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**A new species of hagfish, genus *Eptatretus* (Cyclostomata, Myxinidae), from the Pacific Ocean near Valparaíso, Chile, with new data on *E. bischoffii* and *E. polytrema***

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*Abstract.*—A new species of hagfish of the genus *Eptatretus*, *E. nanii*, is described from the Pacific Ocean near Valparaíso, Chile, and a key to the eastern South Pacific species is given. New data are presented for *E. polytrema* and *E. bischoffii*. A neotype is designated for *E. polytrema*. The extensive use of the name *polytrema* for polybranchiate mixinids from the Chilean area is clarified.

The efferent duct of the posteriormost left gill pouch is separate from that of the pharyngocutaneous duct in 100% of *E. bischoffii*, in 61% of *E. nanii*, and in 9% of *E. polytrema*, but almost never in other known species of *Eptatretus*.

*Resumen.*—Se describe una nueva especie de babosa de mar del género *Eptatretus*, *E. nanii*, obtenida en el Océano Pacífico cerca de Valparaíso, Chile, y se incluye una clave de identificación de las especies del Pacífico sureste. Se presentan nuevos datos sobre las especies *E. polytrema* y *E. bischoffii*. Se designa un neotipo para *E. polytrema*. Se aclara el uso del nombre *polytrema* para mixínidos polibránquios del área chilena. El ducto eferente del saco de la última branquia izquierda posterior está separado del bolsillo del ducto faringocutáneo en 100%, 61% y 9% de los individuos de las especies *E. bischoffii*, *E. nanii* y *E. polytrema*, respectivamente, característica muy raramente encontrada en las otras especies de *Eptatretus*.

#### INTRODUCTION

Hagfishes are primitive eel-like agnathous vertebrates that are cartilaginous, entirely marine, and bottom dwelling. They lack jaws, have three paired sets of sensory barbels around the mouth and feed on invertebrates and dead or moribund fishes. Two sets of keratinous teeth (cusps), one on each side of the mouth, are attached to dental plates, which in turn attach to the anterior end of the dental muscle, a sub-cylindrical complex of muscles and cartilages (the club-shaped muscle, lingual muscle, or great muscle mass, of authors) which laterally evert and retract the two sets, providing a biting-cutting mechanism for feeding. Hagfishes are essentially blind, with rudimentary, light sensitive eyes embedded in the flesh of the head and covered with integument usually less pigmented than the surrounding tissue especially in the genus *Eptatretus*, but not in the genus *Myxine*. Internal gill pouches are supplied with water entering the nasopharyngeal aperture above the mouth and by a velum in the pharynx which acts as a pump. Discharge (posteriorly) is via one or more pairs of adjacent openings to the exterior (branchial apertures) and the pharyngocutaneous duct, an enlarged opening confluent with or contiguous to the last (or only) aperture on the left side. There is a row of internal, mucus-secreting (slime) glands and associated external pores, usually one per body segment, on each side. Habitat is usually soft mud at depths of 10 to 2000 m. In colder waters some species live in shallow depths (5 m) and among rocks.

Six genera of myxinoids, totalling about 37 species (about 15 in the genus *Eptatretus*), are currently recognized but the alpha taxonomy is uncertain due to a paucity of collections and lack of published data. In addition, three new species of *Eptatretus* and one of *Myxine* are being described (Wisner and McMillan, in prep.).

This study of *Eptatretus* from the Pacific Ocean near Valparaiso, Chile, is one of a series resulting from specimens and data largely accumulated under the direction of the late Carl L. Hubbs. Herein we describe a new species, *E. nanii*, and present new data on *E. polytrema* (Girard 1854) and *E. bischoffii* (Schneider 1880). As the putative type specimen of *E. polytrema* (USNM 78530) differs from Girard's description, and cannot in fact be the holotype, we designate a neotype (SIO84-243) for *E. polytrema* in order to stabilize that name. Also, we clarify the use of the species name *polytrema*. Confusion has arisen because most polybranchiate hagfishes collected near Valparaiso have been placed in synonymy with *Bdellostoma polytrema* Girard (1854:199; 1855:252–253, pl. 3, figs. 1–5b). We also make a nomenclatural correction of the gender ending of the species name *Eptatretus laurahubbsae* McMillan and Wisner 1984 in accordance with Article 31 a ii of the International Code of Zoological Nomenclature.

*Abbreviations.*—PCD: external opening of the pharyngocutaneous duct; ordinarily confluent with the posteriormost left gill aperture, and much larger than all other apertures.

GA: gill (branchial) aperture; external opening of the efferent duct leading from a gill pouch.

GP: gill pouch; rounded, serially arranged structures along and posterior to the dental muscle.

DM: dental muscle; the firm, elongate, cylindrical complex of muscles and cartilages that moves the dental plates and sets of cusps during feeding. Posterior portions of DM are shown in Figure 3 lying between the rows of gill pouches.

VA: ventral aorta; the portion between the heart (ventricle) and where it branches to each side of DM.

ABA: afferent branchial artery; one of the small blood vessels that lead to each gill pouch from VA or its branches.

#### METHODS AND MATERIALS

Methods of measuring and counting are essentially those reported by McMillan and Wisner (1984) with the following modification: In the present study we use only the midline incision (of the two incisions for cusp study discussed previously) which is faster and does much less damage to the specimen. There is almost no bilateral variation in counts, thus any confusion caused by the "reverse image" would be insignificant. It is essential to continue the midline incision posteriorly to slightly past the branchial openings in order to make an accurate count of the gill pouches and observe their relationship to the dental muscle and ventral aorta.

Due to variability in confluence in external discharge of the efferent duct of the last gill pouch, left side, and the opening of the pharyngocutaneous duct, we have given only the count for gill pouches (Table 1). Thus for *E. polytrema* the total of exterior openings (left side) would range from 13 to 15, but the range 13–14 in Table 1 represents the actual number of gill pouches.

Features used in counts and measures are shown in Figure 1 and abbreviations are identified in Figures 2 and 3.

As stated by McMillan and Wisner (1984:251, 255), the external opening of PCD ordinarily is confluent with that of the posteriormost left GA and the number of internal GP usually is the same as that of the GA with only slight variation. Normally, PCD is included in the count of the left GA. However, in our material, there is considerable variation in the relationships of the last GA and PCD. In all 35 specimens of *E. bischoffii* examined by us the two are separate. Often the last GA is a narrow slit very closely adjacent to PCD, but it retains its own efferent duct to the exterior from the last GP. In *E. polytrema*, seven of 18 specimens (39%) have the efferent ducts of the last GP and the PCD confluent, and in *E. nanii*, 20 of 22 specimens (91%) those of the last GP and PCD are confluent.

Such variation presents problems in counting the GA. The PCD of *E. bischoffii*

TABLE 1. Number of gill pouches, prebranchial, branchial, trunk, tail, and total slime pores for three species of hagfishes (genus *Eptatretus*) from the Pacific Ocean near Valparaiso, Chile. Counts for *E. polytrema* and *E. nanii* include those for left and right sides; counts for *E. bischoffii* represent the left side only. (Values for type specimens are indicated by an asterisk.)

	Gill pouches										<i>n</i>	$\bar{x}$	$\sigma$		
	10	11	12	13	14										
<i>E. polytrema</i>				12	24*						36	13.67	0.47		
<i>E. nanii</i>			12	35*						47	12.74	0.44			
<i>E. bischoffii</i>	63	7									70	10.10	0.30		
	Prebranchial slime pores										<i>n</i>	$\bar{x}$	$\sigma$		
	6	7	8	9	10	11	12	13	14	15					
<i>E. polytrema</i>	8*	10*	13	1						32	7.22	0.86			
<i>E. nanii</i>			7	18*	14*	2	1				42	9.33	0.89		
<i>E. bischoffii</i>					1	8	16	8	1	1	35	12.09	0.96		
	Branchial slime pores										<i>n</i>	$\bar{x}$	$\sigma$		
	6	7	8	9	10	11	12	13	14						
<i>E. polytrema</i>						1	7	23*	3		34	12.82	0.62		
<i>E. nanii</i>						8*	30*	3			41	11.88	0.50		
<i>E. bischoffii</i>			1	32	1	1				35	9.06	0.41			
	Trunk slime pores										<i>n</i>	$\bar{x}$	$\sigma$		
	38	39	40	41	42	43	44	45	46	47					
<i>E. polytrema</i>		5	10*	7	7	2	2	1			34	41.03	0.15		
<i>E. nanii</i>	1	5	5	7	10	7	6*	3	1	1	46	42.02	0.20		
<i>E. bischoffii</i>			3	5	5	6	9	1	2		31	42.77	0.16		
	Cloacal slime pores					<i>n</i>	$\bar{x}$	$\sigma$							
	2	3	4	5											
<i>E. polytrema</i>		5	26*	3		34	3.94	0.48							
<i>E. nanii</i>		28*	14*			42	3.33	0.47							
<i>E. bischoffii</i>	1	14	16	2		33	3.58	0.65							
	Caudal slime pores							<i>n</i>	$\bar{x}$	$\sigma$					
	7	8	9	10	11	12	13								
<i>E. polytrema</i>		2	4	11*	12*	5		34	10.41	0.11					
<i>E. nanii</i>	1	2	6	25	8*			42	9.88	0.85					
<i>E. bischoffii</i>			9	15	7	2	1	34	10.15	0.97					
	Total tail pores							<i>n</i>	$\bar{x}$	$\sigma$					
	11	12	13	14	15	16	17								
<i>E. polytrema</i>		1	5	14*	10*	3	1	34	14.35	1.03					
<i>E. nanii</i>	2	5	19	15*	1*			42	13.19	0.85					
<i>E. bischoffii</i>		1	9	18	3	2		33	13.88	0.84					
	Total slime pores												<i>n</i>	$\bar{x}$	$\sigma$
	72	73	74	75	76	77	78	79	80	81	82	83			
<i>E. polytrema</i>	2	4*	3	10	4*	2	4	4				33	75.58	2.04	
<i>E. nanii</i>	1	2	5	5	10	5	1	6*	2*	3	1	41	76.71	2.44	
<i>E. bischoffii</i>			2	1	5	8	5	4	3	3	1	32	77.84	2.06	

does not represent a GA and normally would not be counted. But, in *E. nanii* the last GA is seldom separate from the PCD (two of 22 specimens), and for practical purposes the PCD may be included in the count of GA. The high incidence of non-confluence

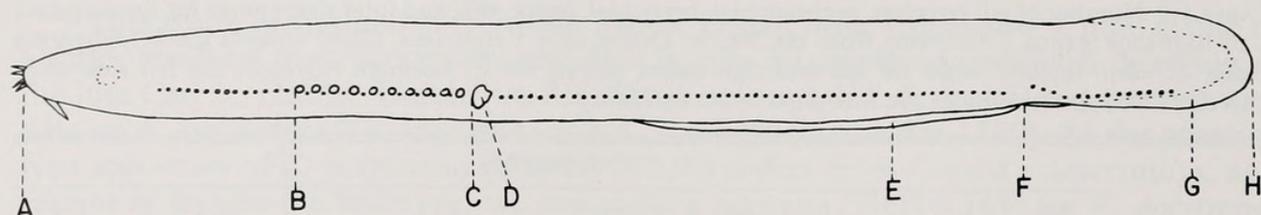


FIGURE 1. Outline of a hagfish (*Eptatretus*) showing regions and features used in measuring and counting: A-H, total length (TL); A-B, prebranchial length; B-C, branchial length, including gill apertures (GA); D, external opening of pharyngocutaneous duct (PCD); E, ventral finfold; C-F, trunk length; F, origin of cloaca; G, caudal finfold. The linear series of dots represents the prebranchial, trunk, and cloacal-caudal (tail) slime pores.

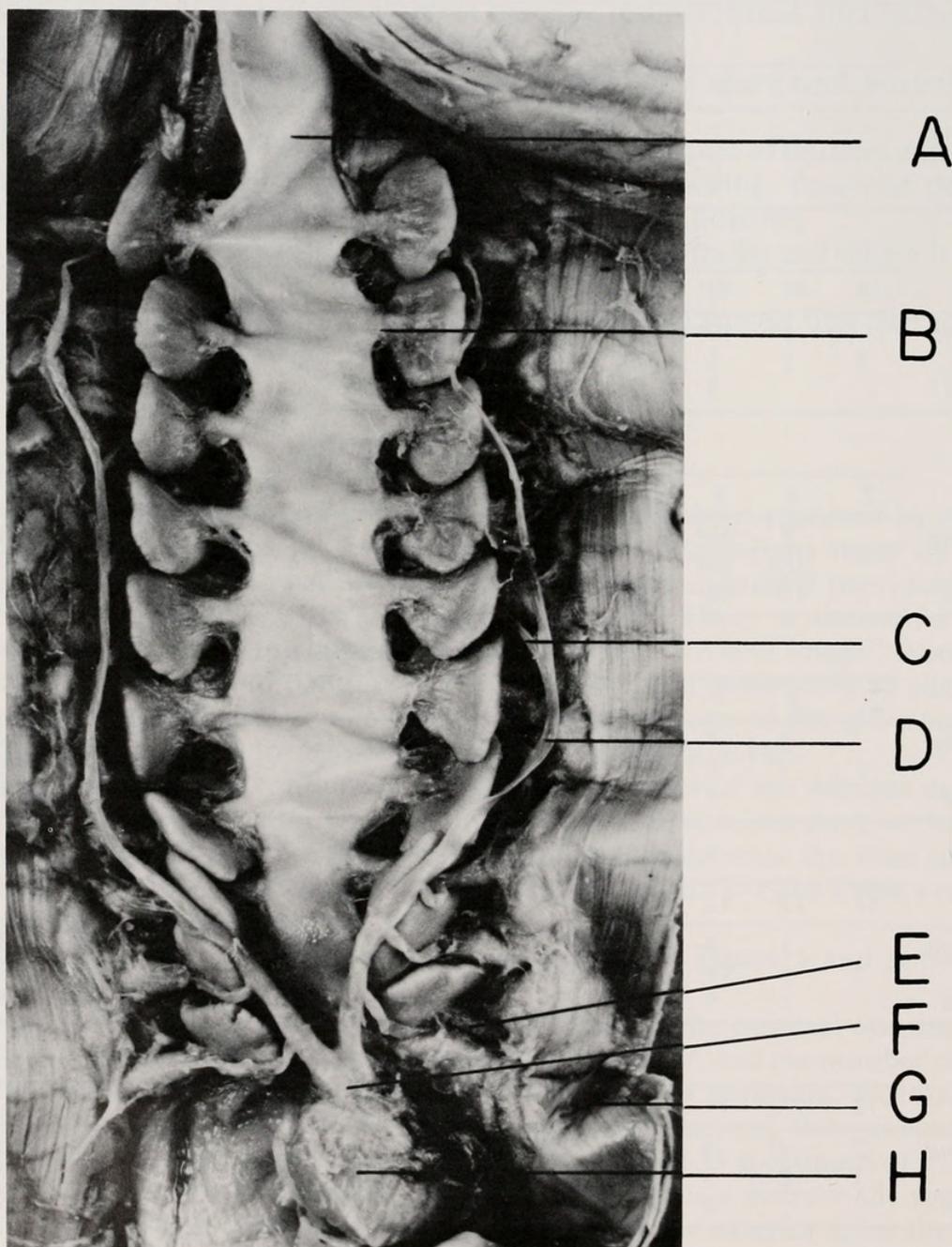


FIGURE 2. Branchial area (*E. bischoffii*), showing features discussed in text: A, pharynx; B, afferent duct and gill pouches (GP); C, afferent branchial artery (ABA); D, left branch of ventral aorta; E, efferent duct from last gill pouch; F, ventral aorta (VA), very short in *E. bischoffii*; G, duct leading from pharynx to external opening (PCD); H, ventricle (V). Dental muscle (DM) not shown.

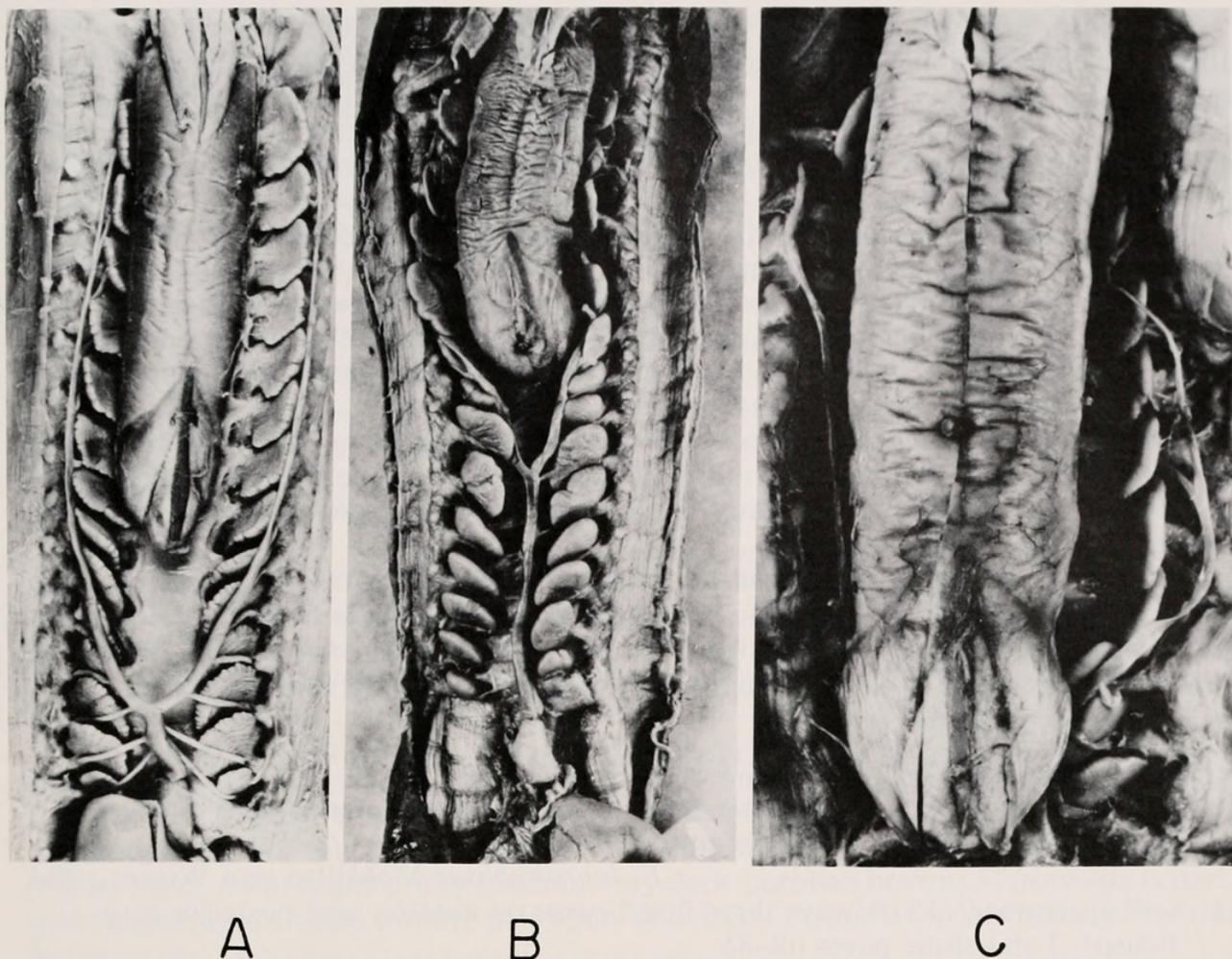


FIGURE 3. Branchial areas, showing arrangements of DM, VA, and GP in: A, *E. polytrema*; B, *E. nanii*; C, *E. bischoffii* (DM often overlies VA). DM is the cylindrical mass lying between the rows of gill pouches.

(61%) in *E. polytrema* means that counts will often be inaccurate. An accurate count requires dissection and examination of the efferent ducts on the left side.

*Head grooves.*—Ayers and Worthington (1907:331, figs. 5–10) referred to lines in the skin of the head near the eyespots of *Bdellostoma Dombeyi* [= *Eptatretus stoutii* (Lockington 1878)] as lateral line canals. McMillan and Wisner (1984:255) used the term sensory canals in reference to these lines. In a study we had overlooked, Bullock *et al.* (1982) found no electroreceptive capacity in *E. stoutii*. Fernholm (1985) examined the lateral line systems of cyclostomes by transmission electron microscopy and found that there are no canals in *E. stoutii* or *E. burgeri* and that the lines are non-innervated grooves containing no neuromasts; he referred to the lines as lateral line grooves. We accept this evidence as lack of sensory capacity and adopt the term “head grooves” in lieu of sensory canals.

Head grooves of the three species treated here are very similar in size, number, and arrangement to those shown by McMillan and Wisner (1984, fig. 4) and by Ayers and Worthington (1907, figs. 5–6) for other species of *Eptatretus*. In no species did a groove extend across the dorsal midline.

Collection data and disposition of specimens examined in this study are listed in the treatment of each species. Institutions which have furnished study material, or in which type specimens have been deposited, are: Scripps Institution of Oceanography, La Jolla, California (SIO); California Academy of Sciences, San Francisco, California (CAS); Natural History Museum, Los Angeles County, Los Angeles, California (LACM); National Museum of Natural History, Washington, D.C. (USNM); Museo Nacional de Historia Natural, Santiago, Chile (MNHNC); Zoological Institute, Academy of Sciences, Leningrad, USSR (ZIL); Gulf Coast Research Laboratory, Ocean Springs, Mississippi (GCRL).

*Discussion of synonymies.*—The problem of including PCD in the count for GA affects the construction of meaningful synonymies for *E. polytrema* and *E. nanii*. Only two authors who may have had these species (Dean 1903, Buzeta 1964) included remarks on color, and only seven gave counts of 14 gill apertures. The color notes almost certainly pertain to *E. polytrema*. No author stated that the PCD was included in the count for GA.

An accurate synonymy may be available only for *E. bischoffii*, based on stated counts of 10 GA. Other authors apparently followed Regan (1912) who gave 10 GA for *Heptatretus decatrema*, and used the name *decatrema* under various genera. Unfortunately, Regan (1912) gave no counts of GA, or indication of having counted them. We must assume that these authors merely followed prior references. Thus, the citations are not includable in an accurate synonymy.

Since none of the 47 individuals of *E. nanii* examined have 14 GA, all references stating 14 GA are placed in the synonymy of *E. polytrema*. We find no statements of numbers of GA other than 14. Only one questionable reference (Perez Canto 1912) may pertain to *E. nanii* (13 GA).

Of a total of 81 citations listed here dealing with polybranchiate myxinids from the coast of Chile, only 22 (32%) included information on counts of GA or color notes, and can be placed in the synonymies of *E. bischoffii* or *E. polytrema*. The remaining 59 citations are listed separately under the heading of "Unassignable Records."

#### KEY TO SPECIES OF *EPTATRETUS* OF THE EASTERN SOUTH PACIFIC OCEAN

- |     |  |       |   |
|-----|--|-------|---|
| 1a. | Gill apertures seven. Two (rarely three) fused cusps on anterior, and three on posterior multicusps. Total slime pores 97–105  | ..... |   |
|     |  | ..... | <i>E. laurahubbsae</i> McMillan and Wisner 1984 |
| 1b. | Gill apertures 9–15. Always three fused cusps on anterior and posterior multicusps. Total slime pores 68–86  | ..... | 2   |
| 2a. | Prebranchial and tail lengths each greater than branchial length. Posteriormost gill aperture (left side) separate from, but closely adjacent to, pharyngocutaneous duct. Gill apertures 10 (9–11). Ventral finfold absent or scarcely developed | ..... | <i>E. bischoffii</i> (Schneider 1880)           |
| 2b. | Prebranchial and tail lengths each less than branchial length. Posteriormost gill aperture (left side) widely separate from pharyngocutaneous duct. Ventral finfold absent to well developed. Gill apertures 12–15                               | ..... | 3   |
| 3a. | Color variably piebald over a dark background. Prebranchial slime pores 7–8 (6–9). Gill apertures 14 (13–15). Ventral finfold varying from absent to well developed  | ..... | <i>E. polytrema</i> (Girard 1854)               |
| 3b. | Color black or dark purplish-brown, not piebald. Prebranchial slime pores 9–10 (8–12). Gill apertures 13 (12–14). Ventral finfold absent or vestigial  | ....  | <i>E. nanii</i> , new species                   |

Although the characters, singly or in combination, of the three species discussed below (*E. laurahubbsae* will not be further discussed), are adequately expressed in the key to species, there is slight to considerable overlap in most counts and body proportions. There is, however, no overlap in numbers of gill pouches between *E. bischoffii* and the other two species (Table 1), and all three show no overlap in numbers of gill pouches in positions relative to DM and VA (Table 3, Area III).

The three species of the *polytrema* complex maybe distinguished by meristic characters. There are significant ( $P \geq .001$ ) differences in numbers of gill pouches, slime pores, and teeth (Tables 1 and 2). The ranges of gill pouches for *E. polytrema* and *E. nanii* (12–14) do not overlap with that of *E. bischoffii* and the means for *E. polytrema* and *E. nanii* (13.67 and 12.74 respectively) differ. Similarly, *E. bischoffii* can be distinguished from the other two species on the basis of mean numbers of prebranchial and branchial slime pores and anterior unicusps. *Eptatretus nanii* and *E. polytrema* differ in mean numbers of prebranchial slime pores, anterior unicusps and total cusps.

The greatest differences in body proportions lie in *E. bischoffii* having the pre-

TABLE 2. Number of unicusps in the anterior and posterior sets of cusps, and of total cusps, of three species of hagfishes (genus *Eptatretus*) from the Pacific Ocean near Valparaiso, Chile. (Values for type specimens are indicated by an asterisk.)

	Anterior unicusps						<i>n</i>	$\bar{x}$	$\sigma$
	7	8	9	10	11	12			
<i>E. polytrema</i>		3	29*	3			35	9.00	0.41
<i>E. nanii</i>			1	14	26*	3	44	10.70	0.62
<i>E. bischoffii</i>	1	7	53	5			66	8.94	0.49

	Posterior unicusps					<i>n</i>	$\bar{x}$	$\sigma$
	7	8	9	10	11			
<i>E. polytrema</i>	1	2*	29*	4		36	9.00	0.53
<i>E. nanii</i>		3	23*	17	1	44	9.36	0.64
<i>E. bischoffii</i>		11	45	10		66	8.98	0.56

	Total cusps												<i>n</i>	$\bar{x}$	$\sigma$
	44	45	46	47	48	49	50	51	52	43	54	55			
<i>E. polytrema</i>		1		4*	10	1	1	1					18	47.94	1.22
<i>E. nanii</i>						2	1	6	5*	3	4	1	22	52.00	1.60
<i>E. bischoffii</i>	2		2	5	17	4	1	1	1				33	47.88	1.53

branchial and tail lengths each greater than the branchial length. The reverse occurs in *E. nanii* and *E. polytrema*. All other proportions of the three species are very similar.

Body color is useful in separating the three species: *E. polytrema* is notably piebald (Figure 4); *E. nanii* is uniformly black or very dark-purplish brown; *E. bischoffii* is dark with randomly scattered minute pale spots and areas, primarily in the anterior ventral region.



FIGURE 4. Contrast in piebald color patterns in *E. polytrema*. The two specimens were taken together (SIO72-148).

TABLE 3. Number of GP (both sides included) in positions relative to DM and VA in *Eptatretus polytrema*, *E. nanii*, and *E. bischoffii*. AREA I—anterior to tip of DM; AREA II—between tip of DM and branching of VA; AREA III—VA posterior to branching. Boundaries of AREAS I, II, III are indicated in Figure 3.

	0	1	2	3	4	5	6	7	8	9	10	<i>n</i>	$\bar{x}$	$\sigma$
	AREA I													
<i>E. polytrema</i>						1	7	6	21	9	6	50	7.96	1.23
<i>E. nanii</i>					3	17	15	1				36	5.39	0.68
<i>E. bischoffii</i>					4	3	5	12	9	9	14	56	7.82	1.82
	AREA II													
<i>E. polytrema</i>	4		9	21	8	7	1					50	3.08	1.34
<i>E. nanii</i>	1	24	9	2								36	1.33	0.62
<i>E. bischoffii</i>	12	11	9	12	5	4	3					56	2.20	1.76
	AREA III													
<i>E. polytrema</i>		3	26	13	8							50	2.52	0.83
<i>E. nanii</i>						4	16	13	1	2		36	6.47	0.93
<i>E. bischoffii</i>	56											56	0.00	0.00

## SYSTEMATICS

### *Eptatretus nanii*, new species

*Homea polytrema*. Perez Canto 1912:1230, 1238 (anguilla negra; Bahía de Arauco, coast of Anconcagua [*E. nanii* presumed]).

*Holotype*.—SIO65-675, female, 609 mm TL, taken about 33.4 km seaward of Valparaiso, Chile, in a commercial shrimp trawl at 274 m, 22–23 December 1965.

*Paratypes*.—SIO65-675, female and three males, 510–593 mm TL, taken with the holotype; SIO81-104, mature female, 664 mm TL, taken at 350 m (no other data); SIO84-244, male, 541 mm TL, taken near Valparaiso, Chile, between 100 and 250 m (no other data); SIO85-60, female, 561 mm TL, taken at 33°09'S, 71°51'W, in a 72 ft shrimp trawl between 170 and 180 m, 1 August 1966; CAS 5612, two females, 486 and 590 mm TL, taken at 33°22'S, 71°52'W, in a 72 ft shrimp trawl between 260 and 270 m, 1 August 1966; LACM 43776-1, two, 570–640 mm TL, taken at 33°09'S, 71°51'W, in a 72 ft shrimp trawl between 170 and 180 m, 1 August 1966; USNM 272583, 6 specimens, 450–610 mm TL, taken at 33°09'S, 71°21'W, in a 72 ft shrimp trawl between 170 and 180 m, 1 August 1966; GCRL 12464, mature female, 619 mm TL, found in a fish-meal plant, San Antonio, Valparaiso Bay, Chile, 21 March 1974; MNHNC (S) P. 6378, male, 614 mm TL, taken at 35°26.5'S, 73°01'W, in a 72 ft shrimp trawl between 290 and 450 m, August 1966; MNHNC (S) P. 6381, male, 570 mm TL, taken at 28°03'S, 71°15'W, at 505 m, 16 January 1981; MNHNC (S) P. 6382, mature female, 600 mm TL, taken at 36°07.3'S, 73°05'W, in a shrimp trawl at 301 m, 20 April 1983.

*Distribution*.—All specimens were taken between Valparaiso, Chile, south to 36°26.5'S, 73°05'W, at depths ranging between 100 and 470 m. *E. nanii* was taken once with *E. polytrema* at 33°22'S, 71°52'W, in a 72 ft shrimp trawl between 260 and 270 m.

*Diagnosis*.—External apertures 13, 13 (13–14); gill pouches 13, 13 (12–13). Body robust, deepest at about midlength. Branchial length greater than either the prebranchial or tail lengths. Three fused cusps (multicusps) on both the anterior and posterior sets of cusps. Color black or very dark purplish-brown with no indication of pale markings. Ventral finfold variably absent to vestigial. Head grooves present near eyespots. Efferent duct of last GP, left side, confluent with that of PCD in 91% of specimens (20 of 22).

*Etymology*.—We are pleased to dedicate this species to Professor Alberto Nani Caputo, formerly of the Department of Oceanography, University of Chile, Viña Del Mar, for his early work on the Myxinidae of Chile, for his considerable aid to us via correspondence with Carl L. Hubbs, and for providing specimens.

TABLE 4. Averages and ranges (in thousandths of total length) of selected body proportions for three species of hagfishes (genus *Eptatretus*) from the Pacific Ocean near Valparaiso, Chile. \*Finfold measurable on only 7 of *E. polytrema* and 6 of *E. nanii*.

<i>n</i> , size ranges (mm)	19 (289–460) <i>E. polytrema</i> Mean av. (range)	22 (446–664) <i>E. nanii</i> Mean av. (range)	34 (210–680) <i>E. bischoffii</i> Mean av. (range)
Preocular length	55 (44–67)	51 (40–61)	58 (40–66)
Prebranchial length	155 (139–169)	144 (128–156)	202 (176–224)
Branchial length	182 (168–201)	192 (175–220)	135 (114–161)
Trunk length	499 (478–530)	504 (475–529)	499 (450–542)
Tail length	152 (127–179)	162 (152–173)	168 (140–218)
Tail depth	71 (57–86)	79 (62–92)	71 (56–83)
Body depth excluding finfold	89 (68–109)	84 (73–99)	89 (71–112)
Body depth including finfold	90 (68–109)*	89 (73–102)*	90 (76–112)
Body depth at cloaca	62 (49–80)	60 (42–76)	67 (56–87)
Length of dental muscle	262 (228–305)	222 (202–260)	294 (251–357)

*Description.*—Counts (Tables 1–3) and morphometrics (Table 4) are given and compared with similar counts for *E. polytrema* and *E. bischoffii*. Body robust, deepest at about PCD, increasingly laterally compressed toward tail; greatest width about 70% of greatest depth. Ventral finfold absent or vestigial, usually present only as a thin, pale line originating at about anterior 40% of TL and ending at cloaca. In a few specimens the finfold is about 1 mm high. Tail spatulate, its ventral outline nearly straight, its depth 1.3 (1.0 to 1.6) times body depth at cloaca, its length about 16% (15–17%) of TL, and slanting downward from cloaca. A thin finfold present around tip of tail, ending dorsally about over cloaca. A narrow, pale margin present on caudal finfold of many specimens; it is absent on the holotype.

Head at eyespots slightly deeper than wide, narrowing slightly to the rostrum. Nasopharyngeal aperture broad, about half the width of head at eyespots. Face sloping at about a 45° angle. Eyespots large but margins vaguely defined, minimally contrasted with background. First two pairs of barbels about equal in length, each about 70% of length of third pair.

Color very dark brown, almost purplish-black in some specimens; others are a lighter brown, but apparently this is an artifact of preservation as data sheets prepared in 1971 state “black” for all specimens. No pale spots or areas (piebald condition) evident. Gill apertures with pale narrow margins; most slime pores appear whitish at centers. Distal half of all barbels whitish.

Head grooves behind eyespots in all specimens in good condition. They also occur before eyespots on most specimens, but often only on one side. The grooves are difficult to see, particularly before eyespots, even on only moderately wrinkled specimens. Arrangement and number of grooves similar to that of *E. polytrema* and *E. bischoffii*. From 1 to 5 grooves occur before eyespots and 1 to 7 behind. Most of those before eyespots lie along the longitudinal axis; those behind are primarily vertical.

Length of DM 22% (20–26%) of TL. DM width 16% (13–22%) of its length, its depth 57% (45–64%) of its width. VA long, 38% (31–50%) of length of DM, branching near tip of DM. An average of 6.4 (4–9) GP lies between ventricle and branching of VA, 1 (0–3) lies between branching and DM, and 5.5 (4–7) lie anterior to tip of DM (Fig. 3B).

*Eggs.*—Large eggs are present in six females. Total length (TL), numbers of eggs and dimensions of the largest egg are given: SIO67-675, 593 mm TL, 33, 27.0 by 6.5 mm; SIO81-104, 664 mm TL, 23, 16.0 by 3.5 mm; SIO85-60, 561 mm TL, 38, 16.5 by 5.0 mm; GCRL 12464, 629 mm TL (number of eggs not recorded), 24.0 by 5.8 mm; LACM 43776-1, 582 mm TL, 22, 21.5 by 5.5 mm; USNM 272583, 612 mm TL, 31, 17.5 by 3.8 mm. Polar caps are well developed but there is no evidence of anchor filaments (hooks) at capsule ends of any egg, as shown by Dean (1899:234, figs. 9–18, pl. 15) and Jensen (1966:90). [This latter reference was incorrectly cited as Å. Jespersen,

1975, by McMillan and Wisner, 1984. Jespersen's study dealt only with spermiogenesis.] An unidentified nematode, about 20 mm long, was coiled among the eggs in a 664 mm female.

*Food items.* — A female, 585 mm TL (SIO85-60), had ingested a juvenile macrourid 195 mm long. About 35 mm of the long, slender tail protruded from the cloaca. The head is missing but the body is relatively intact with minimal damage from digestive action. There are no bones in the gut that can be related to the head of a macrourid fish; perhaps some predator had bitten off the head and did not ingest the body. It is of interest that the fish had been ingested tail first. The only other food item present was the posterior portion of a small, shrimp-like crustacean lying anterior to the macrourid.

*Eptatretus bischoffii* (Schneider 1880)

*Bdellostoma polytrema* not of Girard. Putnam 1874:160 (10 gills, each side; description; eggs; suggests that Girard (1854, 1855) included some mucus pores in his count of 14 gill openings).

*Bdellostoma bischoffii* Schneider 1880:115–116 (original description; 10 gill openings, each side; no locality); Plate 1896:16–21, figs. 1–4 (detailed description of eggs presumed to be of this species; Talcahuano Bay on mud bottom in 8 fathoms; Coquimbo south to Tierra del Fuego.

*Heptatretus decatrema*. Regan 1912:535 (original description; 10 gill openings; Chile; *Bdellostoma polytrema* (non Girard), Putnam).

*Eptatretus dombeyi* (Shaw). Fowler 1940:743, fig. 1:744 (in part; fig. 1, drawing by Richard of example from Napon Bay, Valparaiso, Chile, January 28, 1839; 10 gill openings shown).

*Polistotrema polytrema* not of Girard. deBuen 1961:105–110 (10(14?) openings; figure from Girard 1855; reference to original account and number of gill openings questioned; reddish-brown when fresh, dark-leaden in formalin; extensive synonymy; vernaculars; Valparaiso, Chile).

*Bdellostoma decatrema*. Adam and Strahan 1963; 6 (10 pairs of gills; length to 480 mm; Chile); Rauther 1924:685 (= *B. bischoffii*?; 10 gill openings, each side; coast of Chile).

*Polistotrema decatrema*. Buzeta 1964:49–58, fig. 1, pl. 1 (in part; material with 9–11 gill openings only; characters; compared to *P. polytrema*, with 13 to 14 gill openings; Coquimbo to Puerto Montt, Chile).

*Validity of name.* — We use the name *bischoffii*, applied by Schneider (1880:115–116) to a hagfish with 10 gill openings, presumably from off Southern Chile, despite the fact that the name has been used only twice before (Plate 1896:16–21) Rauther (1924:685). To our knowledge, this is the only hagfish having 10 gill openings. Apparently the name was overlooked by Regan (1912:535) when he described *Heptatretus decatrema* new species, characterized in part as having 10 gill openings. Subsequent authors have applied a variety of names to this species. Inasmuch as the literature on this species is limited, stability is hardly threatened by replacing the specific name *decatrema* by its senior synonym *bischoffii*.

*Material examined.* — SIO65-669, female, 276 mm TL, taken at 32°51'S, 72°08'W, in a 5 ft Agassiz beam trawl at 30 m, 19 December 1965; SIO65-673, two females, 212 and 311 mm TL, taken in Valparaiso Harbor, Chile, in a trap at 30 m, 23–24 December 1965; SIO65-676, female, 244 mm TL, taken in Valparaiso Harbor, Chile, in a trap at 30 m, 24 December 1965; SIO65-678, two females, 313 and 346 mm TL, taken at La Ventana, 30 miles North of Valparaiso, Chile, in a tidepool at 10 m, by fish poison, 28 December 1965; SIO72-148, five females, 215–580 mm TL, taken in Bahía Inglesa, Chile, 27°07'S, 70°55'W, in a trap at 20m, 9–10 April 1972; SIO72-149, five males, 385–466 mm TL, and five females, 372–590 mm TL, taken in Bahía Inglesa, Chile, 27°07'S, 70°55'W, in a trap at 8 m, 9–10 April 1972; SIO72-150, male, 482 mm TL, taken in Bahía Inglesa, Chile, 27°07'S, 70°55'W, in a trap at 12 m, 9–10 April 1972. SIO77-94, female, 331 mm TL, taken near Valparaiso, Chile, at 50 m (no other data); SIO81-101, juvenile, 113 mm TL, taken at 10 m in a tidepool near Montemar Laboratory, Univ. Chile, Viña del Mar (no other data); SIO81-102, female, 485 mm TL, taken at 6 m, near Montemar Laboratory, Univ. Chile, Viña del Mar (no other data); SIO85-12, 9 specimens, 418–605 mm TL, taken in Bahía Concepción, Isla Quiriquiña, Chile, at 10 m in a net over rocky, algae covered bottom, 5–10 April 1972;

ZIL 314-960, male, 500 mm TL, taken from a dry dock at Talcahuano, Chile. Provided by A. P. Andriashev, Zool. Inst., Acad. Sci. U.S.S.R.; PM-413 (Univ. Austral de Chile), juvenile, 320 mm TL, taken at Manquillahue, near Valdivia, Chile, 14 June 1976 (no other data); PM-30 (Univ. Austral de Chile), two juveniles, 210 and 280 mm TL, taken at Mehuín, near Valdivia, Chile, 6 July 1961 (no other data); PM-61 (Univ. Austral de Chile), male, 680 mm TL, taken at Mehuín, near Valdivia, Chile, 3 December 1961 (no other data); USNM 75380, 440 mm TL, sex unknown, taken near Valparaíso, Chile, U.S. Naval Expedition (no other data).

*Distribution.*—Pacific Coast of Chile between about 27°S and 42°S (Caldera to Puerto Montt). Plate (1896) stated, “Coquimbo southward to Tierra del Fuego.”

*Diagnosis.*—External gill apertures and gill pouches 10 (11). Last gill aperture, left side, closely adjacent to, but separate from, pharyngocutaneous duct. Prebranchial and tail lengths each greater than branchial length. Body robust throughout. Ventral finfold absent or very weakly developed. Color purplish-black, with pale areas and spots, principally at mouth and on ventral surface anterior to gill apertures. Spots sparsely scattered over body.

*Description.*—Counts (Tables 1–3) and measurements (Table 4) are provided and compared with similar data for *E. polytrema* and *E. nanii*.

Body robust throughout; greatest width 67% (52–82%) of greatest depth, increasingly laterally compressed toward tail. Prebranchial and tail lengths each greater than branchial length. Depth at cloaca 71% (61–128%) of greatest body depth. Tail slender, spatulate, the ventral outline nearly straight, slanting slightly downward from cloaca, its length about 17% (14–22%) of TL, its depth 42% (35–52%) of its length. Ventral finfold usually absent but a very low one occasionally present. Caudal finfold moderately thickened throughout, ending dorsally over cloaca.

Head at eyespots slightly deeper than wide. Nasopharyngeal aperture about one-third to one-fourth of width of head at eyespots. Eyespots small but prominent, the margins sharply defined. Face sloping at a very slight angle from rostrum. First two pairs of barbels about equal in length, the first 97% (66–131%) of length of second pair and 76% (48–100%) of the third, the second 77% (55–100%) of the third.

Color a very dark brown to purplish-black with randomly scattered small pale spots extending to about cloaca; none were observed in the tail area. The spots are concentrated in the branchial area and are particularly prominent near the mouth. Distal portions of barbels with pale tips. GA and slime pores without pale margins.

Head grooves present near eyespots with a greater number before than behind in contrast to the arrangements in *E. polytrema* and *E. nanii*. The number of grooves in each series is variable, ranging between one and four.

All GA are very small, much smaller than in *E. polytrema* and *E. nanii*. In all our material, the efferent duct of the last GP, left side, is not confluent with that of PCD but lies closely adjacent; the GA is an elongate slit lying very close to PCD and may easily be overlooked.

DM long, robust, 29% (25–36%) of TL, its width 13% (10–19%) of its length, its depth 71% (46–80%) of its width. VA very short, 9% (8–11%) of length of DM, branching only slightly anterior to the ventricle. No ABA lead to GP from VA (Fig. 3C). From 0 to 4 GP may lie between VA and DM, the remainder lying anterior to tip of DM, the latter often overlying VA (Fig. 3C). This arrangement is very similar to that of *E. cirrhatus* (McMillan and Wisner, 1984, fig. 3).

*Eggs.*—Of the females examined, only three have well developed eggs. One, 590 mm TL (SIO72-149), has 40 eggs ranging between 20 mm by 5.8 mm and 23 mm by 6.5 mm. Another, 480 mm TL (SIO72-148), has 12 eggs between 23 by 6.8 mm and 25 by 7.7 mm. A third, 485 mm TL (SIO81-102), has 10 eggs between 15 by 4.7 mm and 17.5 by 5.3 mm. It is not known if the two bearing few developed eggs contain the original number, but there is no indication of damage that could have caused loss of eggs. All three ovaries contain many tiny, round eggs, plus a few in early stages of elongation, about 3 by 0.8 mm. No eggs have protruding anchor filaments, although polar caps are well developed on many.

*Eptatretus polytrema* (Girard 1854)

*Bdellostoma polytrema* Girard 1854:199 (original description; 15 gill openings; Valparaiso Bay, Chile), 1855:252–253, pl. 23, fig. 1, 1855b:48–49 (relation to *Gastrobranche dombeyi* of Lacepède); description; 14 gill openings and gills; color not preserved in specimen described); Günther 1870:512 (*Gastrobranche dombeyi* of Lacepède doubtfully synonymized; Girard's count of 14 gill openings doubted, may have included mucus pores; coast of Chile); Schneider 1880:115–116 (note on status; no locality given; 14 gill openings; description, after Günther); Porter 1903:193, 233 (14 gill openings, each side); Quijada 1913:128 (14 gill openings, each side; coast of Chile); Rauther 1924:685 (14 gill openings, each side; coast of Chile); Adam and Strahan 1963:5 (14 pairs of gills, variation unknown; average length 450 mm, maximum 570 mm; Chile).

*Homea polytrema*. Dean 1903:295–298, fig. 3 (in part; figure of a piebald specimen showing 14 gill openings; Valparaiso, Chile).

*Heptatretus polytrema*. Regan 1912:534–535 (14 gill openings; Valparaiso, Chile).

*Polistotrema polytrema*. Fowler 1951:267 (14 gill openings; Chile); Buzeta 1964:49, 51 (13 to 14 gill openings; color slate gray with white spots over body, bordering on dappled aspect; Valparaiso to Talcahuano, Chile).

*Eptatretus polytrema*. Johansen and Strahan 1963:352–353 (14 pairs of gills).

*Neotype*.—SIO84-243, female, 431 mm, TL; taken off Valparaiso, Chile, at 350 m; no other data; received as a gift from Dr. Alberto Nani, University of Chile, Viña del Mar, November 1970.

*Additional material examined*.—SIO65-673, male, 429 mm TL, and female, 397 mm TL, taken in Valparaiso Harbor, Chile, in a trap on bottom at 30 m, 23–24 December 1965; SIO72-148, two females, 371–440 mm TL, taken in Bahía Inglesa, 27°07'S, 70°55'W, in a trap on bottom at 20 m, 9–10 April 1972; SIO81-103, female, 460 mm TL, taken off Valparaiso, Chile (no other data); USNM 272582, two females, 400–430 mm TL, taken at 33°32'S, 71°52'W, in a 72 ft shrimp trawl between 260 and 270 m, 1 August 1966; CAS 56511, three females, 385–447 mm TL, one male, 420 mm TL, taken at 33°22'S, 71°53'W, in a 72 ft shrimp trawl between 240 and 260 m, 1 August 1966; LACM 43775-1, female, 410 mm TL, taken at 33°27'S, 77°52'W, in a 72 ft shrimp trawl between 175 and 180 m, 1 August 1966; MNHNC (S) P. 6379, male, 395 mm TL, taken at 29°37.5'S, 71°21'W, in a 72 ft shrimp trawl at 110 m, 14 August 1966; MNHNC (S) P. 6380, male, 440 mm TL, taken in area of Talcahuano-Concepción, Chile, in a shrimp trawl (depth not recorded), 8 August 1972.

*Distribution*.—Bahía Inglesa to Concepción Chile. All specimens examined were taken between 10 and 350 m. On two occasions, *E. polytrema* was taken with *E. bischoffii* in Valparaiso Harbor in traps at 30 m and once in Bahía Inglesa (27°07'S, 70°55'W) in a trap at 20 m. Also, it was taken once with *E. nanii* at 33°22'S, 71°52'W in a 72 ft shrimp trawl between 260 and 270 m.

*Diagnosis*.—External gill apertures 14–14; gill pouches 13–14. The neotype has 12 gill apertures on the left side (excluding the PCD), 13 on the right, and 13–13 gill pouches. Branchial length greater than prebranchial or tail lengths. Three fused cusps (multicusps) on both the anterior and posterior sets of cusps. Body moderately slender. Color piebald, with pale areas varying in size and numbers, randomly scattered over a dark background (Fig. 4). Ventral finfold varies between absent to well developed. Head grooves present near eyespots. Efferent duct of last GP, left side, confluent with that of PCD in 39% of specimens (7 of 18). VA short, 14% (3–23%) of length of DM.

*Description*.—Counts (Tables 1–3) and morphometrics (Table 4) are given and compared with similar data for *E. nanii* and *E. bischoffii*. Body moderately slender, increasingly laterally compressed toward tail, deepest at about midlength; greatest body width about 70% of greatest depth; depth at cloaca 70% of greatest body depth. Ventral finfold variably developed, ranging from absent to prominent; it is absent in the neotype. Of the 19 specimens, 12 (385–470 mm TL) have no or only vestigial ventral finfolds; two (390–420 mm TL) have slight but distinct ones, and three (289–440 mm TL) have well developed ones. Apparently size is not a factor in development of ventral finfolds. Tail spatulate, its ventral outline nearly straight, slanting moderately downward from

cloaca; its length 15% (13–18%) of TL, its depth 44% (43–45%) of its length. Caudal finfold moderately thin, extending a short distance out from musculature. Ventrally it is thick with no extension of tissue, but expands around tip of tail and continues dorsally to about over cloaca, becoming thicker anteriorly. Color highly variable, with few to many pale blotches against a dark background. Extreme variation in the piebald condition is shown in Figure 4; the two specimens were taken together (SIO72-148).

Head at eyespots about as deep as wide, narrowing to rostrum. Nasopharyngeal aperture small, its width one-fourth of head width at eyespots. Face sloping 15 to 30 degrees from the horizontal. First two pairs of barbels nearly equal in length, the first pair often slightly shorter, each about two-thirds the length of third pair. All barbels white-tipped on distal third to half. Eyespots prominent, the margins well defined.

Head grooves present on all specimens in good condition, usually behind the eyespots on each side of dorsal midline. About one-fourth, including the neotype, also have grooves before the eyespots arranged longitudinally. There are one to six grooves behind, and one to four before, the eyespots.

Length of DM 26% (23–30%) of TL. DM width 13% (11–16%) of its length, its depth 65% (49–74%) of its width. VA short, 14% (3–23%) of length of DM. An average of 2.25 (1–4) GP lie between ventricle and branching of VA, 2.28 (0–6) lie between branching and DM, and 8 (5–10) GP lie anterior to tip of DM (Fig. 3A). In general, the branchial slime pores lie below the level of, and about midway between, the adjacent GA.

*Eggs.*—A female, 422 MM TL (SIO65-676), has 40 well developed eggs, all 17 to 19 mm in length and about 7 mm in diameter. Of the 19 specimens, 13 are mature females with developing eggs; one immature (289 mm TL) has eggs in the round undeveloped stage. Two specimens (CAS 56511) have large eggs; a 447 mm TL female has 32, the largest 16 mm by 4.5 mm; one well developed egg measures 8 mm by 2.5 mm. A 385 mm TL female has 24 well developed eggs, the largest 27.5 by 7 mm, the smallest 23 by 6.5 mm. A 431 mm TL female has 40 eggs, about 17 by 6 mm. A series of developing eggs is present in three females and range in size from 0.5 to 6.0 mm; most are nearly round (1.0 to 1.5 mm in diameter).

*Discussion of Eptatretus polytrema.*—Girard (1854:199, and 1855:252–253, pl. 3, figs. 1–5b) based *Bdellostoma polytrema* on a specimen described as having “Fourteen respiratory apertures and gills on either side.” He further stated “Color not preserved in the specimen described.” and, “in a precarious state of keeping.”

On February 25, 1975, at the U.S. National Museum, the late Carl L. Hubbs examined a specimen (USNM 78530), about 440 mm TL, labeled as type of *Bdellostoma polytrema* (by J. O. Snyder), taken near Valparaiso, Chile, by the U.S. Naval Astronomical Expedition. Hubbs’ notes state, “It is in bad shape, but body is largely intact. Most of the skin has sloughed off. Gill pouches still discernible, 10 left and 11 right, with the last one on the right less than half the bulk of others [the specimen had not been opened prior to Hubbs’ examination]. The skin was dark, but probably not black, and nowhere is there a trace of light areas. The main blood vessel [ventral aorta] branches opposite the anteriormost [sic; obvious misstatement for posterior] gill pouches of each side. Only 3 gill pouches, each side, lie behind [posterior to] the end of the huge tongue muscle. Slime pore counting seems to be impossible.”

However, Girard’s original (1854) description, although brief, unequivocally stated, “14 respiratory apertures and gills on either side,” and this is reiterated in his subsequent (Girard 1855) account and figure of what must be the same specimen. The question then arises, how did a specimen with 10 gill openings come to be labeled as the type? We have asked G. David Johnson (USNM) to examine the putative holotype for us. He reports that Hubbs’ description of it is accurate; i.e., there are 10 gill openings. However, there is a label in the bottle that reads, “Valparaiso, United States Exploring Expedition.” This is the Wilkes Expedition of 1838–42, and Girard’s specimen was collected during the U.S. Naval Astronomical Expedition to Chile of 1849–52. We can only speculate, but it seems possible that Girard’s specimen, which he stated was in poor condition, was discarded or lost and that subsequently another specimen from Valparaiso was mistakenly regarded as the holotype of *B. polytrema* and so labeled.

We follow Girard in using the name *polytrema* for a species of *Eptatretus* with 14 gill apertures. No specimen conforming to Girard's description and bearing appropriate data is in either the National Museum of Natural History or the Academy of Natural Sciences of Philadelphia, and therefore, the holotype of *Bdellostoma polytrema* Girard must be presumed lost.

In order to stabilize usage of the name we have above selected a specimen (SIO84-243) as neotype. For full data see Material Examined.

#### UNASSIGNABLE RECORDS

Early in an attempt to revise the Myxinidae, the late Carl L. Hubbs constructed a lengthy synonymy of what was then thought to be *Eptatretus polytrema* (Girard 1854). Hubbs was aided in the compilation of citations in the Spanish language by Gumersindo Revuelta A., then a student of Alberto Nani C. at the University of Chile, Viña del Mar. We have determined that a majority of the citations pertain to no recognizable species in that neither counts, useful proportions, nor color notes were provided. As the three species discussed here are sympatric throughout much of their ranges, such references are not useful in distinguishing between them. Thus, we have extracted those citations that definitely pertain to *E. bischoffii* and *E. polytrema*, by reason of data provided by authors. Unfortunately, we are unable to assign any definite references to *E. nanii*.

We list below those references that provide no clue as to species but have been placed in the synonymy of *E. polytrema* by various authors.

*Gastrobranche Dombey* Lacepède 1798:414–415 (original description, based on a dried skin brought to Paris by a traveler, Dombey; apparently a myxinid but genus and species indeterminate; nomen dubium), 1799:990–992, pl. 23, fig. 1 (German language version of original description; nomen dubium) [The dried skin is not now in the collection of the Paris Museum, personal communication, M. L. Bauchot.]

*Gastrobranchus Dombeyi*. Shaw 1804:267–268 (after Lacepède); Fleming 1822:375 (*Gastrobranchus Dombey* of Lacepède is probably of the genus *Homea*); Girard 1855a:251 (relation to *Bdellostoma polytrema*).

*Bdellostoma Dombeyi*. Müller 1834:80 (based on *Gastrobranche Dombeyi* Lac.; no gill openings stated; doubtful whether a *Bdellostoma* or *Myxine*); Schneider 1880:115 (notes on status); Jordan and Gilbert 1883:57 (in part; attributed to Müller; range to southward); *Gastrobranche Dombey* Lac., Müller 1834, and *B. polytrema* Girard synonymized); Dücker 1924:507–514, 524–526, pl. 27, figs. 16, 18, pl. 28, figs. 19–25 (eye structure in detail; Coquimbo, Chile); Holmberg 1970:519–520, 536–537 (eye degenerate; after Dücker 1924).

*Bdellostoma polytrema*. Philippi 1857:266 (cited); Lockington 1878:793 (*B. stoutii* compared; Chile); Günther 1880:25 (cited), 82 (listed); Jordan and Gilbert 1883:6 (cited); Reed 1897a:671 (catalogue; coast of Chile, Valparaiso), 1897b:22 (catalogue); Delfin 1899:178 (listed), 1900a:186 (listed; Talcahuano to Valparaiso, Chile), 1900b:422 (voraciousness; fishes more or less consumed from within); Porter 1900; Gill 1901:737 (*E. Dombeyi* of Cloquet [1819] a composite description drawn from two authors and representing two species); Reed 1901:23 (listed); Wolnitzky 1901:56 (“black congrio”; coast fishery, Anconcagua [possibly an Ophidiid]); Quijada 1912:109 (Coquimbo and Valparaiso, Chile); Lahille 1915:370 (cited); Rauther 1924:685 (brief description); Oliver Schneider 1936:99 (cited); Guerrero 1939:10–11 (cited; Pl. 1); Tortonese 1942:228 (cited); Henckel 1944:69 (description of eyes); Lama 1944; Lindberg and Legeza 1959:22, and 1967:19 (reference; not in Japan).

*Hetpatretus dombeyi*. Jordan and Gilbert 1883:867 (identity of *Polistotrema stouti* with *H. dombeyi* doubtful; Chile).

*Polistotrema dombey* (or *dombeyi*). Jordan and Evermann 1896:6 (brief description); Porter 1909:52, 53 (synonymies), 1910:73, 74 (listed; synonymies); Lahille 1915:

- 350, 370 (listed); Oliver Schneider 1943a:76 (habits; distribution), 1943b:6, 49 (listed); Holmberg 1970:519–520, 536–537 (compared in eye structure with *Myxine glutinosa* on basis of Dücker 1924).
- Homea polytrema*. Garman 1899:344 (compared with *Myxine circifrons*); Delfin 1902a:186 (listed), 1902b:219 (voraciousness); 1903:182 (cited; reference to 1902b); Dean 1904:20 (synonymy; characters; coast of Chile); Albert 1914:82, 85, 89, 91, 93 (listed); Oliver Schneider 1936:99 (cited); Henriquez 1957:1 (cited).
- Polistostrema polytrema*. Fowler 1908:461 (listed); 1941:3 (listed, synonymies); Mann 1954:18 (key), 84, 90 (cited), 91, 92 (brief description); Yañez 1955:41 (cited), 42 (fig. 4); deBuen 1957:266 (listed), 1959:35 (listed); Pequeño 1968:6 (listed); Bahamonde and Pequeño 1975:5 (listed); Pequeño and Lopez 1979 (not seen).
- Polistotrema decatrema*. Fowler 1941:4 (listed, synonymies).
- Dodecatrema polytrema*. Fowler 1947:11 or more gill openings on each side of body; 3 (Type *Bdellostoma polytrema* Girard; *Polistotrema* synonymous with *Homea*; synonymies).
- Homea decatrema*. Fowler 1951:267 (gill openings 6 [error?, possibly *Eptatretus laura-hubbsae* see key]); Mann 1954:18 (key); deBuen 1957:266 (listed).
- Bdellostoma (Polistotrema) decatrema*. Tortonese 1951:86 (San Vicente, Chile [Valparaiso Harbor]).
- Eptatretus polytrema*. Fernholm 1975:203 (*Bdellostoma bischoffii* Schneider synonym: anchor filaments on egg widespread); Fernholm and Holmberg 1975:253, 255–256 (reference to Dücker 1924, on eyes, as *Bdellostoma dombey*).

#### PHYLOGENETIC RELATIONSHIPS

It is not now feasible to attempt construction of a meaningful phylogeny for species (about 15) of *Eptatretus*. A fossil record is non-existent for the group, body proportions, with few exceptions, are quite similar, and color is highly variable, often within species. As discussed already, the number of gill openings (apertures) and associated internal gill pouches offer the only readily available means of grouping the species of *Eptatretus*. Based on these gill characters, three species groups can be recognized: one having 5 or 6 GA; a second having 7 GA only; and a third having 8 to 15 GA. Whether or not this grouping has any phylogenetic significance is a question for future investigations.

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