is named in honour of Professor Boon Indrambarya, former Director-General of the Department of Fisheries and Dean of the Faculty of Fisheries, Kasetsart University, Bangkok, and at present, Fellow of the Royal Institute of Thailand. Being the second of three students to be sent abroad to the U.S.A. for higher education in fisheries under the support of Prince Mahidol of Songkhla, father of His Majesty King Bhumibol , and being a young collegue of Dr. Hugh M. Smith, he has long been energetically engaged in fisheries research and environmental study in Thailand. He is also the senior-most pioneer fisheries biologist of Thailand.

Key to the eight-gilled species of *Eptatretus*

1a. Slime pores 77-82, total cusp count of teeth 45-48, branchial length 8.6-10.6%TL, trunk length 51.7-54.7%TL, greatest depth of body (excluding finfold) 8.3-10.3%TL, Andaman Sea.....................*E. indrambaryai* n.sp.

1b. Slime pores 89-103, branchial length 7.7-9.4%TL, trunk length 56.0-58.0%TL, Japan or South Africa...2

2a. Slime pores 89-94, total cusp count of teeth 48-49, greatest depth of body (excluding finfold) 7.5-8.5%TL, Japan.............................*E. okinoseanus*

2b. Slime pores 102-103, total cusp count of teeth 40, greatest depth of body 5.2%TL, South Africa...*E. octotrema*

Taxonomic position and relationships

Study of the ten specimens of the new species revealed that they are a member of the genus Eptatretus Cloquet, 1819 which take precedence over Bdellostoma Müller, 1834. This generic allocation is based primarily on the study of taxonomy of polybranchiate myxinoids by Strahan (1975). In that work, he is also of the opinion that the generic name Paramyxine must be regarded as a junior synonym of Eptatretus. Adam and Strahan (1963) and Fernholm (unpublished data, 1980), however, regarded the two genera as distinct from each other on the basis of the great difference in number of slime pores in the branchial region. In Eptatretus the slime glands and pores are more numerous and restricted in location. There are 4-8 on each side about the gill apertures, but in Paramyxine, there are none or only one on each side. Fernholm and Hubbs (1981) also recognize the genus Paramyxine as distinct from Eptatretus. In geographic distribution, Eptatretus species are distributed throughout the world, whereas Paramyxine species are restricted to the North China Sea.

At the subfamily level, the new form belong to Eptatretinae (syn.= Bdellostomatinae), the members of which have gill pouches with separate orifices, differing from the Myxininae which are characterized by having 5-15 gill pouches but only one external opening on each side.

In view of the current use of the counts of gill apertures, cusps of teeth and slime pores, I do not feel that the present Andaman form can be placed in any described species. It is a new species that is more closely related to *E. okinoseanus* from Japan and *E. octotrema* from South Africa, chiefly in the presence of 6 gill apertures, than to other groups of *Eptatretus*. This interpretation is also supported by Prof. B. Fernholm (in litt., 5 July 1983).

From Table 1, it is likely that the new species is closer to *E. okinoseanus* than *E. octotrema*. However, their differences are relatively great compared with the intraspecific variation which occurs to some degree in hagfishes. In several essential measurements, the range of the new species does not include the specimens of *E. octotrema* and *E. okinoseanus* at all. Their localities are also completely disconnected. So far that each species of hagfish is confined to a particular oceanic area; therefore one would expect forms from such widely separated seas to be different species. Although a paratype (DEF uncat. 360mmTL) has only 7 gill apertures on both sides, it is almost certainly not a different species because specimens with one more or one less gill aperture are commonly found in species of *Eptatretus* (Strahan, 1975; Hubbs and McMillan, unpublished data). It is also not a variant or subspecies of a species with 7 gill apertures (*E. cirrhatum* from New Zealand, *E. burgeri* from east coast of Japan, and *E.* n.sp. of Fernholm from his unpublished data from deep waters of the Philippines).

Until the capture of the present new species no other hagfish has been known to occur in the Andaman Sea or the major part of the Indian Ocean. The only previous record of this group of fish in the Indian Ocean is E. octotremus from South Africa at Alguhas Bank. That species greatly differs from E. indrambaryai n.sp. as shown in Table 1. It was reported captured from a depth of only about 15-24 m. The other South African species, viz., E. profundus captured off Cape Point at 720 m and E. hexatrema from the Cape of Good Hope from 10-45 m, are generally defined as Atlantic species. Taxonomically, these two species are characterized chiefly by having 4 and 5 gill-apertures, respectively, and also by other important characters. E. longipinnis, from Robe and Cape Douglas of South Australia, has only 6 pairs of gill apertures, a midventral finfold originating anterior to level of third gill aperture, 102-108 slime pores, and a total cusp count of only 30-31. It comes from a depth of about 40 m.

Of the Southeast Asian waters, the recent capture of an undescribed species from deep waters of the Philippines (Fernholm, unpublished data) is very interesting. From the characters given by Prof. B. Fernholm in his unpublished key to the Myxinidae of Eastern Asia, and data from five specimens forwarded to me by Dr. L.R. Wisher (in litt., 14 April 1982), that fish differs from the present new species chiefly in its combination of 7 gill apertures, 76-80 slime pores, 3 cusps on multicuspids of both outer and inner rows of teeth, and total cusps of teeth 47-52.

Habitat and biology

Up to the present, species of the genus Eptatretus (excluding Paramyxine) are known from Japan, Korea, China, Taiwan, Philippines, New Zealand, South Australia, South Africa, French Guiana, Haiti, Gulf of Mexico, Atlantic Ocean off Florida, Caribbean Sea, and the Pacific coast of America off Chile, California and Alaska. They seem to be accumulated in great numbers in the western Atlantic and North China Sea (Dean, 1904; Fernholm and Hubbs, 1981; Fernholm, unpublished data). The present new record of the highly disjunct Eptatretus in the Andaman Sea provides additional knowledge of the distribution and morphological variation of the genus, and at the same time confirms the essentially deep-sea habitat of tropical hagfishes.

Four of the eleven specimens of the deep-sea Andaman hagfish were caught from Nagasaki-maru deep-sea shrimp trap station 3 (lat. 07° 37' 02"N, long. 97° 52' 00 "E), and they originally formed the basis of this work. The discovery occurred on 10 November 1981, in the third and final overnight catch experiment in a series of about fifty shrimp traps. The experiments were randomly distributed on the continental slope of about 45-60°, at depths, of about 267-400 m. The bottom temperatures were 12.2-11.0°C, respectively. The bottom was recorded as sandy mud with patches of rocks or possibly boulders. Each specimen was caught in a separate trap, without accompanying animals. About twenty traps were found empty and the rest contained fishes or other animals. Other fishes captured in the same haul included 3 specimens of Cephaloscyllium fasciatum (Scylliorhinidae), 21 specimens of C. umbratile (Scylliorhinidae), 24 specimens of Squalus fernandinus (Squalidae), 5 specimens of Uroconger lepturus (Congridae), 1 specimen of Gymnotharax fimbriatus (Muraenidae), 1 specimen of Therapon theraps (Theraponidae) possibly traped near the surface during setting out or hauling up of the traps, and 1 specimen of Watasea fasciatus (Brotulidae). Other dominant animals were several species of deep-sea shrimps and hermit crabs.

Seven other specimens of E. indrambaryai were secured from deep-sea shrimps of the R.V. Exploratory 2, (Department of Fisheries, Bangkok), cruise 1/1975, on 8 March 1975 in the Andaman Sea, at a depth of 300-308 m. Water temperature was about 11.4^{o}C, oxygen about 0.68 ppt, and the pH about 7.8. It could not be determined whether the catch was made on or above the substrate, which was recorded as sand. According to Fernholm and Hubbs (1981), this bottom type should be less suitable for hagfish, as many species typically dig into the mud bottom. Mr. T. Panniam (personal communication) stated that the type of bottom was determined from the appearance of smooth scratches on the iron foot of the trawl. However, since the trawl could have passed over a variety of bottom types, the exact habitat of the fish cannot be ascertained.

According to the official field record of the meaningful catch made by Mr. T.Panniam and A. Manprasit, the specimens of the hagfish were caught among 170.0 kg of deep-sea fishes, shrimps and lobsters. The catch was noted to include members of the families Gempylidae, Nomeidae, Triglilidae, Chloropthalmidae and others. Seventeen kg of the catch were sorted and weighted as deep-sea shrimps and lobsters (Puerulus sewelli). In the same jar which contained seven specimens of the hagfish, there were also two specimens of a conger eel, Uroconger lepturus, 240-258 mmSL. This eel was also associated with the Nagasaki-maru specimens.

All the 8 gilled *Eptatretus*, possibly including the new species, seem to be rare, but this may be due to the fact that very few bathyal fishing has taken place at their localities. It seems doubtful if the hagfishes are as rare as records suggest; more might be caught if we knew precisely where, when and how to fish for them. It is noteworthy that Fernholm and Hubbs' (1981) specimens were also caught at night or early morning when hagfishes apparently are most active. Although most of the Andaman specimens were caught by deep-sea trawls rather than traps, Fern-Holm and Hubbs (1981) indicated in their work on Western Atlantic hagfishes that " All specimens treated ... were taken by bottom trawl, a method which usually produces few hagfishes. No doubt, an expedition with baited traps would provide vastly more material that could fill in some gaps in the material we have in our disposal".

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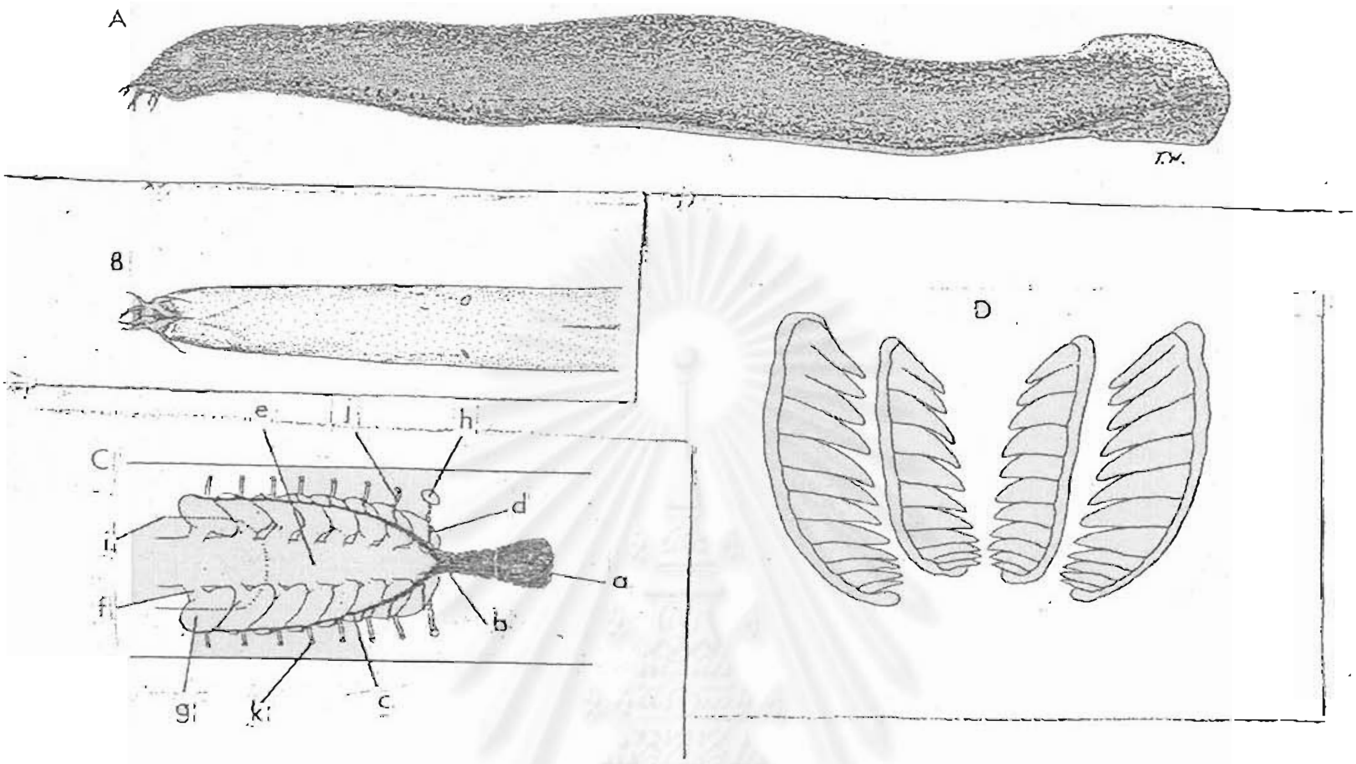

Figure 1.- Drawings to show some characters of Eptatretus indrambaryai n.sp.:

A. lateral view of the holotype, CUMZ (uncat.) 296 mmTL

B. lower surface of anterior part of body of the holotype (x 0.43)

C. diagrammatic representation of heart, adjoining vessels and gill apparatus of a paratype, DEF (uncat.), 274 mmTL, and

D. outline drawing of lingual teeth of the holotype (x 4.2)

Abbreviations:

a. ventricle; b. ventral aorta; c. right branch of ventral aorta; d. afferent branchial artery; e. esophagus; f. afferent gill duct; g. gill pouch; h. common branchial and pharyngo-cutaneous aperture; i. profile of dental (lingual) musculature; j. efferent gill duct; and k. branchial aperture.

Table 1. Measurements in percentage of total length and counts of the holotype and nine paratypes of Eptatretus indrambaryi n.sp. with comparison to two specimens of *E. okinoseanus* and one bad condition specimen of *E. octotrema*

Character	Holotype CUMZ (uncat.)	Paratypes AMS I 23661-001	Paratypes BMNH 1983.3.24.1	Paratypes DEF (uncat.)							*E. okinoseanus*		*E. octotrema*
	E. indrambaryai												
Total length (TL.mm) and sex	♂ 296	193	188	♀437	♀414	♀365	360	♂288	♂274	198	620	375	279
Weight (g)	72.0	14.2	11.1	215.5	144.5	132.4	110.9	48.1	40.0	14.8			
Preocular length	5.40	6.42	6.06	6.02	5.60	6.27	5.67	5.21	5.77	5.30	5.5	5.2	-
Premucous pore length	8.45	10.83	10.48	10.76	10.10	10.00	11.19	9.03	10.15	10.25	-	-	-
prebranchial length	21.21	22.02	22.49	22.70	22.49	21.73	22.42	21.18	21.31	22.42	21.0	20.3	23.9
Branchial length	9.22	9.17	10.00	9.38	9.76	9.86	8.61	10.59	10.62	8.69	8.4	7.7	7.9
Preventral finfold length	43.65	41.66	44.68	46.13	-	43.59	43.69	44.10	49.30	44.85	-	-	-
Trunk length	55.60	54.69	53.99	52.86	52.41	56.98	51.67	53.47	54.38	54.54	58.0	57.0	56.0
Tail length	16.28	15.91	16.49	17.14	16.30	15.78	18.36	16.42	16.46	17.27	12.2	14.7	9.9
Body depth over: ventral finfold origin	8.45	7.46	9.04	-	8.82	9.73	10.11	8.96	8.28	7.83	-	-	-
Body depth over: midlength of body	10.34	9.33	9.26	-	9.18	9.12	10.22	8.51	10.14	8.33	7.5	8.8	5.2
Body depth over: cloaca	7.94	7.10	6.06	8.90	7.24	7.83	7.69	6.91	6.39	7.73	5.9	6.5	3.9
greatest depth of ventral finfold	1.05	1.04	1.00	0.53	0.53	0.40	0.25	0.42	0.63	0.96	-	-	-
greatest depth of tail	9.29	8.78	8.14	9.91	-	8.79	9.19	7.64	8.03	8.74	7.1	7.7	4.9
Body width at above: ventral finfold origin	6.38	4.66	4.15	-	4.78	7.01	4.08	3.78	6.02	4.39	-	-	-
Body width at above: midlength of body	5.10	4.61	3.99	-	3.50	5.36	3.92	4.48	5.20	3.69	4.4	3.9	3.6
Body width at above: cloaca	2.27	2.69	2.29	3.18	2.58	3.09	2.75	2.74	2.92	2.12	-	-	-
Interspace between 1st gill apertures	5.84	5.39	4.47	6.43	5.29	7.09	5.94	-	6.79	4.55	-	-	-
Interspace between last gill apertures	4.90	3.94	3.72	5.83	4.18	5.34	4.39	-	4.49	2.93	-	-	-
Ventral finfold origin to last gill aperture	14.32	10.78	12.66	15.79	-	14.99	13.22	13.19	16.17	9.65	-	-	-
Barbel length: first	1.69	1.55	1.70	1.62	1.23	1.67	1.25	1.49	1.64	1.92	-	-	-
Barbel length: second	1.96	1.61	1.59	1.69	1.35	2.14	1.53	1.56	2.33	2.22	-	-	-
Barbel length: third	2.30	2.49	2.34	2.08	1.93	2.33	2.25	2.26	2.63	2.58	-	-	-
Teeth R/L: cusps on multicuspids; outer, inner rows	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2	3/2,3/2
Teeth R/L: unicuspids; outer row	9,9	9,10	9,10	9,9	9,10	9,9	9,9	9,9	10,9	9,9	10,10	10,11	7,7
Teeth R/L: unicuspids; inner row	9,9	9,9	9,10	9,9	8,9	9,9	9,9	8,9	9,9	9,10	9,9	9,9	8,8
Teeth R/L: total sum of cusps	46	47	48	46	46	46	46	45	47	47	48	49	40
Slime pores R/L: Prebranchial	13,12	13,11	12,12	13,12	13,13	12,12	12,12	11,11	12,12	12,12	17(L)	15(L)	21(L)
Slime pores R/L: Branchial	8,7	7,8	8,8	7,8	8,7	8,7	7,7	8,8	7,8	8,8	7(L)	7(L)	8(L)
Slime pores R/L: Trunk	48,50	48,48	47,47	-	47,48	50,48	46,45	47,48	48,48	48,48	58(L)	55	52
Slime pores R/L: Tail	10,10	10,11	12,12	12,12	12,12	12,11	12,13	12,13	11,10	12,12	12(L)	12(L)	11-12
Slime pores R/L: Total sum of pores	79,79	78,78	79,79	-	80,80	82,78	77,77	78,80	78,78	80,80	94	89	102-103
Gill apertures, R/L	8,8	8,8	8,8	8,8	8,8	8,8	7,7	8,8	8,8	8,8	8,8	8,8	8,8