東海大学大学院平成 30 年度博士論文

Taxonomic studies of the deep-sea assfish, genus *Bassozetus* Gill 1883 (Ophidiiformes: Ophidiidae)

（アシロ科フクメンイタチウオ属魚類の分類学的研究）

冨山　晋一

Taxonomic studies of the deep-sea assfish, genus *Bassozetus* Gill 1883 (Ophidiiformes: Ophidiidae)

Shinichi Tomiyama

The thesis is submitted in partial fulfillment of the requirements for the award of degree of Doctor of Science

Tokai University, Japan

March 2019

Contents

I. Introduction

The genus *Bassozetus* Gill 1883 is a member of the subfamily Neobythitinae (Ophidiiformes: Ophidiidae) including 40 genera and 190 species (Fricke et al. 2018a, b). *Bassozetus* is diagnosed by a number of remarkable morphological characters, including eye much smaller than snout, preopercle almost reaching posterior margin of opercle, opercular spine absent or weak, basibranchial tooth patch 0–1, pelvic-fin with one ray and lateral line absent. The maximum recorded standard length is ca. 800 mm (Cohen and Nielsen 1978; Nielsen and Merrett 2000; Nielsen and Møller 2008). Specimens have been collected mainly from deep-sea bottom depths of ca. 1,000–5,500 m depth (except for *Bassozetus zenkevitchi* Rass 1955, which has a pelagic lifestyle), in tropical to subarctic waters worldwide (Nielsen et al. 1999; Nielsen and Merrett 2000). Little is known of different species' biology, except for the size at maturity and larval stage morphology in some [e.g., at least 240 mm SL (standard length) at maturity in *B. zenkevitchi* (see Nielsen and Merrett 2000) and 22.1 mm SL at the pelagic larval stage in *B. galatheae* (see Okiyama 2014)]. The first *Bassozetus* species (*Bassozetus compressus*) was described by Günther (1878), 10 additional species being described over the years to 1989. However, a generic diagnosis and species-distinguishing characters had remained problematic. Significant progress in this regard was made by Nielsen and Merrett (2000), who recognized 13 valid species, two of them new, on the basis of specimens collected worldwide.

Recently, Tomiyama et al. (2011) noted the first record of *Bassozetus glutinosus* (Alcock 1890) from Japanese waters, based on three specimens collected from Suruga Bay and the Ryūkyū Trench. At that time, examination of a number of comparative specimens revealed problems with some diagnostic characters previously considered valid for several species by Nielsen and Merrett (2000). In addition, some undescribed species were also discovered. The present study reconsiders the taxonomy of *Bassozetus*, in addition to new observations on sexual dimorphism and distribution of species in the Northwest Pacific.

II. Materials and methods

A total of 176 specimens, deposited in 13 research institutions, were examined (detailed collection data shown under "Specimens examined" of each species account in section V). Counts of caudal-fin rays and vertebrae, and definitions of long and short rakers on the first gill arch followed Cohen and Nielsen (1978). Eye diameter and number of oblique scales between the anus and dorsal-fin base followed Nielsen and Merrett (2000). Preanus, prepelvic and preanal lengths, and distance between the pelvic and anal fins followed Tomiyama et al. (2015). Tail length followed Tomiyama et al. (2018). Length of the vomer-arm was measured from the bifurcation point of the left and right arms to the posterior end of either arm, and width of the vomer-arm at the base. Other counts and measurements followed Hubbs and Lagler (1958). All measuring methods are shown in Fig. 1. The number of body scales lost was estimated with high accuracy by repeatedly counting remaining scale pockets until a fixed value was determined. Vertebral counts were determined from radiographs, and sex from gonad examination. The sagittal otolith was removed via a right/left posteroventral incision in the neurocranium. Oblique scale numbers of *Bassozetus* [cited from Nielsen and Merrett (2000)] were treated as approximate values, following a personal communication from Dr. J. G. Nielsen. Morphometric data for *B. oncerocephalus* and *B. werneri* were taken from Nielsen and Merrett (2000), since the holotypes (and only known specimens) of both species could not be examined during the present study. Standard length is abbreviated as SL. Institutional codes follow Fricke and Eschmeyer (2018). Materials and methods unique to individual species are described under those species' headings (see V. 1. *B. compressus* and V. 8. *B. nielseni*).

III. History of taxonomic studies of *Bassozetus*

Prior to the onset of the present study, 13 species had been described as valid. *Bassozetus compressus* (Günther 1878), the first species described, was originally included in *Bathynectes* Günther 1878, but later removed to the newly established genus *Bathyonus* by Goode and Bean (1885), due to *Bathynectes* being preoccupied in Crustacea (Stimpson 1871). Gill's (1883) proposal of *Bassozetus*, included *Bassozetus normalis* as type species, although the genus itself was not well defined. Subsequently, Goode and Bean (1896) included *Bathyonus compressus* under *Bassozetus*, plus two newly-described species, *Bathyonus taenia* Günther 1887 and *Bathyonus glutinosus* Alcock 1890. *Bassozetus oncerocephalus* (Vaillant 1888) was originally included under the genus *Sirembo* Bleeker 1857, but was transferred by Goode and Bean (1896) to a new genus *Dicromita*. Subsequently, Fowler (1925) established the new subgenus *Pterodicromitra* for only *D. oncerocephalus*. However, that species was removed to *Bassozetus* by Norman (1939), *Pterodicromitra* becoming invalid. A further 6 *Bassozetus* species were described over the years to 1986: *Bassozetus nasus* Garman 1899, *Bassozetus elongatus* Smith and Radcliffe in Radcliffe 1913, *Bassozetus robustus* Smith and Radcliffe in Radcliffe 1913, *Bassozetus zenkevitchi* Rass 1955, *Bassozetus multispinis* Shcherbachev 1980 and *Bassozetus levistomatus* Machida 1986. Subsequent to Goode and Bean (1896), the generic definition was progressively updated by several authors (e.g., Alcock 1899; Fowler 1936; Cohen and Nielsen 1978). However, along with specific diagnostic characters, the generic definition remained unclear, due to the paucity of specimens examined. Eventually, Nielsen and Merrett (2000) undertook a global revision of *Bassozetus*, examining a large number of specimens, including most types. They clearly defined the genus, recognized 13 valid species, including two new species (*Bassozetus galatheae* and *Bassozetus werneri*), and provided a key to species. This represented a major step in taxonomic studies of *Bassozetus*.

Subsequently, Tomiyama et al. (2015) demonstrated the synonymy of *B. compressus* and *B. elongatus*, and Tomiyama et al. (2016, 2018) described *Bassozetus*

mozambiquensis and *Bassozetus nielseni* as new species. Additionally, Tomiyama et al. (2011, 2015) and Takami et al. (2011) reported distributional range extensions of *B. glutinosus*, *B. compressus* and *B. robustus*.

IV. Diagnosis and key to species of *Bassozetus*

IV. 1. Diagnosis of *Bassozetus*

Bassozetus Gill 1883: 259 (type by monotypy *Bassozetus normalis* Gill 1883).

Head about one-half of preanal length; eye much smaller than snout; maxilla extending beyond a vertical through posterior margin of eye, its dorsal margin sheathed by skin on cheek. Small conical teeth forming tooth patch on both jaws and palatines (all species), vomer and basibranchial (most species); vomerine teeth absent in *B. werneri*, usually absent in *B. levistomatus*; single tooth patch on basibranchial absent in *B. werneri* and *B. levistomatus*, usually absent in *B. zenkevitchi*. Preopercle posteriorly enlarged, almost reaching posterior margin of opercle; opercular spine absent or weak. Long rakers on first gill arch 9–22; two pseudobranchial filaments. Pectoral-fin with 21–30 rays not reaching a vertical through anterior margin of anus; anteroventral angle of fourth actinost not protruding; pelvic fin with one ray. Abdominal vertebrae 11–17. Scales deciduous; lateral line absent (Cohen and Nielsen 1978; Nielsen and Merrett 2000; Nielsen and Moller 2008; Tomiyama et al. 2015, 2016, 2018; this study).

IV. 2. Key to species of *Bassozetus*

In total, 14 species of *Bassozetus* were recognized in this study (Table 1). The holotype of *B. oncerocephalus* and *B. werneri*, the only known examples of each species, were not examined during the study, their validities being recognized on the basis of the report by Nielsen and Merrett (2000).

1a[*1]. Basibranchial tooth patch completely absent; if present, rudimentary and limited to ca. midpoint of basibranchial 2

1b[*1]. A single median basibranchial tooth patch distinct, extending along dorsal surface of basibranchial 4

2a. Dorsal-fin rays 131; anal-fin rays 108; total vertebrae 71; pelvic-fin length 17.5 % SL ..... *B. werneri*

2b. Dorsal-fin rays 113–126; anal-fin rays 92–103, total vertebrae 63–68; pelvic-fin length 5.7–13.5 % SL 3

3a. Long gill rakers 9–12; vomerine tooth patch usually absent, circular if present ..... *B. levistomatus*

3b. Long gill rakers 15–18; vomerine tooth patch V-shaped ..... *B. zenkevitchi*

4a[*2]. Oblique scales ca. 15–25 (Table 2) 5

4b[*2]. Oblique scales ca. 25–40 (Table 2) 8

5a. Abdominal vertebrae 16; distance between pelvic and anal fins 23.5 % SL ..... *B. oncerocephalus*

5b. Abdominal vertebrae 11–15; distance between pelvic and anal fins 15.0–20.5 % SL (except *B. nielseni*, 18.3–26.2 % SL) 6

6a. Small species (largest known specimen 242 mm SL); head relatively short (e.g., 16.5–18.6 % SL, 136–211 mm SL) (see Fig. 2a) ..... *B. taenia*

6b. Large species (attaining > 480 mm SL); head relatively long (e.g., 19.5–20.6 % SL, 163–239 mm SL) (see Fig. 2a) 7

7a. Tail length 62.7–67.4 % SL in specimens > 342 mm SL (see Fig. 2c); pelvic fin not extending to anus; fins pale yellowish-brown (see Fig. 3a) ..... *B. nielseni*

7b. Tail length 67.9–72.6 % SL in specimens > 346 mm SL (see Fig. 2c); pelvic fin extending beyond anus in specimens 169–216 mm SL (not extending to anus in specimens > 444 mm SL); fins blackish-brown or brown (see Fig. 3b) ..... *B. compressus*

8a[*3]. Pelvic-fin length 0.7–9.5 % SL 9

8b[*3]. Pelvic-fin length 10.7–19.0 % SL 10

9a. Dorsal-fin rays 117; anal-fin rays 98; total vertebrae 65; long gill rakers 14; pelvic-fin length 9.5 % SL ..... *B. mozambiquensis*

9b. Dorsal-fin rays 124–132; anal-fin rays 102–112; total vertebrae 67–73; long gill

rakers 17–22; pelvic-fin length 0.7–6.9 % SL ..... *B. multispinis*

10a[*4]. Dorsal-fin rays 132–142; anal-fin rays 108–114; total vertebrae 71–76; sagittal otolith dorsal margin deeply indented (in specimens ≥ 225 mm SL) .... *B. galatheae*

10b[*4]. Dorsal-fin rays 115–133; anal-fin rays 96–110; total vertebrae 64–72; 1–2 deep indentations present or absent on sagittal otolith dorsal margin 11

11a[*5]. Head length 20.5–22.8 % SL; sagittal otolith large [SL (mm) = 25.9636 × sagitta length (mm) + 52.6156], dorsal margin with 1–2 deep indentations (in specimens ≥ 226 mm SL), ostial channel present ..... *B. robustus*

11b[*5]. Head length 16.5–21.0 % SL; sagittal otolith small (*B. glutinosus*, SL = 80.3760 × sagitta length – 69.7289; *B. nasus*, SL = 57.3404 × sagitta length + 73.6915; *B. normalis*, SL = 90.6476 × sagitta length – 67.0974), dorsal margin lacking deep indentations, ostial channel absent 12

12a. Width to length ratio of vomer arm small (e.g., 12.7–18.2 % SL in specimens 176–266 mm SL) (see Fig. 4a) ..... *B. glutinosus*

12b. Width to length ratio of vomer arm large (e.g., 20.0–30.2 % SL in specimens 168–270 mm SL) (see Fig. 4a) 13

13a. Predorsal length to body depth at anal-fin origin ratio large (e.g., 1.9–2.7 times in specimens 133–225 mm SL) (see Fig. 4b) ..... *B. nasus*

13b. Predorsal length to body depth at anal-fin origin ratio small (e.g., 1.5–1.8 times in specimens 139–221 mm SL) (see Fig. 4b) ..... *B. normalis*

The following should be noted to avoid misidentification:

[*1] *Bassozetus zenkevitchi* usually lacks a basibranchial tooth patch (Nielsen and Merrett 2000), but may on occasion have a rudimentary tooth patch (Machida and Tachibana 1986; this study).

[*2] The following 6 species have ca. 25 overlapping oblique scales: *B. oncerocephalus* and *B. nielseni* (ca. 20–25); *B. galatheae*, *B. glutinosus*, *B. nasus* and *B. normalis* (ca. 25–35). However, the frequency distribution of oblique scale numbers in *B. nielseni* was clearly fewer than those in the other four species (unknown in *B. oncerocephalus*) (Table 2). *Bassozetus nielseni* is also separable from *B. galatheae*

by 122–129 dorsal-fin rays (vs. 132–142), from *B. glutinosus* by 11–14 long gill rakers (vs. 15–21), and from both of the latter by pale yellowish-brown fins (vs. brackish-brown or brown) (Fig. 3a, c, d). In addition, *B. nielseni* is separable from equally-sized *B. nasus* by greater head length (e.g., 20.3–20.6 % SL, 163–242 mm SL vs. 17.0–19.4 % SL, 157–277 mm SL) (Fig. 2a), and from equally sized *B. normalis* by greater head (e.g., 20.3–20.6 % SL, 163–242 mm SL vs. 17.1–19.1 % SL, 159–241 mm SL) and predorsal (e.g., 18.8–19.9 % SL, 147–242 mm SL vs. 15.1–17.3 % SL, 139–242 mm SL) lengths (Fig. 2a, d). *Bassozetus oncerocephalus* differs from *B. galatheae* in having 129 dorsal-fin rays (vs. 132–142) and 105 anal-fin rays (vs. 108–114), and from *B. glutinosus*, *B. nasus* and *B. normalis* in having 16 abdominal vertebrae (vs. 13–15). In addition, the head length of *B. oncerocephalus* (16.0 % SL, 225 mm SL) differs from that of equally-sized *B. glutinosus* (18.2–19.8 % SL, 203–254 mm SL), *B. nasus* (17.4–18.7 % SL, 205–246 mm SL) and *B. normalis* (17.1–18.7 % SL, 204–241 mm SL) (Fig. 2a, b).

*3 Pelvic-fin length to SL ratio of *B. mozambiquensis* (9.5 %) is close to that of *B. galatheae* (11.0–17.0 %) and *B. glutinosus* (10.7–19.0 %) (other species values are 0.7–6.9 % in *B. multispinis*, and 13.5–19.0 % in *B. nasus*, *B. normalis* and *B. robustus* combined). However, *B. mozambiquensis* differs from the latter two by 117 dorsal-fin rays (vs. 132–142 in *B. galatheae*; 120–130 in *B. glutinosus*), 65 total vertebrae (vs. 71–76; 66–71) and pale yellowish-brown fins (vs. brownish in both). Additionally, sagittal otolith morphology of *B. mozambiquensis* (dorsal margin smooth, ostial channel present) also differs from *B. galatheae* (dorsal margin deeply indented in specimens ≥ 225 mm SL, ostial channel absent) and *B. glutinosus* (dorsal margin bulging anteriorly, ostial channel absent)

*4 Dorsal-fin ray, anal-fin ray and total vertebral numbers shown in couplet 10a (*B. galatheae*) and 10b (*B. robustus*, *B. glutinosus*, *B. nasus* and *B. normalis*) all slightly overlap with each other. However, they clearly differ between *B. galatheae* and *B. robustus* (dorsal-fin rays 132–142 in the former vs. 115–123 in the latter; anal-fin rays 108–114 vs. 96–101; total vertebrae 71–76 vs. 64–68). In addition, the combination of number of dorsal-fin rays, anal-fin rays and total vertebrae of *B.*

galatheae is useful for separating this species from *B. nasus* (123–133, 101–110 and 68–72, respectively) and *B. normalis* (121–132, 99–108 and 67–71, respectively). In addition, dorsal-fin rays number more in *B. galatheae* (132–142) than in *B. glutinosus* (120–130).

*5 Head length to SL ratios shown in couplet 11a (*B. robustus*) and 11b (*B. glutinosus, B. nasus* and *B. normalis*) slightly overlap with each other. However, the head length of *B. robustus* (20.5–22.8 % SL) is greater than that of *B. nasus* (17.0–19.5 % SL), *B. normalis* (16.5–20.5 % SL) and equally-sized *B. glutinosus* (e.g., 21.3–22.8 % SL, 85–342 mm SL vs. 16.9–20.8 % SL, 111–370 mm SL) (Fig. 2b). Relational expressions between SL and sagittal otolith length of *B. glutinosus*, *B. nasus* and *B. normalis* are taken from Nielsen and Merrett (2000), who distinguished *B. robustus* (large sagittal otolith) from *B. glutinosus*, *B. nasus* and *B. normalis* (small sagittal otolith).

V. Descriptions

V. 1. *Bassozetus compressus* (Günther 1878)

(Standard English name: Abyssal assfish; standard Japanese name: Ōrin-fukumen-itachiuo; Figs. 2, 3, 5–9; Tables 2, 3)

Bassozetus compressus (Günther 1878) was originally described as *Bathynectes compressus* from specimens collected off New Guinea and in the Mid-Atlantic, the brief description not indicating the number of specimens or registration numbers. Removed to genus *Bathyonus* by Goode and Bean (1885), the species was re-described by Günther (1887) from four specimens, two from off New Guinea, and one each from the Philippines Islands and Mid-Atlantic. Subsequently, Goode and Bean (1896) transferred the species to genus *Bassozetus*, based on the characters described by Günther (1887). The syntypical status of Günther's (1887) four specimens was eventually revealed by Nielsen and Merrett (2000), who designated one of three pacific specimens as the lectotype (BMNH 1887.12.7.47). However, they re-identified the two other Pacific specimens (BMNH 1887.12.7.48 and 49) as *B. glutinosus* [the Atlantic specimen (BMNH 1887.12.7.59) proving impossible to identify because of the dissolution of the sagittal otolith and lack of scales]. On the other hand, *B. elongatus* Smith and Radcliffe in Radcliffe (1913) was originally described from a single specimen collected off Celebes, Indonesia. Both species have been reported from the Indo-West Pacific (Nielsen 1997; Nielsen et al. 1999; Nielsen and Merrett 2000; Nielsen and Møller 2008), the range of *B. compressus* reportedly extending to the Atlantic (Nielsen et al. 1999; Nielsen and Merrett 2000). According to Nielsen and Merrett (2000), *B. compressus* and *B. elongatus* were morphologically similar to each other, only the pelvic-fin length differentiating between them. In addition, the position of a small process on the sagittal otolith differed between the two species, as illustrated by Nielsen and Merrett (2000: fig. 9B and 12B).

Tomiyama et al. (2015) showed that morphology of *B. compressus* and *B.*

elongatus sensu Nielsen and Merrett (2000) from the West Pacific, including the types of both species, did not differ significantly, *B. compressus* therefore being a senior synonym of *B. elongatus*. A new standard Japanese name "Ōrin-fukumen-itachiuo" was proposed for the species on the basis of two specimens from Senkaku Islands and Okinawa Islands (Tomiyama et al. 2015). Tomiyama et al. (2015) also predicted one or more undescribed species, based on the Atlantic and Indian Ocean specimens previously reported as *B. compressus* or *B. elongatus*. These specimens were subsequently described as two new species, *B. mozambiquensis* and *B. nielseni*, by Tomiyama et al. (2016, 2018). In addition, a specimen reported as *B. compressus* from waters off Taiwan (Yeh et al. 2005) was actually *B. robustus*, whereas three specimens reported as *B. elongatus* from off New Caledonia (Nielsen 1997) and subsequently re-identified as *B. galatheae* (Fricke et al. 2011) were, in fact, *B. compressus* (see Tomiyama et al. 2015).

The body profile of one of two syntypes of *B. compressus* from off New Guinea, illustrated in Günther (1887: plate XXII, fig. A, length not shown), was undoubtedly based on BMNH 1887.12.7.47 (lectotype of *B. compressus*), the count of oblique scales (ca. 18) matching that specimen (ca. 27 in the other, BMNH 1887.12.7.47). Since the tail tip of the lectotype is now missing, the standard length was estimated using the ratio of standard length to head length apparent in the illustration (4.92 times).

Bathynectes compressus Günther 1878: 20 (original description; type locality: south-east of New Guinea and Mid-Atlantic).

Bathyonus compressus: Goode and Bean 1885: 603; Günther 1887: 109, pl. XXII, fig. A.

Bassozetus compressus: Goode and Bean 1896: 322; Jordan and Evermann 1898: 2508; Radcliffe 1913: 157; Fowler 1936: 1062; de Beaufort and Chapman 1951: 431; Grey 1956: 209; Beamish et al. 1999: 405; Nielsen 1999: 1980; Nielsen et al. 1999: 57; Nielsen and Merrett 2000: 21, figs 8–10; Nielsen and Robins 2003: 968; Garrido-Linares and Acero 2006: 294; Hoese et al. 2006: 557; Nielsen and

Møller 2008: 25, fig. 6; Tomiyama et al. 2015: [1], figs. 1–4 (indicated the synonymy between *B. compressus* and *B. elongatus*); Tomiyama et al. 2016: [1]; Tomiyama et al. 2018: [1], figs. 4, 6.

Bassozetus elongatus Smith and Radcliffe in Radcliffe 1913: 157, pl. 11, fig. 4 (original description; type locality: Gulf of Tomini, Celebes); Cockerell 1916: 322; de Beaufort and Chapman 1951: 433; Grey 1956: 209; Nielsen 1997: 56, fig. 4; Nielsen 1999: 1980; Nielsen et al. 1999: 57, fig. 54; Nielsen and Merrett 2000: 25, figs. 1A, 11–13.

Specimens examined. Twelve specimens, 169–480 mm SL. BMNH 1887.12.7.47 (right sagittal otolith incorrectly orientated and labelled as "left" by Nielsen and Merrett 2000, fig. 9B), ♀, lectotype, 408 mm length at 62nd vertebrae (tail tip lost), 417 mm estimated SL [calculated as SL to HL ratio based on illustration in Günther (1887; plate XXII, fig. A)], southeast of Raine Island, New Guinea, 12°8′S, 145°10′E, 2,562 m, 29 August 1874, R/V *Challenger*, bottom trawl; ZMUC P771566 [*1, 2], ♂, 465 mm SL, Solomon Sea, 13°45.0′S, 156°41.0′E, 2,255–2,283 m, 19 December 2006, R/V *Vædderen*, 45-foot shrimp otter trawl; USNM 74141, holotype of *Bassozetus elongatus*, ♂, 438 mm SL, Gulf of Tomini, Celebes, 0°8.00′S, 121°19.00′E, 1,992 m, 18 November 1909, R/V *Albatross*, beam trawl; CAS SU (ICH) 25627 [*3], ♂, 346 mm SL, Gulf of Tomini, Celebes, R/V *Albatross*; MNHN 1994-708 [*1, 3] (sagittal otolith could not be extracted), ♂, 444 mm SL, off New Caledonia, 21°16.49′S, 166°43.56′E, 2,340 m, 11 August 1985, *Biocal*, beam trawl; MNHN 1994-709 [*3] (left sagittal otolith, see Nielsen and Merrett 2000, fig. 12B), ♀, 475 mm SL, off New Caledonia, 22°9.02′S, 167°33.18′E, 2,100 m, 4 September 1985, *Biocal*, beam trawl; ZMUC P771150 [*1, 3], ♂, 480 mm SL, off New Caledonia, 21°12.0′S, 166°59.8′E, 2,190–2,205 m, 3 May 1987, *Biogeocal*, beam trawl; ZMUC P771169–771171[*3], three specimens, immature, 169–216 mm SL, off Celebes, 1°50′N, 119°20′E, 4,940–4,970 m, 21 August 1951, R/V *Galathea*, herring otter trawl; BSKU 57864 [*1], ♂, 372 mm SL, west-southwest of Kumejima Island, Okinawa Islands, 26°10′N, 125°50′E–26°11′N, 125°52′E, 2,124–2,164 m, 28 April 2003, R/V *Tansei-maru*, beam trawl; NSMT-P

98867 [*1], ♀, 455 mm SL, southeast of Uotsurijima Island, Senkaku Islands, 24°58.3′N, 123°45′E–23°57.4′N, 123°43.2′E, 1,972–1,974 m, 12 May 2005, R/V *Hakuho-maru*, beam trawl.

*[1] indicates that the extracted sagittal otolith was examined in the present study. [*2] indicates specimens previously reported as *B. compressus* by Nielsen and Møller (2008). [*3] indicates specimens previously reported as *B. elongatus* by Nielsen (1997) and/or Nielsen and Merrett (2000)

Diagnosis. Oblique scales 18–21, abdominal vertebrae 11–13, head length 17.1–20.6, distance between pelvic fin to anal fin 15.8–20.5 % SL; tail length 67.4–72.6 % SL, pelvic-fin length 9.4–23.1 % SL (not extending beyond a vertical from anus in 444–475 mm SL, beyond in 169–216 mm SL specimens), a single median basibranchial tooth patch, and fins brownish (preserved condition).

Description. Major counts and measurements are presented in Table 3. Description of the lectotype is given first, followed by those of other specimens in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded, its length 2.2 (2.0–2.7) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large, posterior margin of maxilla slightly anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw slightly pointed, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine and basibranchial; vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 6); teeth on vomer and palatine somewhat larger than others. Preopercle lacking spines, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres, below eye level, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines

on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal region of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 18th (17th–22nd) dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Dorsal-fin origin slightly posterior to a vertical through posterior margin of preopercle. Anal-fin origin below 22nd (20th–24th) dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/3 (1/2–1/3) of tail, thereafter becoming similar length. Pectoral fin below a horizontal through eye, not reaching a vertical through anterior margin of anus; its bases slightly posterior to axil. Pelvic-fin base below posterior margin of preopercle, close to ventral edge of body; rays broken (not extending beyond a vertical from anus in 444 and 475 mm SL, beyond in 169–216 mm SL specimens, pelvic-fin length to SL ratio decreasing with growth, see Table 3 and Fig. 7). Caudal fin broken (very small, continuous via membrane with dorsal and anal fins). Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Profile almost oval, dorsal margin smooth, a small process on anterior margin (varying slightly in size) (Fig. 8); length to height ratio 1.7 (1.5–1.9), length to thickness ratio 2.6 (2.3–3.0); almost flat on medial aspect, except for sulcus and ostial channel; sulcus distinctly dimpled, undivided centrally; ostial channel indistinct, extending anteriorly. Lateral aspect expanded, smooth.

Coloration in alcohol. Head visibly blackish-brown under light brownish membrane; trunk and tail light brown, except blackish-brown on abdomen (head, trunk and tail brown in 169–216 mm SL specimens). All fins blackish-brown (brown in 169–216 mm SL) (e.g., pectoral fin shown in Fig. 3b). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known only from the southern and western Pacific, from waters off New Caledonia to Kumejima Island, Okinawa Islands, Japan from the bottom in 1,972–4,970 m depth (Fig. 9).

Synonymy of *B. compressus* and *B. elongatus*. According to Nielsen and

Merrett (2000), *B. compressus* and *B. elongatus* differed from each other in pelvic-fin length (12.0–17.5 % SL in *B. compressus* vs. 18.0–25.0 % SL in *B. elongatus*) and the position of a small process on the sagittal otolith (posterior margin vs. anterior margin). A comparison by Tomiyama et al. (2015) of 39 specimens previously reported as *B. compressus* or *B. elongatus*, distinguished between 27 Atlantic and Indian Ocean specimens (being undescribed species, since described as *B. mozambiquensis* and *B. nielseni*), and 12 West Pacific specimens, including types of both of the former species. The general morphology of the 10 non-type western Pacific specimens conformed to both the lectotype of *B. compressus* and holotype of *B. elongatus*, except in pelvic-fin length to SL ratio and position of a small sagittal otolith process. However, both of these differences were shown to be invalid by Tomiyama et al. (2015).

The pelvic-fin rays were broken in seven western Pacific specimens (including both types), the proportions being 10.9–23.1 % SL in the remaining 5 specimens previously identified as *B. elongatus* by Nielsen (1997) and/or Nielsen and Merrett (2000) (Table 3). Although Smith and Radcliffe *in* Radcliffe (1913) indicated that the pelvic-fin length of the holotype of *B. elongatus* (438 mm SL, 79.7 mm HL) was ca. 1.9 times in HL (ca. 9.6 % SL), Nielsen and Merrett (2000) gave the range of pelvic-fin length for *B. elongatus* as 18.0–25.0 % SL, similar to those determined for three smaller western Pacific specimens (17.8–23.1 % SL, 169–216 mm SL). Significantly, two larger (444 and 475 mm SL) western Pacific specimens had ranges of 10.9–11.5 % SL, comparable with the length given for *B. compressus* (12.0–17.5% SL) by Nielsen and Merrett (2000). Accordingly, the pelvic-fin length to SL ratio was shown to be invalid as a distinguishing character between *B. compressus* and *B. elongatus sensu* Nielsen and Merrett (2000), a decrease in the pelvic-fin length proportion with growth being likely in the western Pacific specimens (Fig. 7). Coincidentally, the pelvic-fin length of the lectotype of *B. compressus*, measured from Günther's (1887) illustration (417 mm estimated SL) was ca. 9.4 % SL, a value close to that of the holotype of *B. elongatus* (ca. 9.6% SL in 438 mm SL). Fifteen Atlantic and Indian Ocean *Bassozetus* specimens (= *B. mozambiquensis* and *B. nielseni*) had pelvic fin lengths of 9.5–18.7 % SL (Fig. 7), a range not dissimilar to that given for *B.*

compressus (12.0–17.5 % SL) by Nielsen and Merrett (2000).

A small process was present on the anterior margin of the sagittal otolith in all five western Pacific specimens [ZMUC P771566, formerly identified as *B. compressus* by Nielsen and Møller (2008); USNM 74141, holotype of *B. elongatus*; ZMUC P771150, formerly identified as *B. elongatus* by Nielsen (1997) and Nielsen and Merrett (2000); BSKU 57864; and NSMT-P 98867]. In addition, a small process was similarly located or absent on the anterior margin in the Atlantic and Indian Ocean specimens included in *B. mozambiquensis* and *B. nielseni*. A similar process was shown only on the posterior margin in the description and illustration of the sagittal otolith of the lectotype of *B. compressus* by Nielsen and Merrett (2000: fig. 9B). However, it was apparent that Dr. W. Schwarzhans, who provided the illustration of the sagittal otolith of the lectotype of *B. compressus*, mistakenly assumed the right element as the left. Accordingly, Nielsen and Merrett (2000) incorrectly interpreted the anteroposterior orientation (Dr. W. Schwarzhans and Dr. J. G. Nielsen, pers. comms.). Therefore, the correct position of the small process in the lectotype of *B. compressus* is on the anterior margin (Fig. 8), as in *B. elongatus*.

Nielsen and Merrett (2000) noted that the body depth at anal-fin origin of *B. compressus* (8.0–14.5 % SL) tended to be greater than that of *B. elongatus* (8.2–11.0 % SL). However, this tendency was not so obvious between specimens of *B. compressus* and *B. elongatus sensu* Nielsen and Merrett (2000) from the western Pacific Ocean (greatest body depth 12.3–14.8 % SL in the former vs. 10.8–13.6 % SL in the latter; body depth at anal-fin origin 10.3–11.8 % SL vs. 9.2–10.9 % SL) (Table 3). On the other hand, the Atlantic and Indian Ocean specimens included in *B. mozambiquensis* and *B. nielseni* had greater body depth (body depth at anal-fin origin 8.6–14.6 % SL), the range being similar to the ratio given for *B. compressus* by Nielsen and Merrett (2000) (8.0–14.5 % SL).

Counts and other measurements of the western Pacific specimens did not differ significantly (Table 3), any variations clearly being within intraspecific expectations. Tomiyama et al. (2015) therefore concluded that *B. compressus* and *B. elongatus* are conspecific, the former name being the senior synonym.

V. 2. *Bassozetus galatheae* Nielsen and Merrett 2000

(Standard English name: Galathea assfish; standard Japanese name: Garatea-fukumen-itachiuo; Figs. 3, 9–11; Tables 2, 4)

Bassozetus galatheae Nielsen and Merrett (2000) was originally described on the basis of 22 specimens from the Indo-West Pacific and the western Central Pacific. In addition, a Hawaiian specimen reported by Iwai (1976) as *B. elongatus* is possibly also *B. galatheae* (Nielsen and Merrett 2000). Recently, Okiyama (2014) reported the larval morphology of *B. galatheae* from east of the Philippines. He suggested the possibility of the species' distribution extending to waters around Japan, and proposed a new standard Japanese name "Garatea-fukumen-itachiuo".

Bassozetus galatheae Nielsen and Merrett 2000: 21, fig. 10 (original description; type locality: Indo-Pacific; off Kenya to Fiji Island); Mundy 2005: 242; Fricke et al. 2009: 27; Tomiyama et al. 2016: [4]; Tomiyama et al. 2018: [7].

Bassozetus elongatus (not of Smith and Radcliffe in Rdcliffe 1913): Iwai 1976:149, fig. 21.

Bassozetus glutinosus (not of Alcock 1890): In part, Shcherbachev 1980: 119; Nielsen and Quéro 1991: 193.

Bassozetus n. sp. 1: Nielsen et al. 1999: 58.

Specimens examined. Seven specimens, 108–495 mm SL. ZMUC P771214, paratype, 118 mm SL, ♀, off Kenya, 3°23′S, 44°4′E, 3,960 m, 13 March 1951, R/V *Galathea*, herring otter trawl; ZMUC P771215–1216, paratypes, 108–215 mm SL, 2♀, Bay of Bengal, 17°10′N, 84°30′E, 2,820 m, 24 April 1951, R/V *Galathea*, herring otter trawl; ZMUC P771217, paratype, 372 mm SL, ♂, eastern Indian Ocean, 3°3′S, 83°2.5′E, 1,680–1,800 m, 9 March 1979, R/V *Professor Mesjatsev*, bottom trawl;

ZMUC P771218, paratype, 495 mm SL, ♂, northwestern Pacific Ocean, 17°0.9′N, 150°49′E, 1,287–1,430 m, 194 April 1984, R/V *Chronometz trawl 60*, herring otter trawl; BSKU 65557–65558, 198–226 mm SL, 2♂, north of Papua New Guinea, 2°S, 157°E, 4 January 1968, R/V *Hakuho-maru*, beam trawl.

Diagnosis. Dorsal-fin rays 132–142, anal-fin rays 108–114, oblique scales ca. 25–40, total vertebrae 71–76, pelvic-fin length 11.0–17.0 % SL, a single median basibranchial tooth patch, sagittal otolith with a deep indentation on dorsal margin, and brownish fins (preserved condition).

Description. Major counts and measurements are presented in Table 4. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded; its length 1.6–2.8 times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine basibranchial, pharyngobranchial and inner surface of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 11); teeth on vomer and palatine somewhat larger than others. Preopercle lacking a spine, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 22nd–29th dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just

behind urogenital opening (indistinct in 108–118 mm SL). Dorsal-fin origin above midpoint between posterior margin of preopercle and pectoral-fin axil. Anal-fin origin below 26th–31st dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2 of tail, thereafter becoming similar length. Pectoral-fin just below a horizontal through eye, not reaching a vertical through anterior margin of anus. Pelvic fin bases slightly anterior to a vertical through posterior margin preopercle, close to ventral edge of body; posterior tip of rays reaching posterior ca. 1/3–1/4 part of distance between pelvic-fin base to anus. Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Coloration in alcohol. Head blackish-brown under light brownish membrane; trunk, tail and all fins entirely light brown, except for large specimens (372–495 mm SL), which have a more or less darkish abdomen, scale pocket edges and all fins (e.g., pectoral fin shown in Fig. 3c). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known from bottom depths of 1,100–3,960 m in the Indo-West Pacific and western Central Pacific, between ca. 20°N and 30°S (Nielsen and Merrett 2000; this study) (Fig. 9).

Remarks. The sagittal otoliths were missing in all specimens of *B. galatheae* examined here. However, Nielsen and Merrett (2000; fig. 15D) described and illustrated the sagittal otolith morphology of the holotype (415 mm SL) as follows: margins smooth except for the dorsal which has a deep indentation; length to height ratio 2–3, length to thickness ratio 4–5; undivided sulcus present on medial aspect, and ostial channel absent. Nielsen and Merrett (2000) also examined the sagittal otoliths of 11 paratypes (225–555 mm SL), not finding any intraspecific variations.

Two additional specimens of *B. galatheae* (BSKU 6557, 6558) from north of Papua New Guinea represent the first record of the species from that region.

V. 3. *Bassozetus glutinosus* (Alcock 1890)

(Standard English name: Glutin assfish; standard Japanese name: Nan'yō-fukumen-itachiuo; Figs. 2–4, 12–15; Tables 2, 5)

Bassozetus glutinosus (Alcock 1890) was originally described as *Bathyonus glutinosus* on the basis of five specimens collected from the Bay of Bengal. Subsequently, Goode and Bean (1896) transferred the species to genus *Bassozetus*, on the basis of the characters described by Alcock (1890). The lectotype was selected by Nielsen and Merrett (2000). *Bassozetus glutinosus* has been reported from the Indo-West Pacific, including Japanese waters (Nielsen 1997; Nielsen et al. 1999; Nielsen and Merrett 2000; Nielsen and Møller 2008; Tomiyama et al. 2011). It is morphologically similar to *B. nasus* and *B. normalis*, and could not be separated from either of the latter using characters and keys proposed by Nielsen and Merrett (2000) (see "Remarks"). In addition, morphological data of a single specimen from off Taiwan, reported by Yeh et al. (2005) as *B. glutinosus*, was incomplete (see "Remarks"). Nine of 13 specimens reported by Shcherbachev (1980) as *B. glutinosus* were subsequently described by Nielsen and Merrett (2000) as a new species, *B. galatheae*.

Bathyonus glutinosus Alcock 1890: 211 (original description; type locality: Bay of Bengal); Alcock 1892: fig. 3, pl. 1; Menon and Yazdani 1968: 147.

Bathyonus compressus (not of Günther 1878): In part, Günther 1878: 109.

Bassozetus glutinosus: Goode and Bean 1896: 322; Alcock 1899: 88; Norman 1939: 77; Nielsen 1997: 56, fig. 5; Fricke 1999: 100; Nielsen 1999: 1980; Nielsen et al. 1999: 57; Nielsen and Merrett 2000: 30, figs. 16–18; Hoese et al. 2006: 557; Nielsen and Møller 2008: 25, fig. 7; Fricke et al. 2011: 366; Takami et al. 2011: 177; Tomiyama et al. 2011: 93, figs. 1–4; Tomiyama et al. 2015 [7]; Tomiyama et al. 2016: [4]; Fricke et al. 2018: 83; Tomiyama et al. 2018: [7].

Specimens examined. Thirteen specimens, 111–417 mm SL. BMNH 1890.11.28.37, lectotype, ♂, 183 mm SL, Bay of Bengal, 18°26′N, 85°24′E, 2,397 m, 4

March 1890, R/V *Investigator*, bottom trawl; BMNH 1887.12.7.48, formally syntype of *B. compressus*, ♂, 111 mm SL, off New Guinea, 12°8′S, 145°10′E, 2,562 m, 29 August 1874, R/V *Challenger*, bottom trawl; BMNH 1887.12.7.49, formally syntype of *B. compressus*, ♂, 130 mm SL, off Philippine, 16°42′N, 119°42′E, 1,922 m, 13 November 1874, R/V *Challenger*, bottom trawl; BSKU 20019, ♂, 176 mm SL, off Izu Islands, Japan, 30°49.0′N, 140°22.6′E, 2,350 m, 29 June 1970, R/V *Soyo-maru*, beam trawl; BSKU 22534, ♂, 203 mm SL, Suruga trough, Japan, 21 July 1974, R/V *Hakuhō-maru*; BSKU 22535, ♀, 237 mm SL, Collection data as for BSKU 22534; BSKU 22536, ♂, 154 mm SL, Collection data as for BSKU 22534; BSKU 23720*[1], ♀, 240 mm SL, Indian Ocean, 2,550–2,570 m, 15 February 1977, R/V *Hakuhō-maru*; BSKU 46972, ♂, 308 mm SL, Sampling location is unknown, 8 November 1989; BSKU 47183, ♀, 266 mm SL, Collection data as for BSKU 46972; BSKU 47910, ♀, 254 mm SL, Kumano-Nada Basin, Japan, 33°42.51′N, 136°36.55′E–33°41.62′N, 136°33.58′E, 2,034–2,036 m, 31 August 1990, R/V *Tansei-maru*; BSKU 47911, 370 mm SL, Collection data as for BSKU 47910; BSKU 65561, ♂, 124 mm SL, Sampling location is unknown, 2,000 m, year 1989, beam trawl; BSKU 65562, ♀, 149 mm SL, Collection data as for BSKU 65561; BSKU 85668, ♂, 195 mm SL, off Bōsō Peninsula, Japan, 34°21.401′N, 140°13.135′E–34°20.783′N, 140°16.215′E, 2,480–2,516 m, 2 September 1998, R/V *Tansei-maru*, beam trawl; BSKU 86842*[1], ♀, 320 mm SL, Kumano-Nada Basin, Japan, 33°38.173′N, 136°30.382′E–33°38.185′N, 136°34.622′E, 2,072–2,074 m, 20 December 1999, R/V *Tansei-maru*, beam trawl; BSKU 112309, 179 mm SL, north of Papua New Guinea, 2°S, 157°E, 5 June 1968, R/V *Hakuhō-maru*; HUMZ 149322, ♀, 325 mm SL, East China Sea, Northwest of Okinawa Island, Ryūkyū Islands, 27°6.33′N, 126°43.67′E–27°5.96′N, 126°45.92′E, 1,805–1,864 m, 23 July 1994, mid-trawl; MSM-09-6*[1], ♀, 148 mm SL, Suruga Bay, Japan, 34°41.20′N, 138°34.83′N, 2,213–0 m, 24 October 2004, R/V *Bōsei-maru*, IKMT (extended to substrate); MSM-09-7*[1], ♂, 163 mm SL, Collection data as for MSM-09-6; MSM-18-103*[1], ♂, 211 mm SL, Suruga Bay, Japan; NSMT-P 63889, 223 mm SL, Okinawa Trough, 25°24.5′N, 124°57.6′E–25°25′N, 124°59.4′E, 1,601 m, 25 April 2002, R/V *Tansei-maru*, beam trawl; NSMT-P 98873, 3♀, 344–417 mm SL, Kumano-nada

Basin, Japan, 33°41.964′N, 136°42.441′E–33°41.439′N, 136°44.007′E, 3,000–3,006 m, 26 May 1994, R/V *Tansei-maru*, beam trawl; NSMT-P 98877, ♂ and 2?, 169–233 mm SL, Suruga Trough, Japan, 34°34.561′N, 138°34.778′E–34°36.131′N, 138°34.482′E, 2,365–2,522 m, 21 May 1994, R/V *Tansei-maru*, beam trawl; NSMT-P 98879, ♀, 170 mm SL, Suruga Trough, Japan, 34°39.71′N, 138°35.26′E–34°41.266′N, 138°35.647′E, 2,100–2,216 m, 11 April 1993, R/V *Tansei-maru*, beam trawl; NSMT-P 98882*[1], 260 mm SL, Ryūkyū Trench, 24°59.7′N, 126°40.7′N, 1,814–1,852 m, 19 May 2005, R/V *Hakuhō-maru*, bottom trawl.

*[1] indicates that the sagittal otolith was examined in the present study (radiographs of BMNH 1887.12.7.48 and NSMT-P 63889, and extracted otolith in other specimens).

Diagnosis. Dorsal-fin rays 120–130, oblique scales ca. 25–35, abdominal vertebrae 13–15, total vertebrae 66–71, long gill rakers 15–21, head length 16.5–21.0 % SL, pelvic-fin length 10.7–19.0 % SL, width to length ratio of vomer-arm 11.4–22.2 %, a single median basibranchial tooth patch, sagittal otolith dorsal margin bulging anteriorly, and blackish-brown fins (preserved condition).

Description. Major counts and measurements are presented in Table 5. The holotype description is given first, followed by those of other specimens in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded; its length 2.5 (1.8–2.9) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw slightly pointed, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surface of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped (Fig. 13a); width to length ratio of vomer-arm not observed

[11.4–22.2 % (Fig. 4a)]; median basibranchial tooth patch single, elongated (Fig. 13b); teeth on vomer and palatine somewhat larger than those on both jaws. Preopercle lacking a spine, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below posterior margin of eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Ordinal numbers of dorsal-fin rays just above anterior margin of anus not observed (20–25th). Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Predorsal length to body depth at anal-fin origin ratio 1.3–1.9 (Fig. 4b). Dorsal-fin origin above the posterior margin of preopercle. Anal-fin origin below 25th (23rd–27th) dorsal-fin ray. Lengths of dorsal and anal-fin rays not observed (dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2–2/3 of tail, thereafter becoming similar or shorter length). Pectoral-fin just below a horizontal through eye (usually just below a horizontal through eye, but rarely level with eye); posterior tips of rays broken (not reaching a vertical through anterior margin of anus). Pelvic fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; posterior tip of rays broken (reaching posterior half of distance between pelvic-fin base to anus, but not extending beyond anus). Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Missing in lectotype [profile almost oval, dorsal margin bulging anteriorly, a small process absent on anterior margin (Fig. 14); length to height ratio 1.2–1.4, length to thickness ratio 2.4–3.3; almost flat on medial aspect, except for sulcus which is distinctly dimpled and undivided centrally; ostial channel absent; lateral aspect expanded, smooth].

Coloration when fresh. Not observed in lectotype [head deep black under black

membrane; trunk and tail pale gray, except for abdomen and pectoral-fin base being black. Scale pocket edges black on head and gray on body. Pectoral and pelvic fins black, the other fins gray (based on photograph of MSM-09-6, 148 mm SL, taken just after collection)].

Coloration in alcohol. Head blackish-brown under light brownish membrane; trunk and tail uniformly light brown (abdomen slightly blackish-brown). All fins light brown [pectoral fin blackish-brown (Fig. 3d); BSKU 47910, 47911 and 86842 with a darkish pelvic fin, caudal fin, and dorsal and anal fin margins]. Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known from the Indo-West Pacific and western Central Pacific oceans (Nielsen and Merrett 2000; Nielsen and Møller 2008; Tomiyama et al. 2011; this study) (Fig. 15). Specimens were usually collected from bottom depths of 1,289–3,450 m (Nielsen and Merrett 2000; Nielsen and Møller 2008; Tomiyama et. al. 2011; this study), but rarely in the water column (0–2,250 m) (Nielsen and Merrett 2000; this study).

Remarks. The sagittal otoliths of all 8 specimens of *B. glutinosus* (111–320 mm SL) examined in this study were morphologically similar to that of the lectotype (183 mm SL) described and illustrated by Nielsen and Merrett (2000, fig. 17B) (holotype sagittal otolith now missing). There were no size-related variations.

Nielsen and Merrett (2000) distinguished *B. glutinosus*, *B. nasus* and *B. normalis* primarily from a multivariate analyses of anal-fin ray, pectoral-fin ray and long gill raker numbers. To identify each species, they derived expressions for plotting individual specimens on the scatter graph of the analysis, but coordinates fitting the graph could not be obtained from those expressions. The sagittal otolith dorsal margin of the three species, described and illustrated by Nielsen and Merrett (2000), differed from each other as follows: bulging anteriorly in *B. glutinosus*; bulging posteriorly in *B. nasus*; smooth in *B. normalis*. However, the difference between *B. glutinosus* and *B. normalis* is invalid as a distinguishable character, because a single specimen (BMNH 1991.7.9.827) of *B. normalis* observed in this study had a sagittal otolith with the dorsal margin bulging anteriorly, as in *B. glutinosus*. In addition, the present study

revealed that *B. glutinosus* is distinguishable from equally-sized *B. normalis* and *B. nasus* by a lesser width to length ratio of the vomer arm (e.g., 12.7–18.2 %, 176–266 mm SL vs. 20.0–30.2 %, 181–242 mm SL and 20.0–27.1 %, 207–270 mm SL, respectively) (Fig. 4a). In addition, *B. nasus* is separable from equally-sized *B. normalis* by a greater predorsal length to body depth at anal-fin origin ratio (e.g. 1.9–2.7 times, 133–225 mm SL vs. 1.5–1.8 times, 139–221 mm SL) (Fig. 4b).

Two specimens (68 and 352 mm SL) of B. *glutinosus* were collected from the water column far from the bottom (Nielsen and Merrett 2000; this study), although most *B. glutinosus* were collected from bottom depths (*n* = 52, 92–417 mm SL) (Nielsen and Merrett 2000; Nielsen and Møller 2008; Tomiyama et al. 2011; this study). Accordingly, *B. glutinosus* undoubtedly occupies a benthopelagic habitat, but may ascend considerably in the water column.

Tomiyama et al. (2011) reported *B. glutinosus* for the first time from Japanese waters on the basis of the specimens collected from Suruga Bay (*n* = 2, 148–163 mm SL) and the Ryūkyū Trench (*n* = 1, 260 mm SL), and proposed the new standard Japanese name “Nan’yō-fukumen-itachiuo”, derived from “Nan’yō (= south sea)” and “fukumen-itachiuo (= common name of the genus *Bassozetus*)”. Following this, 16 additional specimens of various sizes (169–417 mm SL) were collected in Japanese waters from Suruga Bay to the Okinawa Trough during the course of this study. The species therefore occurs commonly south of Japan (Fig. 15), Suruga Bay representing the northernmost part of its distribution range.

Yeh et al. (2005) identified a single specimen (ASIZP 61754, 264 mm SL) from Taiwanese waters as *B. glutinosus*, most meristics closely matching those of *B. glutinosus* (except for the broken dorsal- and anal-fin rays and caudal vertebrae) (Nielsen and Merrett 2000; Nielsen and Møller 2008; Tomiyama et al. 2011; this study). However, proportional measurements of Yeh et al.’s (2005) specimen clearly differed from those of equally-sized *B. glutinosus* observed here (223–320 mm SL, *n* = 9), as follows: head length 15.8 % SL in the former vs. 18.6–20.4 % SL in the latter, predorsal length 14.2 % SL vs. 16.9–19.1 % SL, preanal length 29.2 % SL vs. 33.8–36.8 % SL, prepelvic length 12.3 % SL vs. 13.8–16.2 % SL. Further assessment

of the Taiwanese specimen is necessary.

V. 4. *Bassozetus levistomatus* Machida 1989

(Standard Japanese name: Soko-fukumen-itachiuo; Figs. 15–17; Table 6)

Bassozetus levistomatus Machida 1989 was originally described on the basis of a single specimen from the Izu-Bonin Trench, and given the new standard Japanese name “Soko-fuken-itachiuo”. Recently, Ohashi and Shinohara (2015) noted the second record of the species from the western North Pacific, including the first color photograph of a specimen when fresh. *Bassozetus levistomatus* has been reported from all world oceans (Nielsen et al. 1999; Nielsen and Merrett 2000, Ohashi and Shinohara 2011; Vieira et at. 2016), although specimens vary in the presence or absence of a vomerine tooth patch (see “Remarks”).

Bassozetus levistomatus Machida 1989: 187, figs. 1–3 (original description; type locality: Izu-Bonin Trench, Japan); Nielsen 1999: 57; Nielsen and Merrett 2000: 34, figs 19–21; Nielsen and Robins, 2003: 968; Garrido-Linares and Acero 2006: 294; Ohashi and Shinohara 2015: 69, figs. 1–5; Tomiyama et al. 2015: [8]; Nielsen 2016: 1950; Tomiyama et al. 2016: [4]; Vieira et at. 2016: [6], fig. 3e; Tomiyama et al. 2018: [8].

Specimens examined. Four specimens. NMST-P 29533, holotype, 479 mm SL, ♀, Izu-Bonin Trenchi, Japan, 31°10.4′N, 141°44′E, 5,160 m, 20 June 1973, R/V *Soyo-maru*, beam trawl. BMNH 1991.7.9.859[*1], 560 mm SL, ♀, near Madeira, 30°4.3′N, 20°19.1′W, 4,942–4,958 m, 18 August 1990, R/V *Discovery*, trawl; NMST-P 114823[*1], 591 mm SL, ♀, off Fukushima Prefecture, northern Japan, 37°30.9′N, 145°56.3′E–37°24.4′N, 145°3.3′E, 5,531–5,606 m, 3–4 August 2013, R/V *Soyo-maru*, crab trap; VIMS 6888, 184 mm SL, ♀, Caribbean Sea, 15°8.3′N, 69°20.1′W,

3,942–3,993 m, 28 October 1981, R/V *Bartlett*, otter trawl.

*[1] indicates that the extracted sagittal otolith was examined in the present study.

Diagnosis. Dorsal-fin rays 117–126, anal-fin rays 93–103, long gill rakers 9–12, total vertebrae 64–68, pelvic-fin length 8.1–13.5 % SL, basibranchial tooth patch absent, and vomerine tooth patch usually absent (circular if present).

Description. Major counts and measurements are presented in Table 6. Description of the holotype is given first, followed by those of other specimens in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded, its length 2.2 (2.6–3.7) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye rounded. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, palatine, pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis; vomer and basibranchial edentate. Preopercle lacking spine, posteriorly enlarged and almost reaching hind margin of opercle. Opercle thin, soft, with a weak subepidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres, slightly behind a vertical through eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spins on inner surface, pointed distally, on upper and lower lobs and angle, but absent proximally; short rakers with minute spins over entire surface, rounded distally, on proximal regions of upper and lower limbs, respectively. Two short pseudobranchial filaments. Anterior margin of anus below 23rd (22nd–25th) dorsal-fin ray. Urogenital opening slightly posterior to anus. A fleshy process located just behind urogenital opening indistinct. Dorsal-fin origin above the posterior margin of preopercle. Anal-fin origin below 26th (24–28th) dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2 of tail, thereafter becoming shorter. Pectoral-fin just below the horizontal through eye, not

reaching to a vertical through anterior margin of anus. Pelvic fin base below ca. midpoint between posterior margins of maxilla and preopercle, close to ventral edge of body; posterior tip of rays reaching halfway to anus. Caudal fin very narrow, continuous via membrane with both dorsal and anal fins. Deciduous scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Not observed in the holotype [profile almost oval, dorsal margin smooth or slightly rounded, a small process of variable size present on anterior margin (Fig. 17); length to height ratio 1.6–1.8, length to thickness ratio 2.7–3.2; almost flat on medial aspect, except for distinctly dimpled sulcus; ostial channel absent; lateral aspect expanded, smooth].

Coloration in alcohol. The holotype was extremely discolored. Head blackish-brown under light brownish membrane (head completely blackish-brown); trunk and tail light brown (blackish-brown, but damaged area light brown). Scale pocket edges on head and body blackish-brown. All fins light brown (blackish-brown). Oral cavity whitish; gill and abdominal cavities blackish-brown.

Distribution. Collected from bottom depths of 3,285–5,606 m in the North Atlantic, West Indian, and western and eastern North Pacific Oceans (Nielsen and Merrett 2000; Ohashi and Shinohara 2015; Vieira et at. 2016; this study) (Fig. 15).

Remarks. The sagittal otolith morphology of larger specimens (560–591 mm SL) observed in this study differed from that of smaller specimen (185 mm SL) in Nielsen and Merrett (2000, fig. 20A), as follows: dorsal margin smooth in the former vs. slightly concave in the latter; a small process present on anterior margin vs. absent; length to thickness ratio 2.7–3.2 vs. ca. 4–5. These variations are all considered to be growth-related.

Among the 10 specimens of *B. levistomatus* listed in Nielsen and Merrett (2000), a single specimen (BMNH 1994.5.6.1, 735 mm SL) from off Northwest Africa had a small circular vomerine tooth patch (absent in all other specimens, including the holotype). Subsequently, Vieira et al. (2016) reported five additional specimens (605–650 mm SL, probably deposited in the Zoological Museum Hamburg) from the neighboring sampling station, which had a similar vomerine tooth patch. Such a

variation has not been seen in any congeners. The sagittal otolith morphology of BMNH 1994.5.6.1 (Nielsen and Merrett 2000, fig. 20B) also differed from those of similarly-sized specimen (591 mm SL), as follows: dorsal margin bulging in the former vs. smooth in the latter; length to thickness ratio 1.5 vs. 2.7. Further assessment of the Northwest African specimens is necessary.

V. 5. *Bassozetus mozambiquensis* Tomiyama, Takami and Fukui 2016

(Standard English name: Mozambique Assfish; Figs. 18–21; Tables 2, 7)

Bassozetus mozambiquensis Tomiyama, Takami and Fukui 2016 was originally described on the basis of a single specimen from the West Indian Ocean. The holotype, the only known example of the species, was initially reported as *B. compressus* by Nielsen and Merrett (2000), but subsequently identified as an undescribed species by Tomiyama et al. (2015).

Bassozetus mozambiquensis Tomiyama, Takami and Fukui 2016: [1], figs. 1–3 (original description; type locality: West Indian Ocean)

Bassozetus compressus (not of Günther 1878): In part, Nielsen and Merrett (2000): 21, fig. 10.

Specimen examined. USNM 206917, holotype, 431 mm SL, ♀, Mozambique Channel, 21°18′S, 36°18′E, 1,555 m, 2 October 1964, R/V *Anton Bruun*, bottom trawl.

Diagnosis. Dorsal-fin rays 117, anal-fin rays 98, long gill rakers 14, oblique scales 30, total vertebrae 65, pelvic-fin length 9.5 % SL, a single median basibranchial tooth patch.

Description. Major counts and measurements are presented in Table 7. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing and becoming thin at tail tip. Head covered by loose skin.

Snout slightly expanded, its length 3.0 times eye diameter. Two nostrils rounded; anterior and posterior nostrils almost equal in size; anterior nostril near tip of snout; posterior nostril at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla slightly behind a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine and basibranchial (presence or absence of tooth patches on pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis not observed); vomerine tooth patch extending toward tip of upper jaw, V-shape; median basibranchial tooth patch single, elongated (Fig. 19); teeth on vomer, palatine and basibranchial somewhat larger than those on both jaws. Preopercle lacking spines, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye level, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 23rd dorsal-fin ray. Urogenital opening slightly posterior to anus. Dorsal-fin origin slightly anterior to a vertical through posterior margin of preopercle. Anal-fin origin below 26th dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2 of tail, thereafter becoming similar length. Pectoral fin level with eye (posterior portion of all rays broken). Pelvic-fin base below midpoint between posterior margins of maxilla and preopercle, close to ventral edge of body; posterior tip of rays reaching halfway to anus. Caudal fin very narrow (posterior portion of all rays broken). Anteroventral angle of fourth actinost not protruding. Scale pockets on head and body (scales missing). Lateral line absent.

Sagittal otolith. Profile almost oval, dorsal and ventral margins smooth, anterior and posterior margins slightly pointed, a small process on anterior margin absent (Fig.

20); length to height ratio 1.5, length to thickness ratio 3.3; almost flat on medial aspect, except for sulcus and ostial channel; sulcus distinctly dimpled, undivided on centrally; ostial channel indistinct, extended anterodorsally. Lateral aspect slightly expanded, smooth.

Coloration in alcohol. Head blackish-brown under pale yellowish-brown membrane; trunk, tail and all fins pale yellowish-brown. Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known only from bottom depths of 1,510–1,600 m in the Mozambique Channel, West Indian Ocean (Fig. 21).

Remarks. The specific name "*mozambiquensis*" was derived from the type locality (Tomiyama et al. 2016).

V. 6. *Bassozetus multispinis* Shcherbachev 1980

(Figs. 3, 9, 22–24; Tables 2, 8)

Bassozetus multispinis Shcherbachev 1980 was originally described on the basis of five specimens from the Indian Ocean. Formerly known only from the eastern Indian Ridge, Indian Ocean (Nielsen and Merrett 2000), a single specimen from east of Taiwan, West Pacific Ocean, was later reported by Lee et al. (2005).

Bassozetus multispinis Shcherbachev 1980: 124, figs. 1, 2 (original description; type locality: Indian Ocean, 19°54.5'S, 87°52.5'); Nielsen et al. 1999: 58; Nielsen and Merrett 2000: 36, figs. 13, 22, 23; Lee et al. 2005: 114, figs. 3, 4.

Specimens examined. Three specimens. ZMUC P771210–P771212*[1], 293–426 mm SL, 3♀, Indian Ocean, 14°31′S, 88°12′E, 1,820–1,880 m, 18 March 1979, R/V *Professor Masjatsev*, bottom trawl.

*[1] indicates that the extracted sagittal otolith of ZMUC P771212 was examined in

the present study.

Diagnosis. Dorsal-fin rays 124–132, anal-fin rays 102–112, long gill rakers 17–22, oblique scales ca. 30–35, total vertebrae 67–73, pelvic-fin length 0.7–6.9 % SL, a single median basibranchial tooth patch, and distal short raker ca. 1/2 to 3/4 length with adjacent long raker.

Description. Major counts and measurements are presented in Table 8. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded, its length 1.8–2.2 times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla not reaching to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw slightly pointed, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surface of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 23); all teeth similar in size. Preopercle lacking a spine, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus. A row of long and short rakers on first gill arch; long rakers, pointed or rounded distally, on upper and lower limbs and angle, but absent proximally; short rakers somewhat elongated but rounded distally, on proximal regions of upper and lower limbs (distal short raker ca. 1/2 to 3/4 length with adjacent long raker); minute spines over more or less prominent inner surface of both rakers plus dorsal and lateral surface of ca. 1/2 distal portion of short rakers. Two short pseudobranchial filaments. Anterior margin of anus below 21st–22nd dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Dorsal-fin origin above the posterior margin of preopercle. Anal-fin origin below 24th dorsal-fin

ray. Pectoral-fin level with eye. Pelvic-fin base anterior to a vertical through midpoint between posterior margins of maxilla and preopercle, close to ventral edge of body. Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Profile almost oval; a small process on anterior margin (Fig. 24); length to height ratio 1.6, length to thickness ratio 3.0; almost flat on medial aspect, except for undivided and centrally placed sulcus; ostial channel absent; lateral aspect expanded, smooth.

Coloration in alcohol. Head blackish-brown under light brownish membrane; trunk and tail light brown, except for darkish abdomen. All fins blackish-brown (e.g., pectoral fin shown in Fig. 3e). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known from bottom depths of 1,500–2,902 m on the eastern Indian Ridge and east of Taiwan (Nielsen and Merrett 2000; Lee et al. 2005; this study) (Fig. 9).

Remarks. The short gill rakers, with minute spines on the dorsal and lateral surfaces on the ca. distal half are easily distinguished from the long gill rakers (lacking minute spines) in *B. multispinis*. The somewhat elongated short gill rakers of *B. multispinis* are unique among the genus (being less than ca. 1/2 of the length of the adjacent long gill raker in other species).

V. 7. *Bassozetus nasus* Garman 1899

(Figs. 2, 4, 15, 25, 26; Tables 2, 9)

Bassozetus nasus Garman 1899 was originally described on the basis of 9 specimens from the Gulf of Panama, East Pacific Ocean. Subsequently, Nielsen and Merrett (2000) designated the lectotype (MCZ 28646). The species has been reported

only from the easternmost part of the East Pacific (Nielsen and Merrett 2000). However, distinctive characters among *B. nasus*, *B. glutinosus* and *B. normalis* currently remain unclear (see "Remarks" under "*Bassozetus glutinosus*").

Bassozetus nasus Garman 1899: 159, pls. 77 and 78 (original description; type locality: Gulf of Panama); Lendenfeld 1905: 197, pl. 4; Grey 1956: 209; Thiel 1992: 263, fig.; Nielsen and Merrett 2000: 38, fig. 13, 24, 25; Castellanos-Galindo et al. 2006: 197; Tomiyama et al. 2015: [7]; Tomiyama et al. 2016: [4]; Tomiyama et al. 2018: [7], fig. 6.

Bassozetus sp.: Cohen and Haedrich 1983: 375.

Specimens examined. Twenty four specimens, 133–277 mm SL. USNM 57852, paralectotype, ♂, 157 mm SL, off Mexico, 14°46′N, 98°40′W, 3,436 m, 10 April 1891, R/V *Albatross*, bottom trawl; ZMUC P771172–771174, three specimens, 2♂ and 1♀, 133–277 mm SL, Gulf of Panama, 5°49′N, 78°52′W, 3,270–3,670 m, 11 May 1952, R/V *Galathea*, herring otter trawl; ZMUC P771231–771239, 771241–771245, 771247, 771255–771259, 20 specimens, 12♂, 5♀ and 3?, 140–270 mm SL, Gulf of Panama, 9°23′N, 89°32′W, 3,570 m, 6 May 1952, R/V *Galathea*, herring otter trawl.

Diagnosis. Dorsal-fin rays 123–133, anal-fin rays 101–110, oblique scales ca. 25–35, abdominal vertebrae 13–15, total vertebrae 68–72, head length 17.0–19.5 % SL, pelvic-fin length 13.5–15.5 % SL, width to length ratio of vomer arm 16.9–27.1 %, predorsal length to body depth at anal-fin origin ratio 1.8–2.7 times, a single median basibranchial tooth patch, and sagittal otolith dorsal margin bulging posteriorly.

Description. Major counts and measurements are presented in Table 9. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded; its length 1.8–2.4 times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior

margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded or slightly pointed, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surface of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped (Fig. 26a); width to length ratio of vomer-arm 16.9–27.1 % (Fig. 4a); median basibranchial tooth patch single, elongated (Fig. 26b); teeth on vomer and palatine somewhat larger than those on both jaws. Preopercle lacking a spine, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 20–25th dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Predorsal length to body depth at anal-fin origin ratio 1.8–2.7 (Fig. 4b). Dorsal-fin origin above ca. anterior half of region between posterior margin of preopercle and pectoral-fin axil. Anal-fin origin below 21st–28th dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2 of tail, thereafter becoming similar or shorter length. Pectoral-fin just below the horizontal through eye or level with eye, not reaching a vertical through anterior margin of anus. Pelvic-fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; posterior tip of rays reaching posterior half of distance between pelvic-fin base to anus, but not extending beyond anus. Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Coloration in alcohol. Head blackish-brown under light brownish membrane; trunk, tail and all fins light brown. Oral cavity grayish-brown; gill and abdominal

cavities blackish-brown.

Distribution. Known from bottom depths of 2,068–3,670 m in the easternmost part of the East Pacific Ocean (Nielsen and Merrett 2000; this study) (Fig. 15).

Remarks. The sagittal otoliths were missing from all specimens of *B. nasus* examined in this study. However, Nielsen and Merrett (2000; fig. 25B) described the sagittal otolith morphology on the basis of at least 6 specimens (169–282 mm SL), as follows: small and robust; length to height ratio ca. 1.5, length to thickness ratio ca. 3–4; undivided sulcus present on medial aspect; ostial channel absent. In addition, the sagittal otolith dorsal margin of a paralectotype (MCZ 28648, 232 mm SL) was bulging posteriorly in the illustration shown by Nielsen and Merrett (2000, fig. 25B). Intraspecific variations were not indicated.

V. 8. *Bassozetus nielseni* Tomiyama, Takami and Fukui 2018

(Standard English name: Masked Assfish; Figs. 2, 3, 21, 27–30; Tables 2, 10)

Bassozetus nielseni Tomiyama, Takami and Fukui 2018 was originally described on the basis of 29 specimens from the North Atlantic and West Indian oceans. The species was confused with *B. compressus* (or its junior synonym, *B. elongatus*) by Nielsen and Merrett (2000), but was subsequently identified as undescribed species by Tomiyama et al. (2015).

Up to 200 ovarian eggs from each of 8 females, including the holotype (USNM 206928, 541 mm SL; BMNH 1991.7.9.41, 561 mm SL; BMNH 1991.7.9.734, 547 mm SL; BMNH 1994.5.6.3, 542 mm SL; BMNH 1999.4.23.1, 543 mm SL; two of VIMS 19530, 353–358 mm SL; one of VIMS 19531, 370 mm SL), were measured under a binocular stereo microscope equipped with an eyepiece micrometer. The Mann-Whitney *U*-test was performed using the software Bellcurve for Excel (Social Survey Research Information Co., Ltd.) for assessing the significance of male-female differences in morphological characters.

Bassozetus nielseni Tomiyama, Takami and Fukui 2018: [1], figs. 1–6 (original description; type locality: North Atlantic and West Indian oceans)

Bassozetus compressus (not of Günther 1878): In part, Nielsen and Merrett 2000: 21, fig. 10 (Atlantic Ocean).

Bassozetus elongatus (not of Smith and Radcliffe in Radcliffe 1913): In part, Nielsen and Merrett 2000: 25, fig. 13 (West Indian Ocean).

Specimens examined Twenty nine type specimens, 147–615 mm SL. USNM 206928*[1], holotype, ♀, 541 mm SL, Gulf of Mexico, 25°41′N, 91°2′W, 3,155–3,200 m, 25 July 1959, R/V *Oregon*, bottom trawl; BMNH 1990.8.21.141, two paratypes, ♂ and ♀, 520–540 mm SL, Tagus abyssal plain, off Spain, 37°9′N, 11°17′W, 5,112 m, 24 November 1983, R/V *Discovery*, bottom trawl; BMNH 1991.7.9.41, paratype, ♀, 561 mm SL, Goban Spur, southwest of Ireland, 49°33′N, 14°5.54′W, 4,242 m, 5 May 1981, R/V *Discovery*, bottom trawl; BMNH 1991.7.9.734, paratype, ♀, 547 mm SL, Collection data as for BMNH 1990.8.21.141; BMNH 1994.5.6.3, paratype, ♀, 542 mm SL, northwest of Madeira Islands, King's Trough Flank, 34°45.42′N, 18°30′W, 4,835 m, 10 June 1984, R/V *Discovery*, bottom trawl; BMNH 1994.5.6.4*[1], paratype, ♀, 517 mm SL, northwest of Cape Verde Island, 20°53.1′N, 31°13.8′W, 4,523 m, 4 October 1993, R/V *Discovery*, bottom trawl; BMNH 1994.5.6.5*[1], paratype, ♀, 615 mm SL, Collection data as for BMNH 1994.5.6.4; BMNH 1994.5.6.6*[1], paratype, ♂, 494 mm SL, northwest of Cape Verde Island, 20°55.58′N, 31°11.29′W, 4,555 m, 16 October 1993, R/V *Discovery*, bottom trawl; BMNH 1994.5.6.7, paratype, ♂, 505 mm SL, Collection data as for BMNH 1994.5.6.6; BMNH 1994.5.6.8, paratype, 459 mm SL, Monaco Basin, off southwest Madeira Island, 31°12.36′N, 25°12.30′W, 5,440 m, 3 July 1985, R/V *Discovery*, bottom trawl; BMNH 1994.5.9.6, paratype, 147 mm SL, off Spanish Sahara, eastern Central Atlantic, 20°58.40′N, 31°17.25′W, 4,570–4,625 m, 11 October 1993, R/V *Discovery*; BMNH 1994.5.9.10*[1], paratype, ♂, 163 mm SL, off Spanish Sahara, eastern Central Atlantic, 20°53.9′N, 31°13.51′W, 4,480–4,565 m, 4 October 1993, R/V *Discovery*; BMNH 1994.5.9.13, paratype, ♂, 555 mm SL, south of

Madeira, 31°4.3′N, 21°19.1′W, 4,950 m, 18 August 1990, R/V *Discovery*; BMNH 1999.4.23.1, paratype, ♀, 543 mm SL, northeast of Madeira Island, 35°36.6′N, 13°51.5′W, 4,835 m, 27 November 1995, R/V *Challenger*, bottom trawl; VIMS 6889*[1], paratype, 342 mm SL, Caribbean Sea, 15°8.8′N, 69°13.2′W, 3,959 m, 27 October 1981, R/V *Bartlett*, bottom trawl; VIMS 7054*[1], paratype, ♂, 298 mm SL, Bahamas, 23°50′N, 73°13′W, 5,263 m, 6 September 1980, R/V *Columbus Iselin*, bottom trawl; VIMS 19528*[1] (separated from VIMS 6884*[2]), paratype, ♂, 242 mm SL, Caribbean Sea, 14°34.1′N, 67°26.3′W, 5,011 m, 1 December 1981, R/V *Bartlett*, bottom trawl; VIMS 19529 (separated from VIMS 6884*[2]), paratype, 207 mm SL, Collection data as for VIMS 19528; VIMS 19530*[1] (separated from VIMS 6886*[2]), 6 paratypes, 3♂ and 3♀, 239–516 mm SL, Caribbean Sea, 15°8.9′N, 69°13.3′W, 4,012 m, 27 October 1981, R/V *Bartlett*, bottom trawl; VIMS 19531*[1] (separated from VIMS 6887, *Bassozetus normalis* Gill 1883), two paratypes, ♂ and ♀, 308–370 mm SL, Caribbean Sea, 13°26.3′N, 64°47.3′W, 3,576 m, 27 November 1981, R/V *Bartlett*, bottom trawl; VIMS 19532*[1] (separated from VIMS 7055*[2]), paratype, 494 mm SL, Bahamas, 26°9.3′N, 76°25.5′W, 4,538 m, 11 September 1980, R/V *Columbus Iselin*, bottom trawl; ZMUC P771213, paratype, 408 mm SL, off Kenya, 4°47′S, 46°19′E, 4,810 m, 11 March 1951, R/V *Galathea*, herring otter trawl.

*[1] indicates that the extracted sagittal otolith was examined in the present study. *[2] indicates specimens previously reported as *B. compressus* by Nielsen and Merrett (2000), but of presently undetermined taxonomic status due to poor condition.

Diagnosis. Dorsal-fin rays 122–129, long gill rakers 11–14, oblique scales 20–25, abdominal vertebrae 13–14, head length 18.1–21.3 % SL, predorsal length 16.4–20.1 % SL, tail length 62.7–68.0 % SL, posterior tip of pelvic-fin rays anterior to anus, a single median basibranchial tooth patch, and fins pale yellowish-brown (preserved condition).

Description. Major counts and measurements are presented in Table 10. The holotype description is given first, followed by those of paratypes in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head

covered by loose skin. Snout slightly expanded; its length 2.0 (1.7–2.9) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla slightly anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded (rounded or slightly pointed), not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 28); teeth on vomer and palatine somewhat larger than others. Preopercle lacking spines, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres, slightly behind a vertical through eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 21st (20–26th) dorsal-fin ray. Urogenital opening slightly posterior to anus; ovary exposed, projecting from abdominal cavity (not in other females). A small fleshy process located just behind urogenital opening. Dorsal-fin origin above midpoint between posterior margin of preopercle and pectoral-fin axil. Anal-fin origin below 24th (23rd–29th) dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/3 (1/3–1/2) of tail, thereafter becoming shorter (shorter or similar length). Pectoral fin level with eye, not reaching a vertical through anterior margin of anus; its bases slightly posterior to axil. Pelvic-fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; posterior tip of rays slightly anterior to anus (extending beyond at least anterior ca. 2/3 of distance between pelvic-fin base and anus, but not reaching to anus). Caudal fin very small, continuous via membrane with dorsal and

anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Profile almost oval; dorsal margin smooth, a wide process on anterior margin (process absent to wide; see "Remarks") (Fig. 29); length to height ratio 1.5 (1.1–1.6), length to thickness ratio 3.1 (1.9–3.4); almost flat on medial aspect, except for sulcus and ostial channel; sulcus distinctly dimpled, undivided centrally; ostial channel indistinct, extending anteriorly. Lateral aspect expanded, smooth.

Coloration in alcohol. Head blackish-brown under pale yellowish-brown membrane; trunk, tail and all fins pale yellowish-brown (e.g., pectoral fin shown in Fig. 3a). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. A bottom-dwelling species in abyssal depths (3,155–5,440 m) in the North Atlantic and West Indian oceans (Fig. 21).

Reproductive note and sexual dimorphism. The maximum diameter of ovarian eggs was 0.06 mm in three specimens less than 400 mm SL, but between 0.3 and 0.6 mm in five specimens over 541 mm SL (0.4 mm in the holotype). Males and females over 500 mm SL differed significantly from each other in head (18.1–18.9 % SL in males, >505 mm SL vs. 19.0– 21.2 % SL in females, >517 mm SL; $n = 9$, $P < 0.05$), upper jaw (9.0–9.4 vs. 9.8–10.7; $n = 10$, $P < 0.05$) and predorsal (16.4–17.5 % SL vs. 17.6–19.8 % SL; $n = 12$, $P < 0.01$) lengths, greatest body depth (12.1–13.8 % SL vs. 14.0–17.1 % SL; $n = 12$, $P < 0.01$) and body depth at anal-fin origin (10.8–12.0 % SL vs. 11.9–14.6 % SL; $n = 12$, $P < 0.05$) (all are not differing significantly in less than 500 mm SL; $n = 11$, $P = 0.131–0.571$) as shown in Fig. 30a, b, c, d and e. In addition, tail length tended to be greater in males (63.8–67.4 % SL vs. 63.0–65.1 % SL) (Fig. 30f), although not differing significantly ($n = 12$, $P = 0.089$).

Remarks. The head, upper jaw and predorsal lengths, greatest body depth and body depth at anal-fin origin of *B. nielseni* were significantly greater in ripe females > 500 mm SL compared with similarly-sized males, although tail lengths of the females were generally shorter. Such external sexual dimorphism has not been reported in other species of *Bassozetus*.

The process on the sagittal otolith anterior margin varied in *B. nielseni*, being

wide in the holotype (541 mm SL) and seven paratypes (342–517 mm SL: e.g., BMNH 1994.5.6.4) from the northwest and northeast Atlantic, reduced in six paratypes (239–433 mm SL; e.g., VIMS 7054) from the northwest Atlantic, and not evident in three paratypes (163–615 mm SL: e.g., BMNH 1994.5.6.6) from the northeast Atlantic (otoliths missing in the remaining 12 specimens). Such variations may represent intraspecific differences (but not geographic variation) or possibly resulted from the effects of formalin fixation, there being no other significant morphological variations.

The specific name "*nielseni*" was given in honor of Dr. Jørgen G. Nielsen, Associate Professor Emeritus, University of Copenhagen, in recognition of his excellent work on the taxonomy of ophidiid fishes, including the genus *Bassozetus* (see Tomiyama et al. 2018).

V. 9. *Bassozetus normalis* Gill 1883

(Figs. 2, 4, 15, 31–33; Tables 2, 11)

Bassozetus normalis Gill 1883, the type species of the genus, was originally described on the basis of a single specimen from the Northwest Atlantic Ocean. The species has been reported only from the Atlantic Ocean (Nielsen and Merrett 2000). Distinctive characters among *B. normalis*, *B. glutinosus* and *B. nasus* currently remain unclear (see "Remarks" under "*Bassozetus glutinosus*").

Bassozetus normalis Gill 1883: 211 (original description; type locality: northwestern Atlantic); Goode and Bean 1896: 322, fig. 287; Jordan and Evermann 1898: 2507; Grey 1956: 208; Anderson et al. 1985; Nielsen et al. 1999: 58; Nielsen and Merrett 2000: 40, figs. 18, 26, 27; Nielsen and Robins 2003: 968; Moore et al. 2003: 206; McEachran and Fechhelm 2005:17; Garrido-Linares and Acero 2006: 294, Tomiyama et al. 2015: [7]; Tomiyama et al. 2016:[4]; Nielsen 2016:1950; Tomiyama et al. 2018:[7], fig. 6.

Bassozetus compressus (not of Günther 1878): In part, Nielsen and Merrett 2000: 21, fig. 10.

Specimens examined. Twenty-one specimens, 103–242 mm SL. BMNH 1991.7.9.827–829*[1], three specimens, 2♂ and 1♀, 206[+]–222[+] mm SL, Cape Verde Plateau, off northwestern Africa, 17°1.53′N, 21°58.22′W, 25 September 1990; BMNH 1999.8.4.11, two specimens, ♂ and ?, 216–242 mm SL, Cape Verde Plateau, off northwestern Africa, 20°50.6′N, 18°55.3′W, 3,875 m, 18 November 1976, R/V *Discovery*, bottom trawl; UF 221734 (formerly UMML 21734), 210 mm SL, off San Thomé, 1°13′N, 7°46′E, 2,525 m, 17 May 1965, R/V *Discovery*, bottom trawl; USNM 206918, two specimens, ♂ and ♀, 150–168 mm, Gulf of Mexico, 25°21′N, 91°2′W, 1,725–1,750 m, 25 July 1959, R/V *Oregon*, bottom trawl; USNM 206921, ♂, 139 mm SL, Collection data as for USNM 206918; USNM 206939, three specimens, 2♀ and 1?, 104–188 mm SL, Gulf of Mexico, 27°6′N, 89°13′W, 2,195 m, 29 July 1959, R/V *Oregon*, bottom trawl; USNM 39416, ♂, 241 mm SL, Gulf of Mexico, 28°2.30′N, 87°43.45′W, 2,617 m, 2 March 1885, R/V *Albatross*, bottom trawl; VIMS 6887, ♂, 141 mm SL, Caribbean Sea, 13°26.6′N, 64°47.3′W, 3,477 m, 29 November 1981, R/V *Bartlett*, bottom trawl; VIMS 6893 [formerly identified as *B. compressus* by Nielsen and Merrett (2000)], 103 mm SL, Caribbean Sea, 13°26.9′N, 64°42.7′W, 3,437 m, 26 November 1981, R/V *Bartlett*, bottom trawl; ZMUC-P771262–771264, three specimens, 2♂ and 1♀, 204–221 mm SL, off San Thomé, 1°42′N, 7°51′E, 2,620 m, 30 November 1950, R/V *Galathea*, bottom trawl; ZMUC-P771266–771268, three specimens, 1♂, 1♀ and 1?, 159–188 mm SL, off Loanda, 8°40′S, 11°10′E, 2,710 m, 11 December 1950, R/V *Galathea*, bottom trawl.

*[1] indicates that the extracted sagittal otoliths of BMNH 1991.7.9.827–829 were examined in the present study.

Diagnosis. Dorsal-fin rays 121–132, anal-fin rays 99–108, oblique scales ca. 25–35, abdominal vertebrae 13–15, total vertebrae 67–71, head length 16.5–20.5 % SL, predorsal length 15.0–18.5 % SL, pelvic-fin length 14.5–19.0 % SL, width to length ratio of vomer arm 16.2–30.2 %, predorsal length to body depth at anal-fin origin ratio

1.5–2.2 times, a single median basibranchial tooth patch, and sagittal otolith dorsal margin smooth or slightly bulging anteriorly (Nielsen and Merrett 2000; this study).

Description. Major counts and measurements are presented in Table 11. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded; its length 1.7–2.3 times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surface of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped (Fig. 32a); width to length ratio of vomer-arm 16.2–30.2 % (Fig. 4a); median basibranchial tooth patch single, elongated (Fig. 32b); teeth on vomer and palatine somewhat larger than those on both jaws. Preopercle lacking a spine, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 20–24th dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Predorsal length to body depth at anal-fin origin ratio 1.5–2.2 (Fig. 4b). Dorsal-fin origin above the posterior margin of preopercle. Anal-fin origin below 24–27th dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2–2/3 of tail, thereafter becoming similar length. Pectoral-fin at level with eye or just below the horizontal through eye, not reaching a vertical through anterior margin of anus.

Pelvic-fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; posterior tip of rays reaching posterior half of distance between pelvic-fin base to anus, but not extending beyond anus. Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Profile almost oval, dorsal margin smooth (BMNH 1991.7.9.828 and 829, 206^{+}–222^{+} mm SL, caudal tip missing) or bulging anteriorly (BMNH 1991.7.9.827, 244^{+} mm SL, caudal tip missing), a small process absent on anterior margin (Fig. 33); length to height ratio 1.4–1.5, length to thickness ratio 2.9–3.8; almost flat on medial aspect, except for sulcus which is distinctly dimpled and undivided centrally; ostial channel absent; lateral aspect expanded, smooth.

Coloration in alcohol. Head blackish-brown under light brownish membrane; trunk, tail and all fins light brown. Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. A bottom-dwelling species known from depths of 1,725–3,875 m and 5,062 m in the Atlantic Ocean (Nielsen and Merrett 2000; this study) (Fig. 15).

Remarks. The sagittal otolith dorsal margin of the holotype of *B. normalis* (276 mm SL) is smooth in the illustration given by Nielsen and Merrett (2000, fig. 27B). Among three *B. normalis* observed in the present study, two (206^{+}–222^{+} mm SL) had a similar sagittal otolith dorsal margin, the remaining specimen (244^{+} mm SL) having the dorsal margin bulging anteriorly. Such variations may represent intraspecific differences (but not size-related), there being no other significant morphological variations.

A specimen (VIMS 6893, 103 mm SL) reported as *B. compressus* from the Atlantic Ocean by Nielsen and Merrett (2000) was, in fact, *B. normalis*, being characterized by 34 oblique scales (ca. 25–35 in *B. normalis* vs. 18–20 in *B. compressus*), other counts of the two species overlapping [e.g., 125 dorsal-fin rays (121–132 in *B. normalis* and 118–127 in *B. compressus*), 104 anal-fin rays (99–108 and 102–107) and 16 long gill rakers (13–20 and 11–16)].

V. 10. *Bassozetus robustus* Smith and Radcliffe in Radcliffe 1913

(Standard English name: Robust assfish; standard Japanese name: Ishi-fukumen-itachiuo; Figs. 2, 3, 9, 34–39; Tables 2, 12)

Bassozetus robustus Smith and Radcliffe in Radcriffe (2013) was originally described on the basis of a single specimen from the Philippines, West Pacific Ocean. Subsequently, several authors reported the species from the Indo-West Pacific and West Atlantic oceans (e.g., Shcherbachev 1980; Nielsen and Merrett 2000; Mincarone et al. 2008; Takami et al. 2011). However, the present study revealed that the morphology of the West Pacific specimens, including the holotype, differed from that of the West Atlantic specimens (see "Remarks"). The following description is based on West Pacific specimens only (see "Remarks" for West Atlantic specimen data). Takami et al. (2011) noted the first record of *B. robustus* from Japanese waters, and proposed the new standard Japanese name, "Ishi-fukumen-itachiuo".

Bassozetus robustus Smith and Radcliffe in Radcliffe 1913: 156, pl. 11, fig. 3 (original description; type locality: Palawan Passage); de Beaufort and Chapman 1951: 432, fig. 75; Shcherbachev 1980: 122, figs. 12, 13; Nielsen and Cohen 1986: 345; Nielsen 1997: 57, fig. 6; McEachran and Fechhelm 1998:709; Nielsen 1999:1980; Nielsen et al. 1999: 58, fig. 52; Nielsen 2000:596; Nielsen and Merrett 2000: 43, figs. 21, 31, 32; Nielsen and Robins 2003: 968; Prokofiev 2005:113; Yeh et al. 2005: 286, fig. 1, pl. 1D; Hoese et al. 2006: 557; Mincarone et al. 2008: 50, fig. 3D; Fricke et al. 2011:366; Takami et al. 2011: 177, figs. 1, 2; Nakabo and Kai 2013: 1878; Tomiyama et al. 2015: [8]; Tomiyama et al. 2016: [4]; Tomiyama et al. 2018: [8], figs. 4e, 6d.

Bassozetus compressus (not of Günther 1878): Yeh et al. 2005: 284, fig. 1, pl. 1B.

Specimens examined. Nine specimens, 84–525 mm SL: USNM 74140[*1],

holotype, ♀, 323 mm SL, Palawan Passage, 10°54′N, 118°26.20′E, 1,335 m, 27 December 1908, R/V *Albatross*, bottom trawl; ASIZP 63832[*1], 226 mm SL, off Su-ao, Taiwan, 24°25.43′N, 122°12.40′E–24°20.80′N, 122°15.26′E, 1,134–1,188 m, 12 September 2002, R/V *Ocean Researcher I*, otter trawl; BSKU 49476[*1], 49477, 49479, 49555[*1], four specimens, 3♂ and 1♀, 232–438 mm SL, Hyuga-nada Basin, Japan, 32°18.5′N, 132°10.9′E–32°16.2′N, 132°11.2′E, 1,453–1,481 m, 3 April 1991, R/V *Shinkai-maru*, bottom trawl; BSKU 57826[*1], ♀, 525 mm SL, Okinawa Trough, 26°31.548′N, 127°4.923′E–26°27.935′N, 127°2.656′E, ca. 1,900 m, 17 April 2002, R/V *Tansei-maru*, beam trawl; MSM-10-445[*1], 85 mm SL, Suruga Bay, 34°41.9'N, 138°38.0'E, 20 October 2009, R/V *Bōsei-maru*, IKMT (extended to substrate); NSMT-P 100021[*1], 342 mm SL, Ryukyu Trench, 26°19.5'N, 128°21.2'E, 1,338–1,396 m, 24 May 2005, R/V *Hakuhō-maru*, Bottom trawl.

*[1] indicates that the sagittal otolith was examined in the present study (radiographs of the holotype, and extracted otolith in other specimens).

Diagnosis. Dorsal-fin rays 115–123, anal-fin rays 96–101, oblique scales 28–36, total vertebrae 64–68, head length 20.5–22.8 % SL, pelvic-fin length 14.0–18.3 % SL, a single median basibranchial tooth patch, and sagittal otolith with 1–2 deep indentations on dorsal margin (over 226 mm SL specimen).

Description. Major counts and measurements are presented in Table 12. The holotype description is given first, followed by those of others in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded; its length 3.0 (2.2–4.0) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla slightly anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw slightly pointed; protruding beyond upper jaw when mouth closed (not protruding in 85 mm SL specimen). Tooth patches comprising small conical teeth on premaxilla, dentary, vomer,

palatine and basibranchial; presence or absence of tooth patches on pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis are not observed (both present in the others); vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 35); teeth on vomer and palatine equal or somewhat larger in size than those on basibranchial and both jaws. Preopercle lacking spines, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 21st (20–25th) dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening (indistinct in 84 mm SL specimen). Dorsal-fin origin slightly anterior to the pectoral-fin axil (slightly anterior or just above the pectoral-fin axil). Anal-fin origin below 24th (24–29th) dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 2/3 (1/3–1/2) of tail, thereafter becoming similar length (shorter or similar). Pectoral fin level with eye (level with eye or just below it), not reaching to a vertical through anterior margin of anus; its bases slightly posterior to axil. Pelvic-fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; posterior tip of rays broken (extending beyond at least anterior ca. 2/3 of distance between pelvic-fin base and anus, but not reaching to anus in 226–525 mm SL specimens; slightly beyond anus in 84 mm SL specimen). Caudal fin very small, continuous via membrane with dorsal and anal fins. Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Profile almost oval, except for one deep indentation on dorsal margin (one or two indentations in 226–525 mm SL specimens; slightly undulating profile in 84 mm SL specimen) (Fig. 36); anterior margin slightly pointed (pointed or

rounded in 226–525 mm SL specimens; rounded in 84 mm SL specimen), ventral and posterior margins rounded. Length to height ratio ca. 1.8 (1.7–2.5 in 342–525 mm SL specimens; 1.4 in 84 mm SL specimen), length to thickness ratio not observed (5.9–7.0 in 342–525 mm SL specimens; 3.3 in 84 mm SL specimen). Medial and lateral aspects not observed (former almost flat, except for sulcus and ostial channel; sulcus distinctly dimpled, undivided centrally; ostial channel indistinct, extended anteriorly. Lateral aspect smooth, not expanded in 226–525 mm SL specimens but slightly expanded in 84 mm SL specimen). Relationship between SL and sagittal otolith length expressed as SL (mm) = 25.964 × sagittal otolith length (mm) + 52.616 (R^2 = 0.943, *n* = 5) (Fig. 37).

Coloration when fresh. Not observed in the holotype [head black under pale gray membrane; trunk and tail pale gray, except for abdomen and pectoral-fin base being black. Scale pocket edges on head and body gray. All fins pale gray (based on photograph of MSM-10-445, 84 mm SL, taken just after collection)].

Coloration in alcohol. Holotype discolored. Head blackish-brown under pale yellowish-brown membrane; trunk and tail pale yellowish-brown (slightly darkish on abdomen). Pectoral, pelvic and caudal fins light brown (blackish-brown or brown) (e.g., pectoral fin shown in Fig. 3f); dorsal and anal fins pale yellowish-brown, except for light brownish margins (margins blackish-brown or brown). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. Known from the West Pacific Ocean (Fig. 9). Except for two specimens collected from ca. 0–2,500 m depth high in the water column, all West Pacific specimens were collected from the bottom at depths of 809–4,420 m (Nielsen and Merrett 2000; Yeh et al. 2005; Takami et al. 2011; this study).

Remarks. *Bassozetus robustus* has been previously reported from the Indo-West Pacific and West Atlantic oceans (e.g., Shcherbachev 1980; Nielsen and Merrett 2000; Mincarone et al. 2008; Takami et al. 2011). However, the present study revealed that 9 West Pacific specimens, including the holotype (85–525 mm SL), differed from 12 West Atlantic specimens (89–412 mm SL) (Fig. 38) as follows: oblique scales 30–36 in the West Pacific vs. 39–45 in the West Atlantic; tip of lower

jaw slightly protruding beyond upper jaw when mouth closed (except for 85 mm SL specimen, not protruding) vs. not protruding. Additionally, head length and greatest body depth of the West Pacific specimens tended to be greater than those of equally-sized West Atlantic specimens (Fig. 39), suggesting that the latter represent an undescribed species. Indian Ocean specimens, previously reported as *B. robustus* were not available for this study.

Sagittal otolith morphology changed with growth, with transformation completed at least before attaining 226 mm SL, based on the differences between small (dorsal margin slightly undulating at 85 mm SL) and large (dorsal margin with 1–2 deep indentations at 226–525 mm SL) specimens.

Although two West Pacific specimens (138 and 413 mm SL) were collected high in the water column (Nielsen and Merrett 2000), others collected from the bottom (*n* = 35, 85–640 mm SL) (Smith and Radcliffe in Radcliffe 1913; Nielsen 1997; Nielsen and Merrett 2000; Yeh et al. 2005; Takami et al. 2011; this study) clearly demonstrated the benthopelagic habit of *B. robustus*.

Comparative material. *Bassozetus* sp. (similar to *B. robustus*) (12 specimens, 89–412 mm SL): UF 113525, three specimens, 282–412 mm SL, Andros Island, Bahama Islands, 23°48.29′N, 77°2.59′W, 1,355–1,360 m, 4 February 1974; UF114997, 6 specimens, 89–395 mm SL, Andros Island, Bahama Islands, 23°35.30′N, 77°3.45′W, 1,350–1,360 m, 9 March 1976; UF 134455, three specimens, 316–406 mm SL, Bahama Islands, 23°39.15′N, 76°46.23′W, 1,324 m, 8 April 1975.

V. 11. *Bassozetus taenia* (Günther 1887)

(Figs. 2, 21, 40–42; Tables 2, 13)

Bassozetus taenia (Günther 1887), originally described as *Bathyonus taenia* on the basis of a single specimen from the Mid-Atlantic Ocean, was subsequently transferred to the genus *Bassozetus* by Goode and Bean (1896). *Bassozetus taenia* has

been reported only from the North Atlantic Ocean (e.g., Nielsen and Merrett 2000).

Bathyonus taenia Günther 1887: 110, pl. 23, fig. A (original description; type locality: tropical Atlantic, 2°25'N, 20°1'W).

Bassozetus taenia: Goode and Bean 1896: 323; Jordan and Evermann 1898: 2510; Roule1935: 6; Fowler 1936: 1062, fig. 441; Nybelin 1953: 3; Nybelin 1957: 284; Nielsen 1975: 1; Shcherbachev 1980: 120, fig. 13; Hureau and Nielsen 1981: 7; Nielsen 1990: 565; Nielsen et al. 1999: 58; Nielsen and Merrett 2000: 8, figs 30, 33–35; Nielsen and Robins 2003: 968; Garrido-Linares and Acero 2006: 294; Tomiyama et al. 2015: [7]; Nielsen 2016: 1949; Vieira et al. 2016: [6], fig.3f; Tomiyama et al. 2016: [4]; Tomiyama et al. 2018: [8], fig. 6.

Bassozetus sp.: Nybelin 1951: 15.

Bassozetus sp. B: Anderson et al. 1985: 799 (in part).

Specimens examined. 14 specimens, 89–237 mm SL. BMNH 1887.12.7.51, holotype, ♀, 237 mm SL, Atlantic Ocean, 2°25′N, 20°1′W, 4,575 m, 23 August 1873, R/V *Challenger*, bottom trawl; BMNH 1995.1.12.1, ♀, 229 mm SL, northeast Atlantic, 30°12.8′N, 25°18.3′W, 5,440 m, 2 July 1985, R/V *Discoverly*, bottom trawl; MNHN 1979-233, ♂, 211 mm SL, Atlantic Ocean, 10°58.3′N, 45°14.3′W, 5,100 m, 13 November 1977, *Biovema*, bottom trawl; MNHN 1979-234–237, four specimens, 2♀, 1♂ and 1?, 89–182 mm SL, Atlantic Ocean, 10°59′N, 45°15′W, 5,073 m, 14 November 1977, *Biovema*, bottom trawl; MNHN 1992-1224, ♂, 203 mm SL (one of two specimens in one lot), Atlantic Ocean, 10°24′N, 46°47′W, 4,850 m, 23 September 1980, R/V *Jean Charcot*, bottom trawl; MNHN 1992-1226, ♂, 219 mm SL, Atlantic Ocean, 10°21′N, 46°48′W, 4,450 m, 26 September 1980, R/V *Jean Charcot*, bottom trawl; MNHN 1992-1227, 112 mm SL (one of three specimens in one lot), Atlantic Ocean, 10°24′N, 46°45′W, 4,850 m, 27 September 1980, R/V *Jean Charcot*, bottom trawl; MNHN 1992-1228, ♀, 136 mm SL (one of two specimens in one lot), Atlantic Ocean, 10°24′N, 46°46′W, 4,850 m, 28 September 1980, R/V *Jean Charcot*, bottom trawl; MNHN 1992-1229, ♂, 186 mm SL (one of three specimens in one lot), 10°24′N,

46°46′W, 4,850 m, 29 September 1980, R/V *Jean Charcot*, bottom trawl; UF 228470 [formerly UMML 28470 identified as *B. normalis* by Nielsen and Merrett (2000)], 156 mm SL, Caribbean Sea, 19°14′N, 73°14′W, 1,760 m, 30 Jun 1970, R/V *Pillsbury*, bottom trawl; VIMS 7066*[1], ♂, 166 mm SL (one of three specimens in one lot), 24°14.2′N, 76°6.5′W, 1,783 m, 2 September 1980, R/V *Jean Columbus Iselin*, bottom trawl.

*[1] indicates that the extracted sagittal otolith was examined in the present study.

Diagnosis. Oblique scales 17–22, abdominal vertebrae 12–15, head length 15.0–19.5 % SL, distance between pelvic fin to anal-fin 15.0–20.2 % SL, a single median basibranchial tooth patch, and sagittal otolith with anteriorly bulging dorsal margin and a small process absent on anterior margin.

Description. Major counts and measurements are presented in Table 13. The holotype description is given first, followed by those of paratypes in parentheses when different. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded, its length 2.9 (2.0–3.7) times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye slightly horizontally elongate. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw rounded, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, vomer, palatine, basibranchial, pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped; median basibranchial tooth patch single, elongated (Fig. 41); teeth on vomer and palatine somewhat larger than those of both jaws. Preopercle lacking spines, posteriorly enlarged, almost reaching hind margin of opercle. Opercle thin, soft, with a weak sub-epidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally below eye with antimeres, detached from isthmus. A row of long and short rakers arranged on first gill arch; long rakers with minute spines on

inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spines over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 19th (19–24th) dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Dorsal-fin origin above posterior margin of preopercle. Anal-fin origin below 22nd (22nd–26th) dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 2/3 of tail, thereafter becoming similar. Pectoral-fin just below a horizontal through eye; its bases slightly posterior to axil; rays broken. Pelvic-fin bases slightly anterior to a vertical through posterior margin of preopercle, close to ventral edge of body; rays broken (posterior tip of rays extending beyond anterior ca. 3/4 of distance between pelvic-fin base to anal-fin origin, but not reaching to anus). Caudal-fin base very narrow; distal part of rays broken in all (caudal-fin rays continuous via membrane with dorsal and anal fins). Deciduous cycloid scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Sagittal otolith. Sagittal otolith missing in holotype [profile almost oval except for dorsal margin bulging anteriorly (Fig. 42); length to height ratio 1.3, length to thickness ratio 2.8; almost flat on medial aspect, except for sulcus and ostial channel; sulcus distinctly dimpled, undivided centrally; ostial channel indistinct, extending anteriorly. Lateral aspect expanded, smooth].

Coloration in alcohol. Head, trunk and tail uniformly pale yellowish-brown (head blackish-brown under pale yellowish-brown membrane; abdomen darkish). All fins pale yellowish-brown (pectoral fin slightly darkish). Oral cavity grayish-brown; gill and abdominal cavities blackish-brown.

Distribution. A bottom-dwelling species, collected from depths of 1,760–2,047 m in Exuma Sound (off Bahamas) and the Caribbean Sea, and 4,450–5,605 m in the North Atlantic Ocean between ca. 20–52°W (Nielsen and Merrett 2000; Vieira et al. 2016; this study) (Fig. 21).

Remarks. Tomiyama et al. (2015) distinguished *B. taenia* from *B. compressus* on the basis of two characters, following Nielsen and Merrett (2000), viz. snout length

to eye diameter ratio (3–5 in *B. taenia* vs. 2.0–2.7 in *B. compressus*) and sagittal otolith morphology (a small process absent on anterior margin, dorsal margin bulging anteriorly vs. a small process present, dorsal margin smooth). However, the snout length to eye diameter ratio is invalid as a distinguishing character due to recently-determined values for *B. taenia* (2.0–3.7, present study) overlapping those of *B. compressus*. On the other hand, the present study revealed that *B. taenia* is separable from equally-sized *B. compressus* by the shorter head length in the former (e.g., 16.5–18.6 % SL, 136–211 mm SL vs. 19.5–20.6 % SL, 169–216 mm SL) (Fig. 2a).

V. 12. *Bassozetus zenkevitchi* Rass 1955

(Standard Japanese name; Fukumen-itachiuo; Figs. 9, 43, 44; Table 14)

Bassozetus zenkevitchi Rass 1955 was originally described on the basis of a single specimen collected off the Kurile Islands, west North Pacific Ocean, which was subsequently lost (Nielsen and Merrett 2000). Machida and Tachibana (1986) noted the second record of the species following the collection of three specimens from Japanese waters, and proposed the new standard Japanese name "Fukumen-itachiuo". To date, *B. zenkevitchi* has been reported from the Okhotsk Sea, the Bering Sea, and the North Pacific Ocean between Japan and Hawaii (e.g., Machida and Tachibana 1986; Nielsen and Merrett 2000; Orr et al. 2005).

Bassozetus zenkevitchi Rass 1955: 333, fig. 5 (original description; type locality: Kuril-Kamchatka trench, off Iturup Island, Kuril Islands); Machida and Tachibana 1986: 437, fig. 1, 2; Machida 1989: 189; Nielsen et al. 1999: 58; Nielsen and Merrett 2000: 52, figs 13, 38, 39; Nakabo 2000: 442; Sheiko and Fedorov 2000: 23; Mundy 2005: 242; Orr et al. 2005: 66, fig. 1, 2; Shinohara et al. 2005: 413; Fujii et al. 2010: 512; Nakabo and Kai 2013: 521; Parin et al. 2014: 183; Tomiyama et al. 2015: [8]; Tomiyama et al. 2016: [4]; Tomiyama et al.

2018: [6].

Specimens examined. Four specimens, 178–259 mm SL. BSKU 19548, 178 mm SL, ♀, off Torishima Island, near Izu-Ogasawara Trench, 30°51.5′N, 140°45.5′E, 2,470 m, 5 December 1964, R/V *Soyo-maru*, beam trawl; BSKU 19941, 256 mm SL, ♀, off Torishima Island, near Izu-Ogasawara Trench, 30°37.0′N, 141°40.5′E, 2,140 m, 3 July 1968, R/V *Soyo-maru*, beam trawl; BSKU 76792, 219 mm SL, ♀, South-southeast of Cape Muroto, Kochi prefecture, Japan, 32°20.8′N, 134°6.6′E–32°16.4′N, 134°15.5′E, 1,738–2,017 m, 15 November 2005, R/V *Tansei-maru*, beam trawl; USNM 149783, 259 mm SL, ♀, Pacific Ocean, off Japan, 34°00′N, 137°49.40′E, 0–1,679 m, 20 October 1906, R/V *Albatross*, Agassiz trawl.

Diagnosis. Dorsal-fin rays 113–120, anal-fin rays 92–101, long gill rakers 15–18, total vertebrae 63–66, pelvic-fin length 5.7–8.8 % SL, vomerine tooth patch V-shaped, and basibranchial tooth patch usually absent.

Description. Major counts and measurements are presented in Table 14. Body elongate, compressed; body depth and width greatest just behind posterior margin of opercle, gradually decreasing, becoming thin at tail tip. Head covered by loose skin. Snout slightly expanded, its length 1.8–2.4 times eye diameter. Two nostrils rounded; anterior nostril near tip of snout; posterior nostril slightly larger, at ca. midpoint between anterior nostril and eye. Eye rounded. Mouth large; posterior margin of maxilla anterior to a vertical through midpoint between posterior margins of eye and preopercle; dorsal margin of maxilla sheathed by skin on cheek; tip of lower jaw slightly pointed, not protruding beyond upper jaw when mouth closed. Tooth patches comprising small conical teeth on premaxilla, dentary, palatine, pharyngobranchial and inner surfaces of 2nd and 3rd upper-limb basis; vomerine tooth patch extending toward tip of upper jaw, V-shaped (Fig. 44). Basibranchial edentate, except for BSKU 19941 with a rudiment tooth patch at ca. midpoint on the right side of basibranchial. Preopercle lacking spine, posteriorly enlarged and almost reaching hind margin of opercle. Opercle thin, soft, with a weak subepidermal posterodorsal spine. Gill slit wide; gill membranes fused ventrally with antimeres below eye, detached from isthmus.

A row of long and short rakers arranged on first gill arch; long rakers with minute spins on inner surface, pointed distally, on upper and lower limbs and angle, but absent proximally; short rakers with minute spins over entire surface, rounded distally, on proximal regions of upper and lower limbs. Two short pseudobranchial filaments. Anterior margin of anus below 20th–22nd dorsal-fin ray. Urogenital opening slightly posterior to anus. A small fleshy process located just behind urogenital opening. Dorsal-fin origin slightly anterior to a vertical through posterior margin of opercle. Anal-fin origin below 22nd–25th dorsal-fin ray. Dorsal-fin rays longer than opposite anal-fin rays on anterior ca. 1/2–2/3 of tail, thereafter of similar length. Pectoral-fin at level with eye, not reaching to a vertical through anterior margin of anus. Pelvic-fin bases slightly posterior to a vertical through midpoint between posterior margins of maxilla and preopercle, close to ventral edge of body; posterior tip of rays extending beyond anterior ca. 1/3 of distance between pelvic-fin base and anus. Caudal fin very narrow, continuous via membrane with both dorsal and anal fins. Deciduous scales or scale pockets on head and body; both jaws and gill membranes naked. Lateral line absent.

Coloration in alcohol. Head blackish-brown; trunk and tail light brown with blackish edged scale pockets. All fins blackish-brown. Oral cavity blackish-gray; gill and abdominal cavities blackish-brown.

Distribution. Known from the Okhotsk Sea, the Bering Sea and the North Pacific Ocean between Japan and Hawaii (e.g., Rass 1955; Machida and Tachibana 1986; Nielsen and Merrett 2000; Orr et al. 2005; Shinohara et al. 2005; this study) (Fig. 9). Specimens have been more frequently caught by (non-closing) pelagic gear towed between the surface and 6,930 m depth (9 stations), than by bottom trawls between 1,493–2,470 m (6 stations) (Rass 1955; Machida and Tachibana 1986; Nielsen and Merrett 2000; Shinohara et al. 2005; Orr et al. 2005; this study).

Remarks. *Bassozetus zenkevitchi* usually lacks a basibranchial tooth patch (Nielsen and Merrett 2000), although a rudimentary tooth patch occasionally persists at about the midpoint (right side) of the element (Machida and Tachibana 1986; this study).

The sagittal otolith of *B. zenkevitchi* could not be examined in this study. However, Nielsen and Merrett (2000; fig. 39B) described the sagittal otolith morphology on the basis of at least 10 specimens (57–263 mm SL) as follows: small and robust; profile elongate with even rim; length to height ratio ca. 2 and length to thickness ratio ca. 3; an undivided sulcus present; ostial channel absent.

VI. General considerations

The present study recognized 14 valid species of *Bassozetus*, *B. compressus* being redescribed as a senior synonym of *B. elongatus* (see Tomiyama et al. 2015), and *B. mozambiquensis* and *B. nielseni* being newly described by Tomiyama et al. (2016, 2018). The study also includes redescriptions of 9 established species, except for *B. oncerocephalus* and *B. werneri* (known only from holotypes, which were unavailable) and updated their diagnoses. Both of the latter species were treated as valid due to their morphology, described in Nielsen and Merrett (2000), clearly differing from the remaining 12 species. As a result of the study, each species diagnosis became clear, enabling reliable identification. The key to *Bassozetus* species presented here was based on meristic and morphological characters, including number of dorsal- and anal-fin rays, long gill rakers, vertebrae and oblique scales, head and pelvic fin lengths, and the absence or presence of a basibranchial tooth patch. Interspecific overlapping morphological characters are supplemented by detailed explanations. Although individual *Bassozetus* species may have unique sagittal otolith morphology, valuable for specific identification, such was considered as secondary due to breakdown of the otolith following prolonged preservation in formalin, not to mention the frequent loss of otoliths from the limited number of museum-curated specimens. Nielsen and Merrett (2000) distinguished *B. glutinosus*, *B. nasus* and *B. normalis* primarily from a multivariate analysis of anal-fin ray, pectoral-fin ray and long gill raker numbers, deriving two expressions for plotting individual specimens on a scatter graph of the analysis. However, coordinates fitting the graph could not be obtained from those expressions. The present study revealed that the three species were, in fact, easily separable from each other by the width to length ratio of the vomer arm, and predorsal length to body depth at anal-fin origin ratio.

The taxonomic confusion between *B. compressus* and *B. elongatus* were resolved in this study. Both species occur in the Indo-West Pacific, the range of the former extending to the Atlantic (Nielsen and Merrett 2000; Nielsen and Møller 2008). According to Nielsen and Merrett (2000), the two species differ from each other in

pelvic-fin length (12.0–17.5 % SL in *B. compressus* vs. 18.0–25.0 % SL in *B. elongatus*) and the position of a small process on the sagittal otolith (posterior margin vs. anterior margin). Examination of 12 West Pacific specimens, including the lectotype of *B. compressus* and holotype of *B. elongatus*, showed that the above-mentioned diagnostic characters are invalid, and that the differences in pelvic-fin length and sagittal otolith morphology were actually due to an error in the description. Therefore, *B. compressus* and *B. elongatus* are conspecific, the former being the senior synonym (Tomiyama et al. 2015). On the other hand, the Indian and Atlantic Ocean specimens of *B. compressus* or *B. elongatus sensu* Nielsen and Merrett (2000) were recently described as *B. mozambiquensis* (*n* = 1, West Indian Ocean) and *B. nielseni* (*n* = 29, North Atlantic and West Indian oceans) (Tomiyama et al. 2016, 2018). *Bassozetus compressus* is separable from the two new species by its blackish-brown or brown fins (vs. pale yellowish-brown), plus (from *B. mozambiquensis*) fewer oblique scales (18–21 vs. 30) and shallower body (greatest depth 10.8–14.8 % SL vs. 18.0 % SL), and (from *B. nielseni*) greater tail length (67.9–72.6 % SL, ≥ 346 mm SL vs. 62.7–67.4 % SL, ≥ 342 mm SL) and longer pelvic-fin (posterior tip extending beyond anus, ≤ 216 mm SL vs. constantly anterior to the anus). As mentioned above, *B. compressus* and *B. elongatus sensu* Nielsen and Merrett (2000) in fact comprised *B. compressus*, *B. mozambiquensis* and *B. nielseni*, the distributional range of *B. compressus* being separated from that of the other two species. The present study also revealed that the Atlantic specimens of *B. robustus sensu* Nielsen and Merrett (2000) were actually an undescribed species.

The external sexual dimorphism observed in *B. nielseni* is the first example of such in the genus (Tomiyama et al. 2018). The head, upper jaw and predorsal lengths, greatest body depth and body depth at the anal-fin origin of *B. nielseni* were significantly greater in ripe females over 500 mm SL than in similarly-sized males, although the tail lengths of those specimens were generally shorter in the females. The large mouth and trunk of ripe females are adapted for ingesting bigger or more prey, and it would be advantageous to efficiently get the nutrients for ovary development. External sexual dimorphism is also known in other deep-sea neobythitin species, e.g.,

Barathrodemus manatinus Goode and Bean 1883 [body depth greater in females (Carter and Musick 1985)] and *Eretmichthys pinnatus* Garman 1899 [pectoral-fin length greater in males (Shcherbachev 1980)], but such reports are few.

The distribution of *Bassozetus* in Japanese waters was extended. The first Japanese records of *B. glutinosus* (Suruga Bay and the Ryūkyū trench; new standard Japanese name "Nan'yō-fukumen-itachiuo") and *B. compressus* (off the Ryūkyū and Senkaku Islands; "Ōrin-fukumen-itachiuo") were noted by Tomiyama et al. (2011, 2015), and that of *B. robustus* (Suruga Bay and the Ryūkyū trench; "Ishi-fukumen-itachiuo") by Takami et al. (co-author Tomiyama) (2011). Previously only *B. zenkevitchi* and *B. levistomatus* had been known (Machida and Tachibana 1986; Machida 1989). Subsequently, several additional specimens of *B. glutinosus* and *B. robustus* have been collected in waters of southern Japan, and both species are now considered to be relatively common in Japanese waters.

As pointed out above, the present study resolved the continuing taxonomic confusion of *Bassozetus* despite previous reports. In addition, instances of external sexual dimorphism and the Japanese distribution of *Bassozetus* have been clarified.

VII. Summary

1) The purpose of this study was to resolve the taxonomic confusion surrounding the deep-sea genus *Bassozetus* (Ophidiiformes: Ophidiidae: Neobythitinae), in addition to new observations on sexual dimorphism and the distribution of species in the Northwest Pacific Ocean. The history of taxonomic studies of *Bassozetus* was also summarized for the first time.

2) A total of 176 specimens, deposited in 12 research institutions worldwide, were examined in detail and compared directly.

3) *Bassozetus* was characterized by a number of significant morphological characters, including basibranchial tooth patch 0–1, pelvic-fin with one ray and lateral line absent.

4) A total of 14 valid species of *Bassozetus*, including 12 of 13 previously described and two new species, were recognized, and a key to species provided.

5) *Bassozetus compressus* was recognized as a senior synonym of *B. elongatus* (Tomiyama et al. 2015). Differences in the pelvic-fin length to SL ratio and sagittal otolith morphology, previously considered to distinguish between *B. compressus* and *B. elongatus*, were found to be the description error. The distributional range of the species is limited to the western Pacific.

6) Atlantic and Indian Ocean specimens, previously confused with *B. compressus* or *B. elongatus*, were newly described as *B. mozambiquensis* and *B. nielseni* (see Tomiyama et al. 2016, 2018). Both species are separable from *B. compressus* by fin color.

7) The remaining 9 species, except for *B. oncerocephalus* and *B. werneri* [known only from holotypes, which were unavailable but validated following Nielsen and Merrett (2000)], were redescribed and their diagnoses updated.

8) Two new significant diagnostic characters, width to length ratio of the vomer arm and predorsal length to body depth at the anal-fin origin ratio, were established for the identification of *B. glutinosus*, *B. nasus* and *B. normalis*, previously distinguished from each other only on the basis of multivariate analyses of anal-

and pectoral-fin rays, and long gill raker numbers.

9) Atlantic *B. robustus sensu* Nielsen and Merrett (2000) was predicted as an undescribed species, several morphological characters such as oblique scale numbers differing from those of western Pacific *B. robustus* (including the holotype).

10) The first example of external sexual dimorphism in *Bassozetus* was observed in *B. nielseni* (Tomiyama et al. 2018), in which the head, upper jaw and predorsal lengths, greatest body depth, and body depth at the anal-fin origin were significantly greater in ripe females over ca. 500 mm SL than in similarly-sized males. The tail lengths of those specimens were generally shorter in the females.

11) The first Japanese records of *B. glutinosus* and *B. compressus* were noted by Tomiyama et al. (2011, 2015), and that of *B. robustus* by Takami et al. (co-author Tomiyama) (2011). It is considered that *B. glutinosus* and *B. robustus* are relatively common around southern Japan, several additional specimens of both species having been collected subsequently.

VIII. Acknowledgments

I am most grateful to Professor A. Fukui (The Graduate School of Bioscience, Tokai University) for the opportunity to work on this study, and for his critical reading of the manuscript and constant encouragement. I gratefully acknowledge Professor N. Suzuki, Professor J. Nishikawa (The Graduate School of Bioscience, Tokai University), Professor N. Akiyama (The Graduate School of Geo-environmental Science, Tokai University) and Professor S. Tanaka (Tokai University; formally The Graduate School of Bioscience, Tokai University) for critical suggestions and valuable comments. I also wish to thank Contract Junior Associate Professor M. Takami (School of Marine Science and Technology, Tokai University) for his helpful comments. I greatly appreciate Dr. J.G. Nielsen (ZMUC), who made a significant previous taxonomic study of *Bassozetus*, for providing important information and constructive comments. I also thank Dr. W. Schwarzhans (Hamburg, Germany) for helpful comments, and Dr. G.S. Hardy (Ngunguru, New Zealand) for providing help with English and helpful comments. The following kindly loaned me the specimens: Mr. P.-L. Lin (ASIZP), Mr. J. Maclaine, Ms T. Heath and Mr. D. Nicholson (BMNH), Dr. H. Endo (BSKU) and Dr. N. Nakayama (BSKU; currently School of Marine Science and Technology, Tokai University), Dr. D. Catania (CAS), Dr. T. Kawai (HUMZ), Mr. P. Pruvost, Mr. R. Casse and Mrs. Z. Gabsi (MNHN), Dr. G. Shinohara (NSMT), Mr. R.H. Robins (UF), Dr. J.T. Williams and Ms S.J. Raredon (USNM), Dr. J.G. Nielsen and Mr. T. Menne (ZMUC) and Dr. E.J. Hilton and Dr. S.K. Huber (VIMS). Additionally, Dr. G. Shinohara assisted with my visit to check the collections in his care. I greatly appreciate the help received from all of the above. This study was supported in part by a Grants-in Aid for Scientific Research (no. 18H00333) from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

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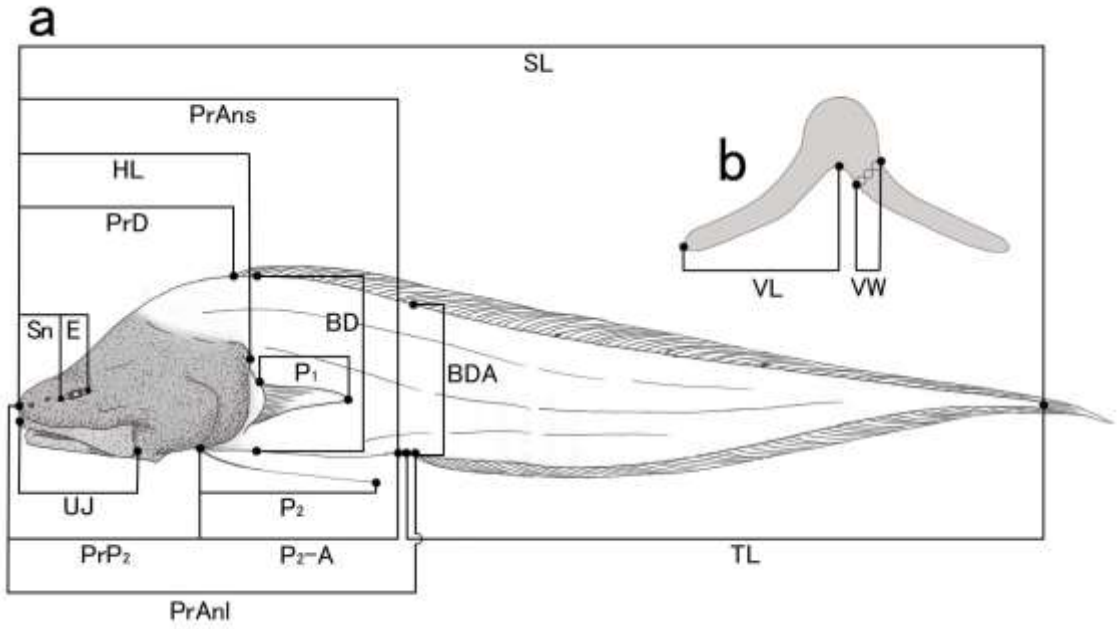

Fig. 1 Measurement methods for *Bassozetus*: (**a**) whole body; (**b**) vomerine tooth patch. *SL* standard length; *HL* head length; *BD* greatest body depth; *BDA* body depth at anal fin origin; *Sn* snout length; *E* eye diameter; *UJ* upper jaw length; *PrAns* preanus length; *PrD* predorsal length; *PrAnl* preanal length; *PrP2* prepelvic length; *P2-A* distance between pelvic fin to anal fin; *TL* tail length; *P1* pectoral-fin length; *P2* pelvic-fin length; *VL* length of vomer arm; *VW* width of vomer arm

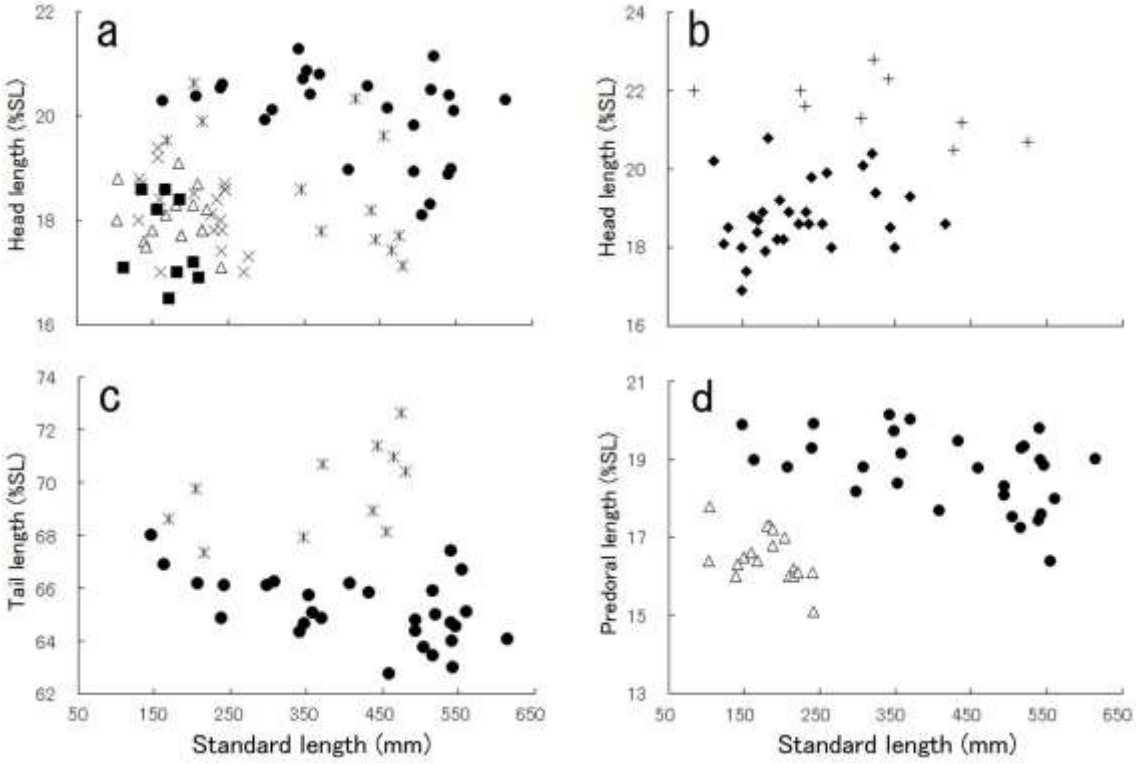

Fig. 2 Relationships of (**a, b**) head length, (**c**) tail length and (**d**) predorsal length (all as % SL) to standard length (mm) in selected *Bassozetus* species. *Bassozetus compressus* (*asterisks*), *B. glutinosus* (*diamonds*), *B. nasus* (*crosses*), *B. nielseni* (*circles*), *B. normalis* (*triangles*), *B. robustus* (*pluses*) and *B. taenia* (*squares*)

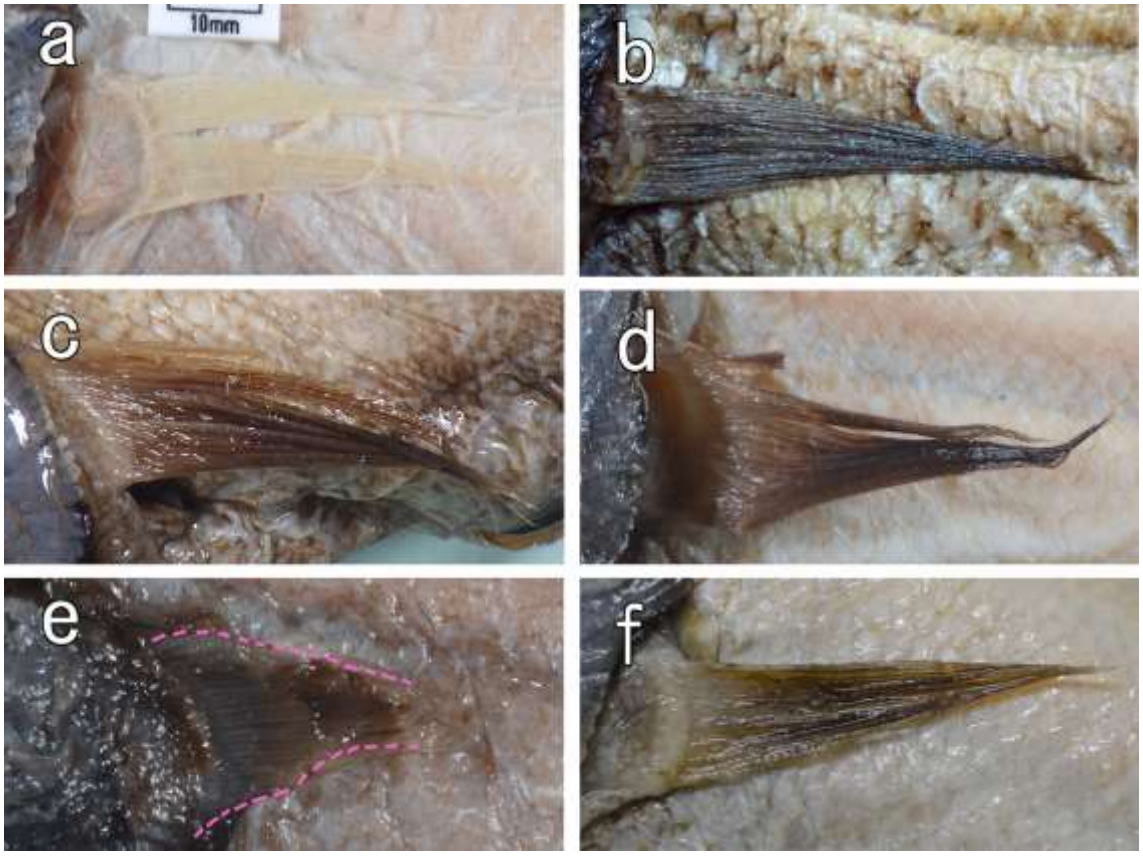

Fig. 3 Coloration of pectoral fin in selected *Bassozetus* species. (**a**) *Bassozetus nielseni*, BMNH 1994.5.6.4, paratype, 517 mm SL, coll. 4 October 1993; (**b**) *Bassozetus compressus*, MNHN 1994-709, 475 mm SL, coll. 4 September 1985; (**c**) *Bassozetus galatheae*, ZMUC-P 771218, 495 mm SL, coll. 19 April 1984; (**d**) *Bassozetus glutinosus*, BSKU 47911, 370 mm SL, coll. 31 August 1990; (**e**) *Bassozetus multispinis*, ZMUC-P 771212, 293 mm SL, coll. 18 March 1979; (**f**) *Bassozetus robustus*, BSKU 49476, 438 mm SL, coll. 3 April 1991

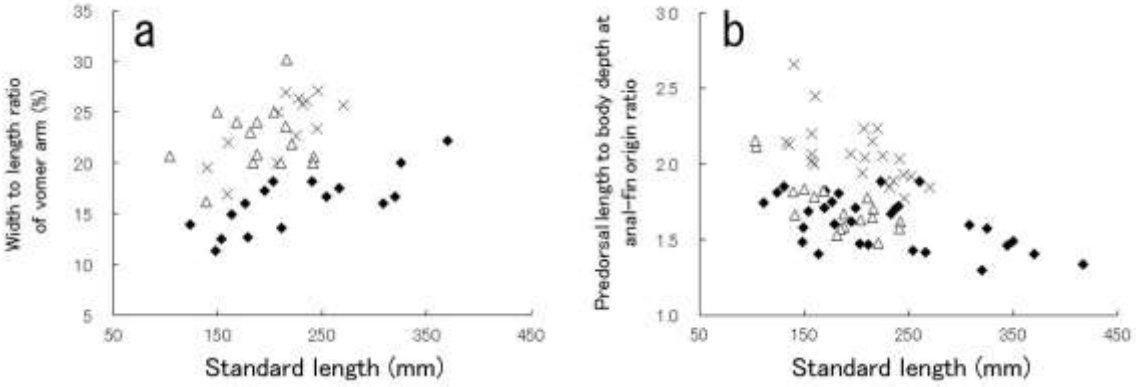

Fig. 4 Relationships of (**a**) width to length ratio of vomer arm (%) and (**b**) predorsal length to body depth at anal-fin origin ratio to standard length (mm) in selected *Bassozetus* species. *Bassozetus glutinosus* (*diamonds*), *B. nasus* (*crosses*), *B. normalis* (*triangles*)

Fig. 5 *Bassozetus compressus*: (**a**) BMNH 1887.12.7.47, lectotype, 408 $^{+}$ mm SL (417 mm estimated SL); (**b**) USNM 74141, holotype of *Bassozetus elongatus*, 438 mm SL

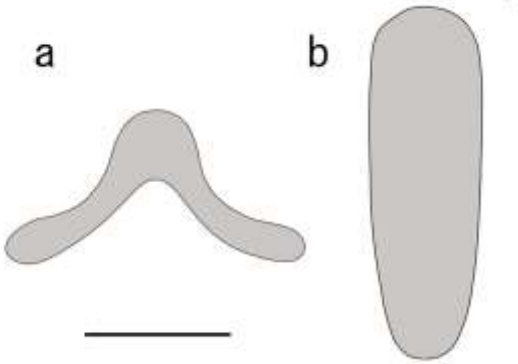

Fig. 6 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus compressus*, BMNH 1887.12.7.47, lectotype, 408 $^{+}$ mm SL (417 mm estimated SL) . *Bar* 5 mm

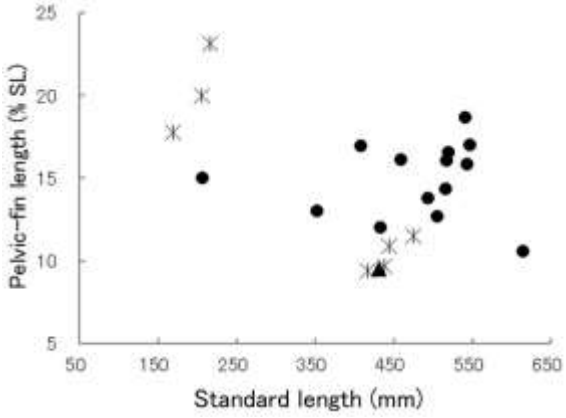

Fig. 7 Relationship of pelvic-fin length (as % SL) to standard length (mm) in selected *Bassozetus* species. *Bassozetus compressus* (*asterisks*), *Bassozetus mozambiquensis* (*triangles*) and *Bassozetus nielseni* (*circles*)

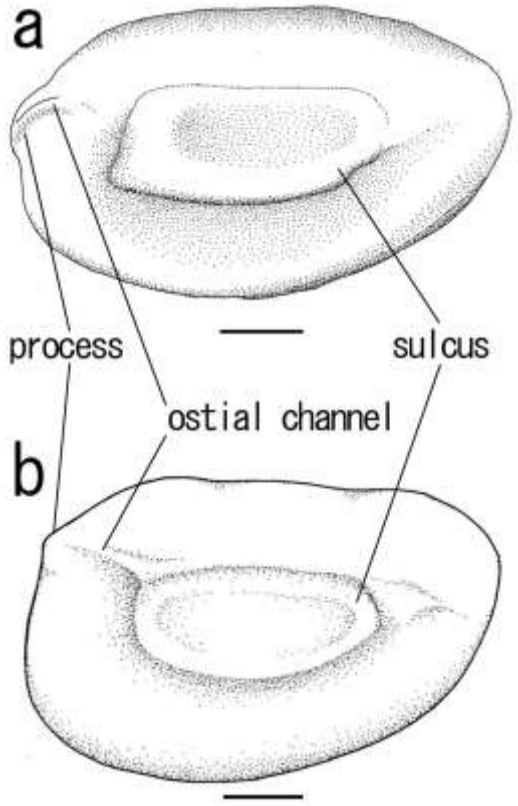

Fig. 8 Diagrammatic median views of right sagittal otolith of *Bassozetus compressus*. (**a**) BMNH 1887.12.7.47, lectotype, 408 $^{+}$ mm SL (417 mm estimated SL), revised illustration from Nielsen and Merrett (2000); (**b**) USNM 74141, holotype of *Bassozetus elongatus*, 438 mm SL. *Bars* 1 mm

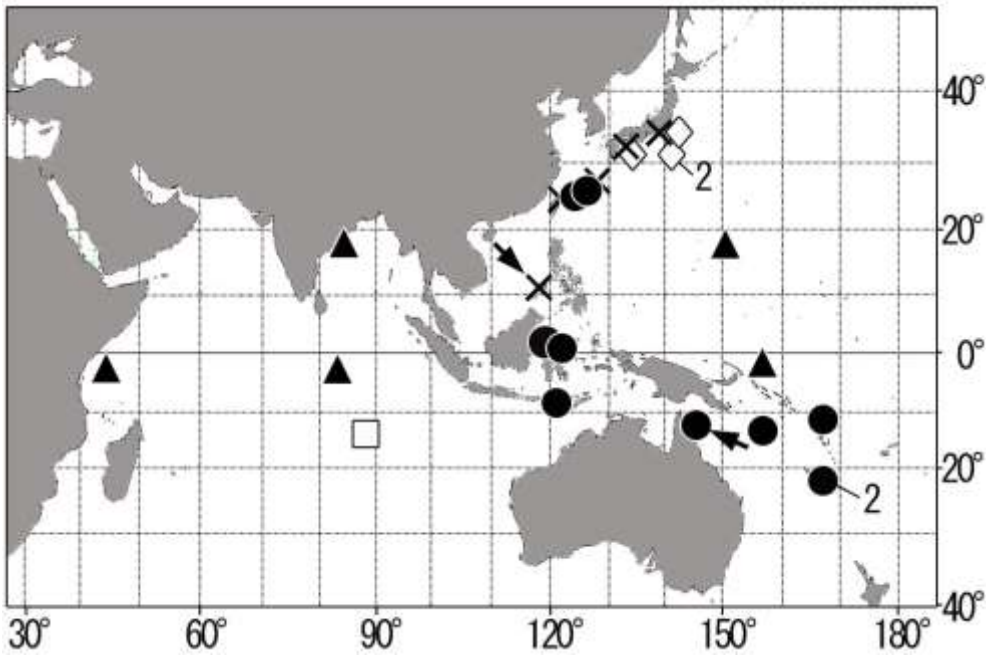

Fig. 9 Collection localities of *Bassozetus compressus* (*circles*), *Bassozetus galatheae* (*triangles*), *Bassozetus multispinis* (*squares*), *Bassozetus robustus* (*crosses*) and *Bassozetus zenkevitchi* (*diamonds*) examined in this study. *Arrows* indicate lectotype of *B. compressus* and holotype of *B. robustus*. Numbers indicate number of neighboring stations.

Fig. 10 *Bassozetus galatheae*, ZMUC P771218, paratype, 495 mm SL

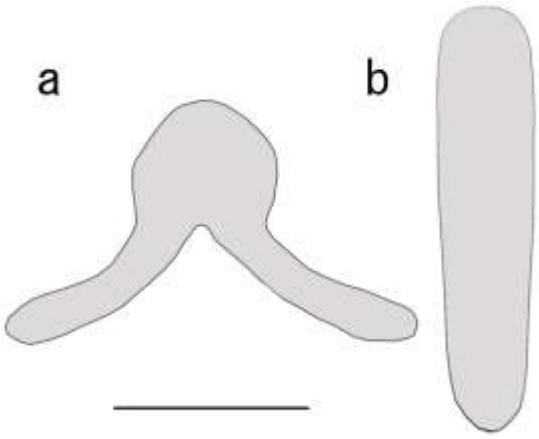

Fig. 11 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus galatheae*, ZMUC P771218, paratype, 495 mm SL. *Bar* 5 mm

Fig. 12 *Bassozetus glutinosus*: (**a**) BMNH 1890.11.28.37, lectotype, 183 mm SL; (**b**) BSKU 86842, 320 mm SL

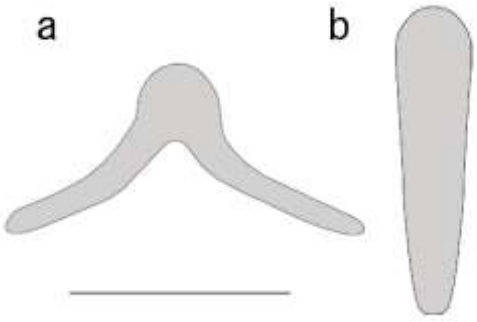

Fig. 13 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus glutinosus*, BSKU 86842, 320 mm SL. *Bar* 5 mm

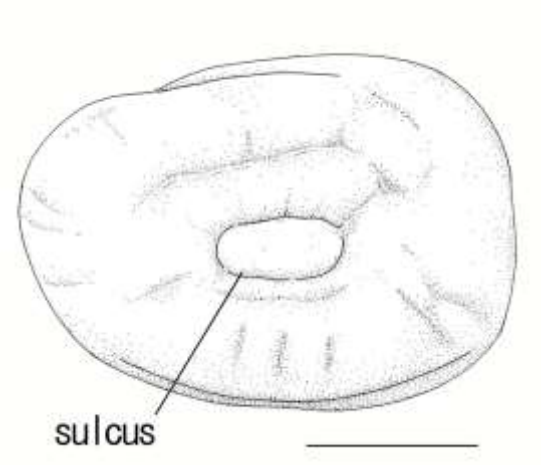

Fig. 14 Diagrammatic median view of left sagittal otolith of *Bassozetus glutinosus*, MSM-09-6, 148 mm SL. *Bar* 1 mm

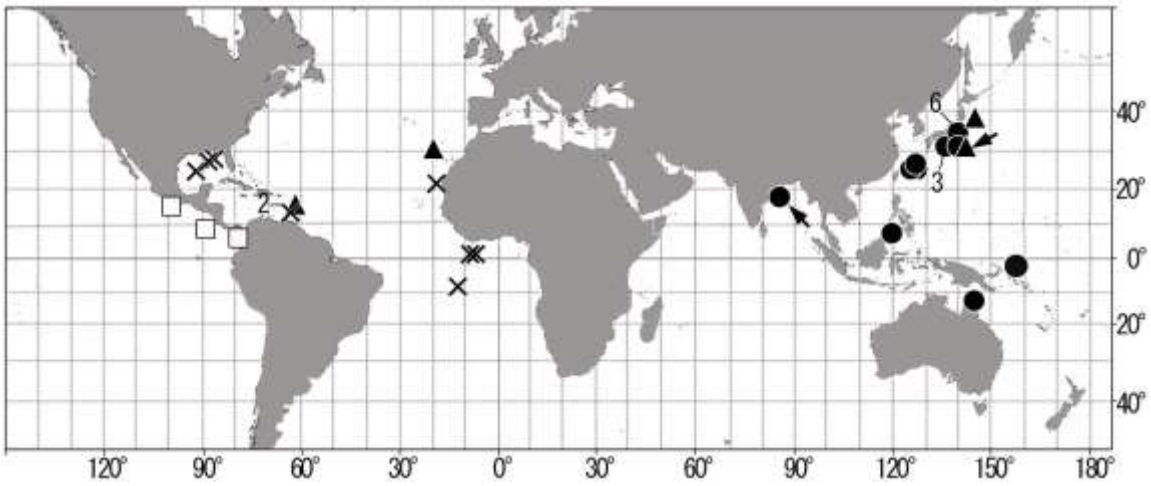

Fig. 15 Collection localities of *Bassozetus glutinosus* (*circles*), *Bassozetus levistomatus* (*triangles*), *Bassozetus nasus* (*squares*) and *Bassozetus normalis* (*crosses*) examined in this study. *Arrows* indicate lectotype of *B. glutinosus* and holotype of *B. levistomatus*. Numbers indicate number of neighboring stations

Fig. 16 *Bassozetus levistomatus*: (**a**) NSMT-P 29533, holotype, 479 mm SL; (**b**) NSMT-P 114823, 591 mm SL

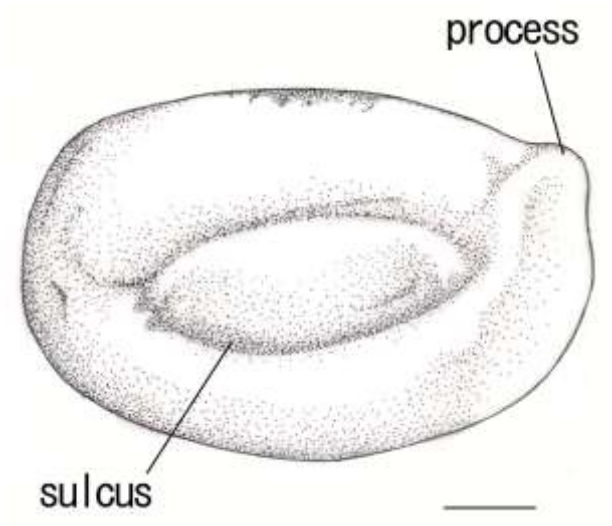

Fig. 17 Diagrammatic median view of left sagittal otolith of *Bassozetus levistomatus*, NSMT-P 114823, 591 mm SL. *Bar* 1 mm

Fig. 18 *Bassozetus mozambiquensis*, USNM 206917, holotype, 431 mm SL

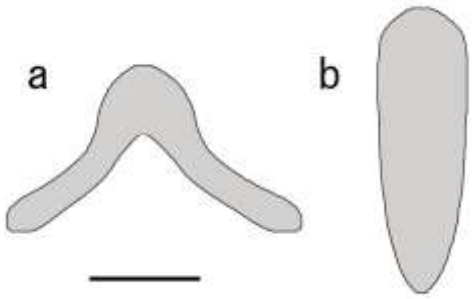

Fig. 19 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus mozambiquensis*, USNM 206917, holotype, 431 mm SL. *Bar* 5 mm

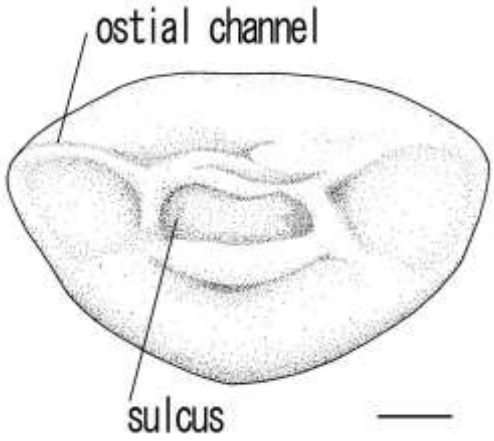

Fig. 20 Diagrammatic median view of right sagittal otolith of *Bassozetus mozambiquensis*, USNM 206917, holotype, 431 mm SL. *Bar* 1 mm

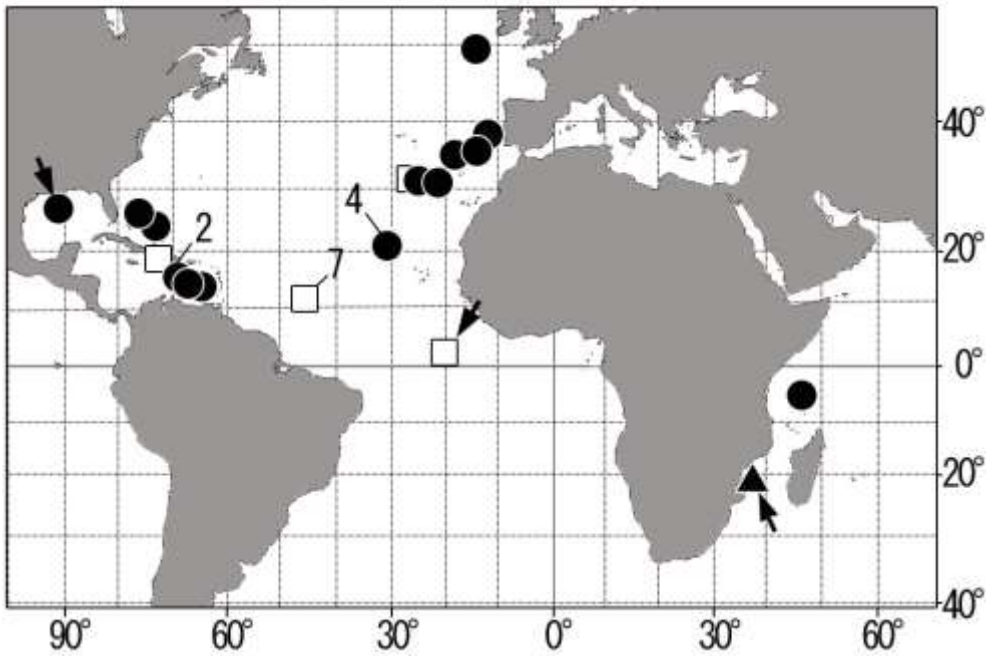

Fig. 21 Collection localities of *Bassozetus mozambiquensis* (*triangles*), *Bassozetus nielseni* (*circles*) and *Bassozetus taenia* (*squares*) examined in this study. *Arrows* indicate holotypes of *B. mozambiquensis*, *B. nielseni* and *B. taenia*. Numbers indicate number of neighboring stations

Fig. 22 *Bassozetus multispinis*, ZMUC P771210, 426 mm SL

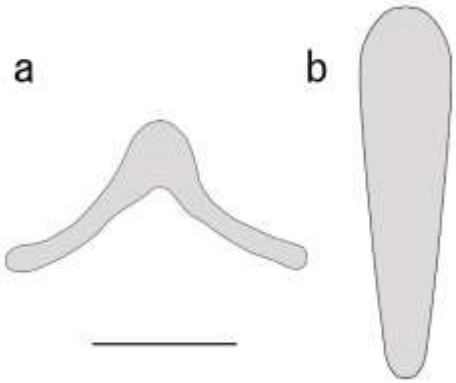

Fig. 23 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus multispinis*, ZMUC P771210, 426 mm SL. *Bar* 5 mm

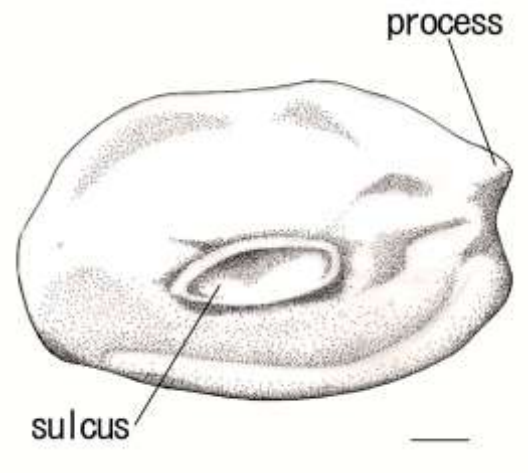

Fig. 24 Diagrammatic median view of left sagittal otolith of *Bassozetus multispinis*, ZMUC P771212, 293 mm SL. *Bar* 1 mm

Fig. 25 *Bassozetus nasus*, ZMUC-P 771238, 270 mm SL

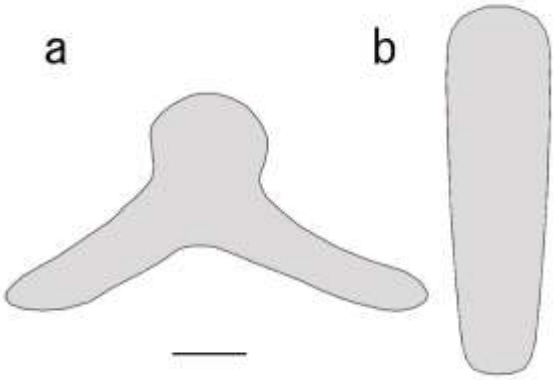

Fig. 26 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus nasus*, ZMUC-P 771238, 270 mm SL. *Bar* 1 mm

Fig. 27 *Bassozetus nielseni*: (**a**) USNM 206928, holotype, female, 541 mm SL; (**b**) BMNH 1994.5.6.7, paratype, male, 505 mm SL

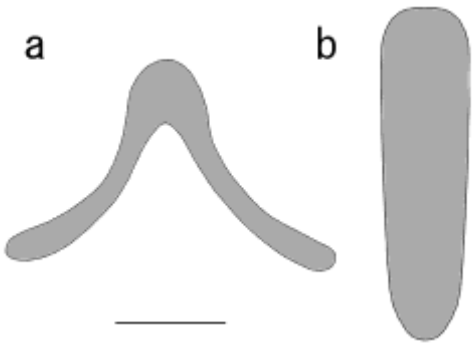

Fig. 28 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus nielseni*, USNM 206928, holotype, 541 mm SL. *Bar* 5 mm

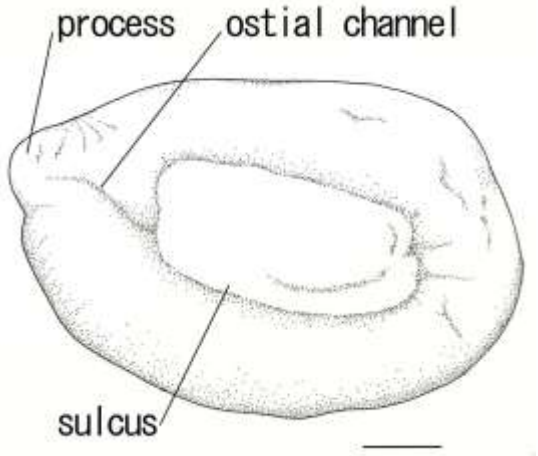

Fig. 29 Diagrammatic median view of right sagittal otolith of *Bassozetus nielseni*, USNM 206928, holotype, 541 mm SL. *Bar* 1 mm

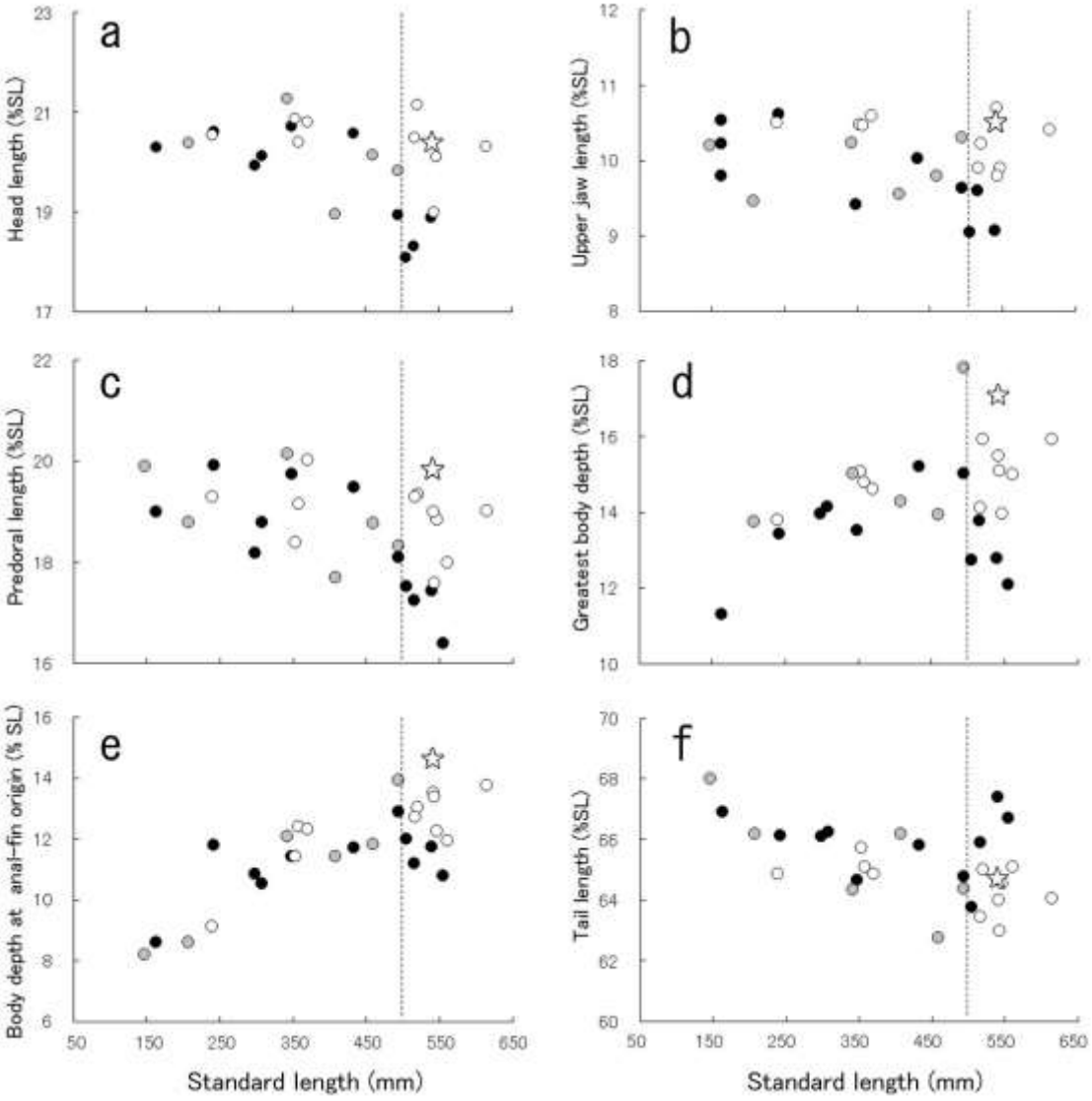

Fig. 30 Relationships of (**a**) head length, (**b**) upper jaw length, (**c**) predorsal length, (**d**) greatest body depth, (**e**) body depth at anal-fin origin and (**f**) tail length (all as % SL) to standard length (mm) in *Bassozetus nielseni* (*Star*, holotype, female; *black circles*, male; *white circles*, female; *gray circles*, sex unknown). *Broken lines* indicate 500 mm SL

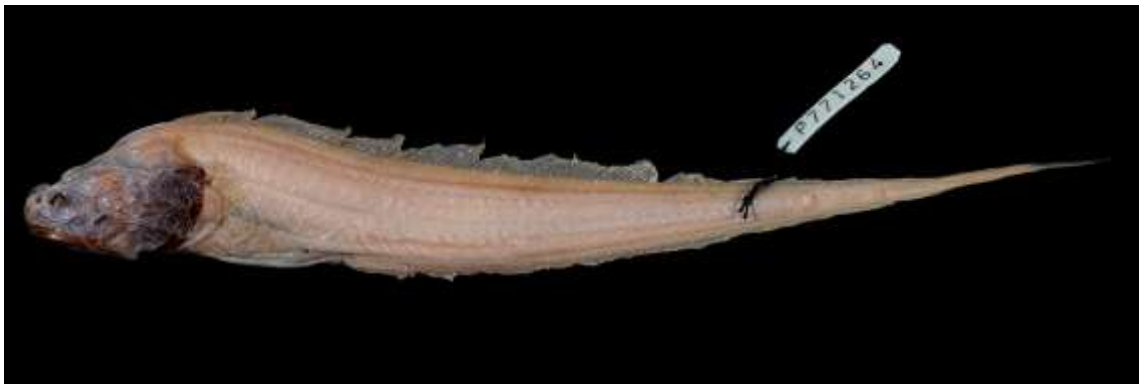

Fig. 31 *Bassozetus normalis*, ZMUC-P 771264, 221 mm SL

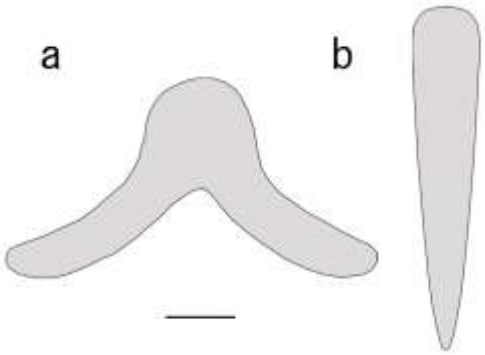

Fig. 32 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus normalis*, ZMUC-P 771264, 221 mm SL. *Bar* 1 mm

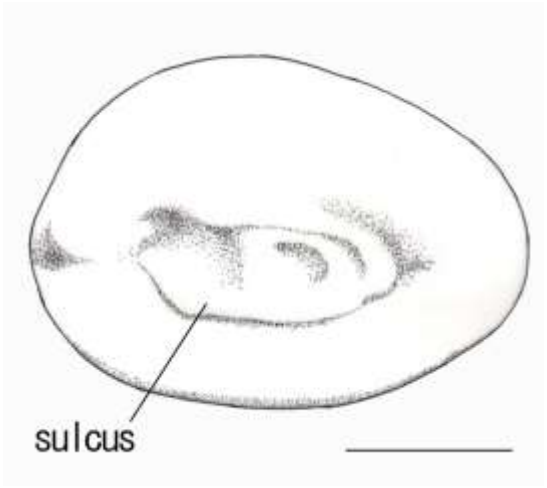

Fig. 33 Diagrammatic median view of right sagittal otolith of *Bassozetus normalis*, BMNH 1991.7.9.827, 244 $^{+}$ mm SL. *Bar* 1 mm

Fig. 34 *Bassozetus robustus*: (**a**) USNM 74140, holotype, 323 mm SL; (**b**) BSKU 49476, 438 mm SL

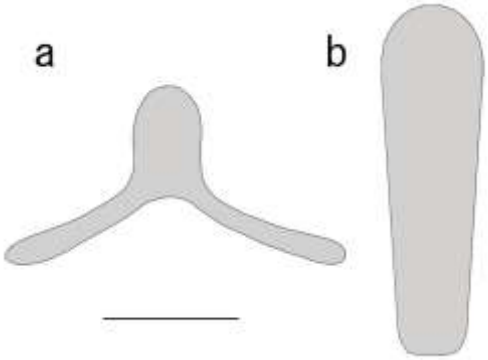

Fig. 35 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus robustus*, BSKU 49476, 438 mm SL. *Bar* 5 mm

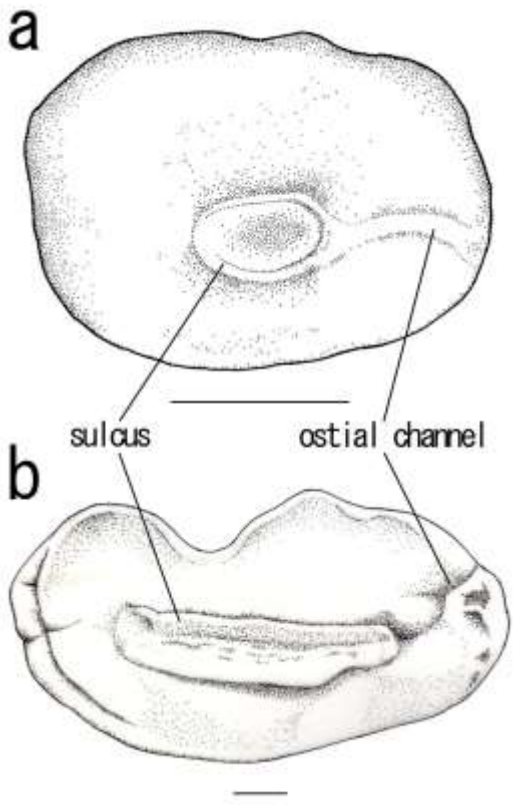

Fig. 36 Diagrammatic median views of left sagittal otolith of *Bassozetus robustus*: (**a**) MSM-10-445, 85 mm SL; (**b**) BSKU 49476, 438 mm SL. *Bars* 1 mm

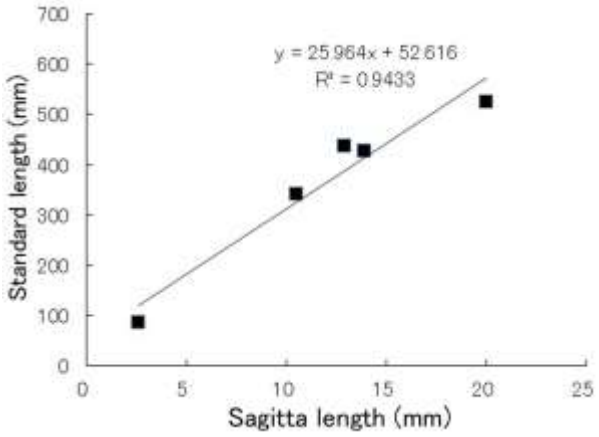

Fig. 37 Relationships of standard length (mm) to sagitta length (mm) in *Bassozetus robustus*

Fig. 38 West Atlantic *Bassozetus* specimen similar to *Bassozetus robustus*, UF 114997, 380 mm SL

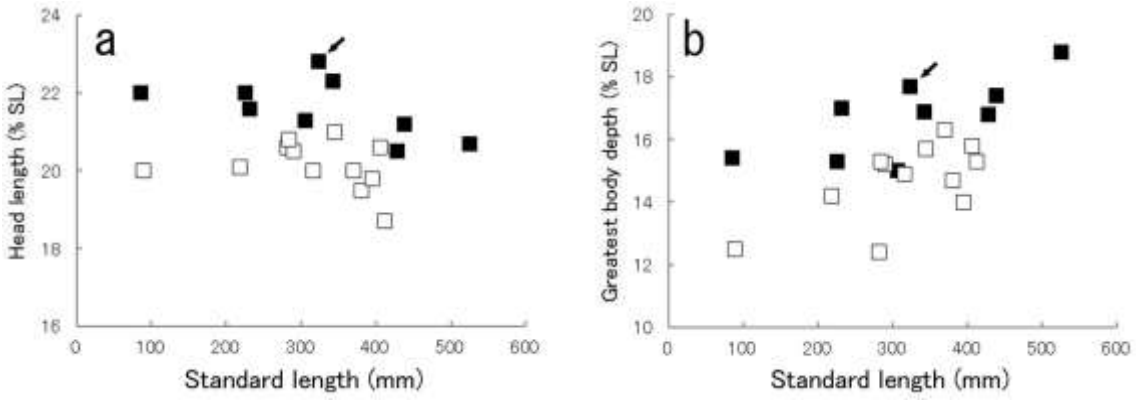

Fig. 39 Relationships of (**a**) head length and (**b**) greatest body depth (all as % SL) to SL (mm) in *Bassozetus robustus* from the West Pacific (*closed square*) and similar specimens from the West Atlantic (*open square*). *Arrows* indicate holotype

Fig. 40 *Bassozetus taenia*: (**a**) BMNH 1887.12.7.51, holotype, 237 mm SL; (**b**) MNHN-1979-233, 211 mm SL

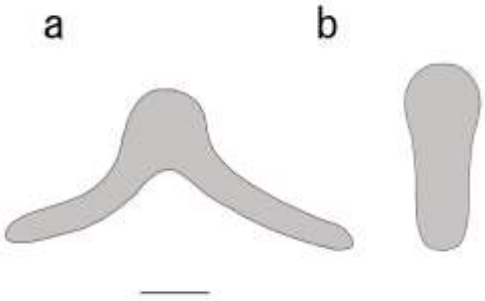

Fig. 41 Diagrammatic vomerine (**a**) and basibranchial (**b**) tooth patches of *Bassozetus taenia*, MNHN-1979-233, 211 mm SL. *Bar* 1 mm

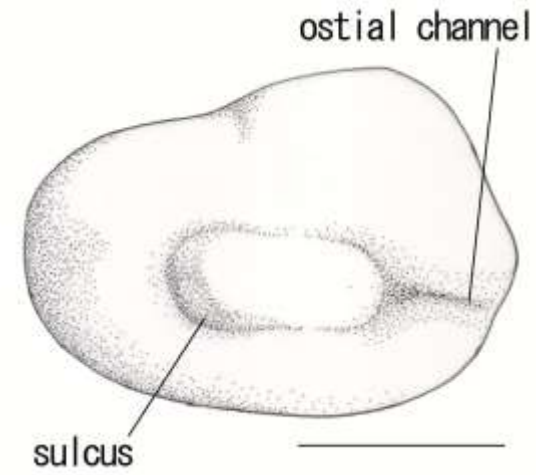

Fig. 42 Diagrammatic median view of left sagittal otolith of *Bassozetus taenia*, VIMS 7066, 166 mm SL. *Bar* 1 mm

Fig. 43 *Bassozetus zenkevitchi*, BSKU 76792, 219 mm SL

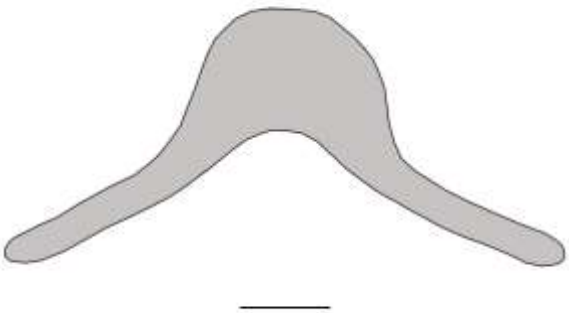

Fig. 44 Diagrammatic vomerine tooth patch of *Bassozetus zenkevitchi*, BSKU 76792, 219 mm SL. *Bar* 1 mm

Table 1 List of nominal species of *Bassozetus* and current status

Original name	Valid name
Bathynectes compressus Günther 1878	*Bassozetus compressus* (Günther 1878)
Bassozetus normalis Gill 1883	*Bassozetus normalis* Gill 1883
Bathyonus taenia Günther 1887	*Bassozetus taenia* (Günther 1887)
Sirembo oncerocephalus Vaillant 1888	*Bassozetus oncerocephalus* (Vaillant 1888)
Bathyonus glutinosus Alcock 1890	*Bassozetus glutinosus* (Alcock 1890)
Bassozetus nasus Garman 1899	*Bassozetus nasus* Garman 1899
Bassozetus elongatus Smith and Radcliffe 1913	*Bassozetus compressus* (Günther 1878)
Bassozetus robustus Smith and Radcliffe 1913	*Bassozetus robustus* Smith and Radcliffe 1913
Bassozetus zenkevitchi Rass 1955	*Bassozetus zenkevitchi* Rass 1955
Bassozetus multispinis Shcherbachev 1980	*Bassozetus multispinis* Shcherbachev 1980
Bassozetus levistomatus Machida 1989	*Bassozetus levistomatus* Machida 1989
Bassozetus galatheae Nielsen and Merrett 2000	*Bassozetus galatheae* Nielsen and Merrett 2000
Bassozetus werneri Nielsen and Merrett 2000	*Bassozetus werneri* Nielsen and Merrett 2000
Bassozetus mozambiquensis Tomiyama, Takami and Fukui 2016	*Bassozetus mozambiquensis* Tomiyama, Takami and Fukui 2016
Bassozetus nielseni Tomiyama, Takami and Fukui 2018	*Bassozetus nielseni* Tomiyama, Takami and Fukui 2018

Table 2 Frequency distribution of oblique scales in 11 species of *Bassozetus* with a single median basibranchial tooth patch

	Based on specimens observed in this study															Previously
Large scales	17	18	19	20	21	22	23	24	25	-	-	-	-	-	mean (*n*)	reported range
Bassozetus compressus		4 [L]	3	3	1										19.1 (11)	ca. 18–20 [a]
Bassozetus nielseni				1	6	9	8 [H]	1	1						22.2 (26)	20–25 [b]
Bassozetus oncerocephalus	not observed														-	ca. 20–25 [c]
Bassozetus taenia	2	4	1	3 [H]	1	2									19.2 (13)	ca. 15–20 [c]

	Based on specimens observed in this study															Previously
Small scales	27	28	29	30	31	32	33	34	35	36	37	38	39	40	mean (*n*)	reported range
Bassozetus galatheae		1				2						1		1	34.0 (5)	ca. 25–35 [c]
Bassozetus glutinosus	3	3	3	4 [L]	1	1	2	3	1	1					30.6 (22)	ca. 25–35 [c]
Bassozetus mozambiquensis				1 [H]											30.0 (1)	ca. 30 [d]
Bassozetus multispinis				1					2						33.3 (3)	ca. 30–35 [c]
Bassozetus nasus	1		1	1	3	2	2								30.9 (10)	ca. 25–35 [c]
Bassozetus normalis				6	3	1		3	3						32.0 (16)	ca. 25–35 [c]
Bassozetus robustus				2 [H]			2	1	2	2					33.6 (9)	ca. 28–36 [a, e, f, g]

[H] and [L], including holotype and lectotype, respectively

[a] Data from Tomiyama et al. (2015); based on 11 *B. compressus*, and one *B. robustus*

[b] Data from Tomiyama et al. (2018); based on 26 specimens

[c] Data from Nielsen and Merrett (2000); number of observed specimens of each species not indicated

[d] Data from Tomiyama et al. (2016); based on one specimen

[e] Data from Nielsen (1997); based on one specimen

[f] Data from Takami et al. (2011); based on two specimens

[g] Data from Yeh et al. (2005); based on one specimen

Table 3 Major counts and measurements of *Bassozetus compressus*

	Lectotype of *B. compressus* BMNH 1887.12.7.47	Holotype of *B. elongatus* USNM 74141	Non-types			
			Reported prior to Tomiyama et al. (2015) [a]			
			as *B. compressus* *n* = 1 [b]	as large *B. elongatus* *n* = 4 [c]	as small *B. elongatus* *n* = 3 [c]	Tomiyama et al. (2015) *n* = 2
SL (mm)	414+ (417 [d])	438	465	346–480	169–216	372–455
Counts						
Dorsal-fin rays	117+	120	127	122–125	124–127	118–122
Anal-fin rays	100+	102	106	104–107	105–107	102–106
Pectoral-fin rays	25	24	24	22–25	25–26	22–23
Caudal-fin rays	lost	8	8	8	8	8–9
Long gill rakers	1 + 1 + 12 = 14	1 + 1 + 14 = 16	1 + 1 + 11/12 = 13/14 [e]	1 + 1 + 11–14 = 13–16	1 + 1 + 9–11 = 11–13	1 + 1 + 11–13 = 13–15
Short gill rakers	4 + 5/4 = 9/8 [e]	5 + 4 = 9	4 + 4 = 8	4–5 + 4–5 = 8–10	4 + 3–5 = 7–9	4 + 4–6 = 8–10
Oblique scales	18	18	broken	18–19	20	19–20
Total vertebrae	62 +	66	68	66–69	69	66–68
Abdominal vertebrae	11	11	12	11–12	12–13	11–12
Caudal vertebrae	51+	55	56	54–58	56–57	55–56
Vertebral ordinal numbers						
Just below dorsal-fin origin	3	4	4	3–4	3–4	3–4
Just above anal-fin origin	14	14	14	13–14	15	13–15
Measurements (% of SL)						
Head length	20.3 [f]	18.2	17.4	17.1–18.6	19.5–20.6	17.8–19.6
Greatest body depth	14.8 [f]	12.8	12.3	10.8–13.1	11.8–13.6	13.5–14.5
Body depth at anal-fin origin	11.8 [f]	10.6	10.3	9.3–10.9	9.2–10.8	11.7–12.0
Snout length	4.2 [f]	3.6	4.2	3.4–4.1	4.0–4.3	4.2–4.3
Eye diameter	1.9 [f]	1.8	1.7	1.5–1.6	1.9–2.0	1.5–1.8
Upper jaw length	10.2 [f]	9.3	9.3	8.8–9.6	9.2–10.3	9.4–10.4
Preanus length	33.6 [f]	30.0	28.2	27.6–32.1	30.1–33.1	29.8–30.6

Continued

Predorsal length	19.7 [f]	16.5	16.2	15.6–17.5	17.6–18.8	16.4–18.6
Preanal length	35.3 [f]	31.8	29.2	28.6–32.7	31.6–34.7	30.8–34.7
Prepelvic length	17.1 [f]	15.5	14.8	13.7–16.4	15.7–18.3	14.9–15.6
Distance between pelvic fin to anal fin	20.0 [f]	17.8	17.0	15.8–18.6	17.3–20.0	17.3–20.5
Tail length	ND	68.9	71.0	68.9–72.6	67.4–69.8	68.1–70.7
Pectoral-fin length	9.3 [f]	9.0	9.5	9.4–10.6 [i]	7.1–9.7	10.2
Pelvic-fin length	ca. 9.4 [g]	ca. 9.6 [h]	broken	10.9–11.5 [j]	17.8–23.1	broken

[a] Tomiyama et al. (2015) concluded that *B. compressus* is a senior synonym of *B. elongatus*

[b] Reported by Nielsen and Møller (2008)

[c] Reported by Nielsen and Merrett (2000)

[d] Estimated SL, calculated as the ratio of SL to HL based on illustration in Günther (1887; plate XXII, fig. A)

[e] Left side／right side

[f] Ratio to estimated SL

[g] Based on measurements from illustration in Günther (1887; plate XXII, fig. A)

[h] Data from Smith and Radcliffe in Radcliffe (1913)

[i] Based on three specimens

[j] Based on two specimens

Table 4 Major counts and measurements of *Bassozetus galatheae*

	Paratypes *n* = 5	Other specimens *n* = 2	Nielsen and Merrett (2000) *n* = 21
SL (mm)	108–495	198–226	109–573
Counts			
Dorsal-fin rays	133–139	132–134	132–142
Anal-fin rays	108–113	110	108–114
Pectoral-fin rays	23–30	23–28	26–29
Caudal-fin rays	8	8	8
Long gill rakers	1 + 1 + 12–15 = 14–17	1 + 1 + 15–16 = 17–18	14–17
Short gill rakers	4–5 + 3–5 = 7–10	4–5 + 4–5 = 8–9	8–10
Oblique scales	28–40	broken	ca. 25–35
Total vertebrae	71–76	72–73	71–76
Abdominal vertebrae	14–17	15–16	14–17
Caudal vertebrae	56–59	57	ND
Vertebral ordinal numbers			
Just below dorsal-fin origin	3–4	2–3	3–5
Just above anal-fin origin	16–19	16–17	16–20
Measurements (% of SL)			
Head length	17.6–18.9	16.1–17.7	17.5–20.5
Greatest body depth	9.5–12.0	11.6–13.3	ND
Body depth at anal-fin origin	6.0–11.5	9.1–9.2	6.9–12.6
Snout length	3.4–4.1	3.2–3.5	ND
Eye diameter	1.3–2.2	1.7–1.9	ND
Upper jaw length	9.1–9.8	8.9–9.0	8.4–10.0
Preanus length	28.2–36.6	30.1–30.2	ND
Predorsal length	16.0–17.7	15.5–16.3	16.0–19.5
Preanal length	29.8–38.4	31.6–31.7	26.5–40.5
Prepelvic length	13.3–14.9	13.1–13.4	14.0–16.5
Distance between pelvic fin to anal fin	17.1–25.1	18.4–18.9	17.0–25.5
Tail length	63.2–70.3	67.7–69.2	ND
Pectoral-fin length	8.3–10.0 [a]	broken	ND
Pelvic-fin length	14.4–16.9 [b]	broken	11.0–17.0

ND no data

[a] Based on three specimens

[b] Based on four specimens

Table 5 Major counts and measurements of *Bassozetus glutinosus*

	Lectotype	Other specimens	Previous studies [a]
	BMNH 1890.11.28.37	*n* = 29	*n* = 40
SL (mm)	183	111–417	69–368
Counts			
Dorsal-fin rays	121	120–130	120–130
Anal-fin rays	101	98–107 [b]	98–108
Pectoral-fin rays	26	26–30	24–30
Caudal-fin rays	broken	8	8
Long gill rakers	1 + 1 + 16/15 = 18/17	1 + 1 + 13–18 = 15–20	15–21
Short gill rakers	5 + 5/4 = 10/9	4–5 + 3–6 = 7–11	7–10
Oblique scales	30	27–35 [c]	ca. 25–35
Total vertebrae	68	68–71 [d]	66–71
Abdominal vertebrae	14	13–15 [d]	13–15
Caudal vertebrae	54	54–56 [d]	54–56
Vertebral ordinal numbers			
Just below dorsal-fin origin	4	3–4 [d]	3–4
Just above anal-fin origin	16	14–16 [d]	14–17
Measurements (% of SL)			
Head length	20.8	16.9–20.4	16.5–21.0
Greatest body depth	12.8	11.4–17.0	12.5–13.1
Body depth at anal-fin origin	10.8	9.1–14.7	8.5–13.5
Snout length	4.2	3.1–4.9	3.1–4.4
Eye diameter	1.7	1.3–2.5	1.7–1.8
Upper jaw length	10.2	8.8–11.1	7.9–11.0
Preanus length	35.8	28.0–35.6	29.6–33.2
Predorsal length	19.5	14.9–19.1	14.9–21.0
Preanal length	37.5	30.0–37.3	30.0–39.5
Prepelvic length	15.1	13.2–16.4	13.3–15.0
Distance between pelvic fin to anal fin	23.4	17.2–24.2	16.0–23.5
Tail length	ND	64.6–71.0 [e]	ND
Pectoral-fin length	broken	7.5–14.4 [f]	9.4
Pelvic-fin length	broken	10.7–16.7 [g]	13.6–19.0

ND no data

[a] Data from Nielsen and Merrett (2000), Nielsen and Møller (2008) and Tomiyama et al. (2011)

[b] Based on 28 specimens

[c] Based on 21 specimens

[d] Based on 15 specimens

[e] Based on 27 specimens

[f] Based on 13 specimens

[g] Based on 12 specimens

Table 6 Major counts and measurements of *Bassozetus levistomatus*

	Holotype	Other specimens	Previous studies [a]
	NSMT-P 29533	*n*=3	*n*=11
SL (mm)	479	184–591	185–805
Counts			
Dorsal-fin rays	120	117–125	117–126
Anal-fin rays	94	93–100	93–103
Pectoral-fin rays	29	24–29	27–29
Caudal-fin rays	8	8	8–9
Long gill rakers	1 + 1 + 9 = 11	1 + 1 + 8–10 = 10–12	9–11
Short gill rakers	3 + 4 = 7	3–4 + 3–4 = 6–8	6–7
Oblique scales	30	34–35 [b]	ca. 25–30
Total vertebrae	65	64–66	64‑68
Abdominal vertebrae	15	14	14–16
Caudal vertebrae	50	50–52	ND
Vertebral ordinal numbers			
Just below dorsal-fin origin	ND	3–4	3–4
Just above anal-fin origin	19	17	17–23
Measurements (% of SL)			
Head length	22.5	21.4 [c]	21.0–23.5
Greatest body depth	17.5	14.8–17.9 [b]	ND
Body depth at anal-fin origin	12.3	10.3–15.3	10.5–19.0
Snout length	5.3	5.0–5.9	ND
Eye diameter	2.5	1.6–2.0	ND
Upper jaw length	12.6	10.9–11.5 [b]	11.5–13.0
Preanus length	34.0	33.0–41.8	ND
Predorsal length	21.1	17.4–21.0	18.5–22.5
Preanal length	35.9	35.0–39.8	35.5–45.5
Prepelvic length	17.1	15.1–16.4 [b]	15.0–18.0
Distance between pelvic fin to anal fin	19.2	19.8–26.1	19.0–32.0
Tail length	63.7	61.8–64.1	ND
Pectoral-fin length	12.6	13.0 [c]	ND
Pelvic-fin length	broken	13.4 [c]	8.1–12.0

ND no data

[a] Data from Nielsen and Merrett (2000) and Ohashi and Shinohara (2015)

[b] Based on two specimens

[c] Based on one specimen

Table 7 Major counts and measurements of *Bassozetus mozambiquensis*

	Holotype USNM 206917
SL (mm)	431
Counts	
Dorsal-fin rays	117
Anal-fin rays	98
Pectoral-fin rays	26
Caudal-fin rays	8
Long gill rakers	1 + 1 + 12 = 14
Short gill rakers	4 + 4/5 = 8/9 [a]
Oblique scales	30
Total vertebrae	65
Abdominal vertebrae	13
Caudal vertebrae	52
Vertebral ordinal numbers	
Just below dorsal-fin origin	4
Just above anal-fin origin	16
Measurements (% of SL)	
Head length	21.5
Greatest body depth	18.0
Body depth at anal-fin origin	13.5
Snout length	5.1
Eye diameter	1.7
Upper jaw length	11.4
Preanus length	34.7
Predorsal length	19.7
Preanal length	37.1
Prepelvic length	15.8
Distance between pelvic fin to anal fins	22.5
Tail length	65.2
Pectoral-fin length	broken
Pelvic-fin length	9.5

[a] left side / right side

Table 8 Major counts and measurements of *Bassozetus multispinis*

	Present study	Previous studies [a]
	n = 3	*n* = 18
SL (mm)	293–426	164–452
Counts		
Dorsal-fin rays	125–127	124–132
Anal-fin rays	103–106	102–112
Pectoral-fin rays	23–25	23–24
Caudal-fin rays	8	8
Long gill rakers	1 + 1 + 16–18= 18–20	17–22
Short gill rakers	5 + 4–5 = 9–10	6–10
Oblique scales	30–35	ca. 30–35
Total vertebrae	67–69	67–73
Abdominal vertebrae	13–14	13–15
Caudal vertebrae	54–55	ND
Vertebral ordinal numbers		
Just below dorsal-fin origin	4–5	3–5
Just above anal-fin origin	15–16	15–17
Measurements (% of SL)		
Head length	20.0–23.0	16.3–23.0
Greatest body depth	16.8–18.3	ND
Body depth at anal-fin origin	10.5–13.5	7.5–14.0
Snout length	4.9–5.5	ND
Eye diameter	2.5–2.8	ND
Upper jaw length	10.2–11.7	9.5–12.0
Preanus length	33.6–35.2	ND
Predorsal length	20.2–22.9	15.7–22.5
Preanal length	34.5–36.6	29.5–39.5
Prepelvic length	17.5–18.7	15.5–19.0
Distance between pelvic fin to anal fin	17.2–21.0	17.6–23.0
Tail length	63.6–65.9	ND
Pectoral-fin length	broken	ND
Pelvic-fin length	1.5 [b]	0.7–6.9

ND no data

[a] Data from Nielsen and Merrett (2000) and Lee et al. (2005)

[b] Based on one specimen

Table 9 Major counts and measurements of *Bassozetus nasus*

	Paralectotype USNM 57852	Other specimens *n* = 23	Nielsen and Merrett (2000) *n* = 48
SL (mm)	157	132–277	80–282, 465
Counts			
Dorsal-fin rays	128	123–132 [a]	124–133
Anal-fin rays	106	101–110 [b]	102–110
Pectoral-fin rays	broken	21–27 [c]	22–26
Caudal-fin rays	8	8	7–8
Long gill rakers	1 + 1 + 12–13 = 14–15	1 + 1 + 11–15 = 13–17	13–17
Short gill rakers	4 + 3–4 = 7–8	4–5 + 3–5 = 6–9	5–9
Oblique scales	broken	27–33 [d]	ca. 25–35
Total vertebrae	69	68–72 [a]	68–72
Abdominal vertebrae	14	14–15	13–15
Caudal vertebrae	55	53–57 [a]	ND
Vertebral ordinal numbers			
Just below dorsal-fin origin	4	3–4 [b]	3–5
Just above anal-fin origin	15	15–17 [b]	15–17
Measurements (% of SL)			
Head length	broken	17.0–19.4 [e]	17.5–19.5
Greatest body depth	11.7	10.1–12.9	ND
Body depth at anal-fin origin	8.3	7.6–10.9	7.7–11.5
Snout length	3.6	3.4–4.7 [b]	ND
Eye diameter	2.0	1.5–2.0 [e]	ND
Upper jaw length	9.6	8.0–10.1 [c]	8.6–10.5
Preanus length	35.0	27.7–33.4	ND
Predorsal length	18.3	15.7–19.0	16.5–21.0
Preanal length	33.9	30.1–36.1	30.0–37.5
Prepelvic length	14.5	12.2–14.6 [b]	ND
Distance between pelvic fin to anal fin	19.3	17.5–22.2 [b]	18.0–22.5
Tail length	66.9	65.3–68.9 [c]	ND
Pectoral-fin length	broken	9.4 [f]	ND
Pelvic-fin length	broken	13.5–15.4 [g]	13.5–15.5

ND no data

[a] Based on 22 specimens

[b] Based on 20 specimens

[c] Based on 21 specimens

[d] Based on 10 specimens

[e] Based on 15 specimens

[f] Based on one specimens

[g] Based on four specimen

Table 10 Major counts and measurements of *Bassozetus nielseni*

	Holotype Female USNM 206928	Paratypes Females *n* = 11	Paratypes Males *n* = 11	Paratypes Sex unknown *n* = 6
SL (mm)	541	239–615	163–555	147–494
Counts				
Dorsal-fin rays	125	122–129	122–128 [c]	122–129
Anal-fin rays	105	101–109	102–107	103–107
Pectoral-fin rays	26	24–29	25–28	25–28
Caudal-fin rays	8	8 [b]	8–9 [c]	7–8
Long gill rakers	1 + 1 + 11 = 13	1 + 1 + 9–12 = 11–14	1 + 1 + 9–12 = 11–14	1 + 1 + 9–11 = 11–13
Short gill rakers	4 + 4/5 = 8/9 [a]	3–5 + 4–7 = 7–11	4 + 3–6 = 7–10	4 + 3–5 = 7–9
Oblique scales	23	21–24 [b]	21–25 [c]	20–23
Total vertebrae	69	68–71 [c]	68–71	67–70
Abdominal vertebrae	13	13–14 [c]	13–14	13–14
Caudal vertebrae	56	55–58 [c]	55–58	54–57
Vertebral ordinal numbers				
Just below dorsal-fin origin	4	3–5 [c]	3–4	4–5
Just above anal-fin origin	16	14–16 [c]	15–17	15–17
Measurements (% of SL)				
Head length	20.4	19.0–21.2 [b]	18.1–20.7 [c]	19.0–21.3 [e]
Greatest body depth	17.1	13.8–15.9	11.3–15.2	13.8–17.8 [e]
Body depth at anal-fin origin	14.6	9.1–13.8	8.6–12.9	8.2–13.9
Snout length	4.2	3.7–4.9	3.8–4.6	4.1–4.6
Eye diameter	2.2	1.6–2.0	1.7–2.4	1.4–2.1 [e]
Upper jaw length	10.5	9.8–10.7 [c]	9.0–10.6 [c]	9.5–10.3
Preanus length	32.9	34.1–37.9 [c]	32.1–36.8	30.9–37.4
Predorsal length	19.8	17.6–20.0	16.4–19.9	17.7–20.1

Continued

Preanal length	35.9	35.9–39.2	33.4–38.8	33.0–39.0
Prepelvic length	16.1	14.1–21.7	14.5–18.6	15.4–20.4
Distance between pelvic fin to anal fin	21.3	19.5–24.2	19.1–26.2	18.3–24.1
Tail length	64.7	63.0–65.7	63.8–67.4	62.7–68.0
Pectoral-fin length	10.6	9.3–10.5 [d]	9.7–11.6 [e]	9.6–12.0 [g]
Pelvic-fin length	18.7	10.6–17.0 [d]	12.7–14.3 [f]	15.0–16.9 [g]

[a] left side / right side

[b] Based on 9 specimens

[c] Based on 10 specimens

[d] Based on 6 specimens

[e] Based on five specimens

[f] Based on four specimens

[g] Based on three specimens

Table 11 Major counts and measurements of *Bassozetus normalis*

	Present study	Nielsen and Merrett (2000)
	n = 18	*n* = 35
SL (mm)	103–242	60–255
Counts		
Dorsal-fin rays	123–132 [a]	121–132
Anal-fin rays	100–107 [b]	99–108
Pectoral-fin rays	23–27	22–28
Caudal-fin rays	8	7–8
Long gill rakers	1 + 1 + 12–15 = 14–17	13–20
Short gill rakers	4–5 + 3–6 = 7–10	7–10
Oblique scales	30–35 [a]	ca. 25–35
Total vertebrae	68–71 [b]	67–71
Abdominal vertebrae	14–15 [b]	13–15
Caudal vertebrae	53–56 [b]	ND
Vertebral ordinal numbers		
Just below dorsal-fin origin	3–4 [a]	3–4
Just above anal-fin origin	15–17 [a]	15–20
Measurements (% of SL)		
Head length	17.1–19.1 [b]	16.5–20.5
Greatest body depth	9.6–13.6 [b]	ND
Body depth at anal-fin origin	7.2–11.3	8.4–10.8
Snout length	3.3–4.4	ND
Eye diameter	1.5–2.0 [a]	ND
Upper jaw length	8.2–9.3	7.5–9.5
Preanus length	28.9–33.4	ND
Predorsal length	15.1–17.3	15.0–18.5
Preanal length	29.5–35.3	29.5–37.5
Prepelvic length	12.9–15.2 [b]	12.0–18.0
Distance between pelvic fin to anal fin	16.4–22.5	16.0–22.5
Tail length	66.5–69.3 [b]	ND
Pectoral-fin length	8.8–10.8 [c]	ND
Pelvic-fin length	15.7–17.9 [d]	14.5–19.0

ND no data

[a] Based on 16 specimens

[b] Based on 17 specimens

[c] Based on three specimens

[d] Based on 8 specimens

Table 12 Major counts and measurements of *Bassozetus robustus*

	Holotype	Other specimens	Previous studies [a]
	USNM 74140	*n* = 8	*n* = 4
SL (mm)	323	84–525	84–520
Counts			
Dorsal-fin rays	123	119–123	115–122
Anal-fin rays	101	96–101	96–100
Pectoral-fin rays	25	26–28	27
Caudal-fin rays	8	8 [b]	8
Long gill rakers	1 + 1 + 10 = 12	1 + 1 + 9–12= 11–14	12–14
Short gill rakers	4 + 5 = 9	4 + 3–5 = 7–9	8
Oblique scales	30	30–36	ca. 30–36
Total vertebrae	66	66–68	64–67
Abdominal vertebrae	14	14–15	15
Caudal vertebrae	52	51–54	49–52
Vertebral ordinal numbers			
Just below dorsal-fin origin	3	3–4	3–4
Just above anal-fin origin	15	15–17	15–17
Measurements (% of SL)			
Head length	22.8	20.5–22.3	21.2–22.3
Greatest body depth	17.7	15.0–18.8	15.0–16.9
Body depth at anal-fin origin	14.2	12.4–16.0	11.6–15.2
Snout length	5.5	4.5–5.7	5.0
Eye diameter	1.8	1.4–1.9	1.4–1.9
Upper jaw length	11.5	9.9–11.4	9.8–11.1
Preanus length	35.4	32.0–38.9	32.0–35.3
Predorsal length	20.8	19.4–22.5	20.2–22.5
Preanal length	37.0	33.9–42.1	33.9–37.0
Prepelvic length	18.1	15.3–17.5	16.8–17.0
Distance between pelvic fin to anal fin	20.5	19.1–27.7	19.1–24.1
Tail length	64.4	64.2–65.7	ND
Pectoral-fin length	11.2	9.8–12.1	ND
Pelvic-fin length	13.0 < (broken)	14.0–18.3	18.1–18.3

ND no data

[a] Data from Nielsen (1997); Yeh et al. (2005); Takami et al. (2011)

[b] Based on 7 specimens

Table 13 Major counts and measurements of *Bassozetus taenia*

	Holotype	Other specimens	Previous studies [a]
	BMNH1887.12.7.51	*n* = 13	*n* = 28
SL (mm)	237	89–229	85–260
Counts			
Dorsal-fin rays	126	121–133	122–128
Anal-fin rays	106	100–110 [c]	100–109
Pectoral-fin rays	28	25–27	25–27
Caudal-fin rays	broken	8	8
Long gill rakers	1 + 1 + 14 = 16	1 + 1 + 12–18 = 14–20	15–20
Short gill rakers	5 + 5/4 =10/9 [b]	3–5 + 3–5 = 6–10	7–10
Oblique scales	20	17–22 [c]	ca. 15–20
Total vertebrae	69	67–73 [c]	67–73
Abdominal vertebrae	13	13–15 [c]	12–14
Caudal vertebrae	56	54–57 [c]	ND
Vertebral ordinal numbers			
Just below dorsal-fin origin	3	3–5 [d]	3–4
Just above anal-fin origin	15	15–17 [d]	14–16
Measurements (% of SL)			
Head length	broken	16.5–18.6 [d]	15.0–19.5
Greatest body depth	9.2	8.5–10.8 [e]	10.0
Body depth at anal-fin origin	7.3	4.5–8.8	6.4–9.7
Snout length	3.5	3.1–4.4	ND
Eye diameter	1.2	1.0–1.9 [c]	ND
Upper jaw length	7.2	4.4–9.9 [c]	7.6-10.4
Preanus length	27.4	25.1–30.7 [c]	ND
Predorsal length	15.3	14.0–18.0	13.0–19.0
Preanal length	29.4	28.2–31.5	27.5–33.5
Prepelvic length	11.7	11.1–17.1 [c]	11.5–14.5
Distance between pelvic fin to anal fin	18.7	15.2–20.2	15.0–19.0
Tail length	70.5	68.1–71.4	ND
Pectoral-fin length	broken	broken	ND
Pelvic-fin length	broken	13.3–16.1 [f]	12.0–18.0

ND no data

[a] Data from Nielsen and Merrett (2000) and Vieira et al. (2016)

[b] Left side/right side

[c] Based on 12 specimens

[d] Based on 9 specimens

[e] Based on 10 specimens

[f] Based on 5 specimens

Table 14 Major counts and measurements of *Bassozetus zenkevitchi*

	Present study	Previous studies [a]
	n = 4	*n* = 17
SL (mm)	178–259	57–275
Counts		
Dorsal-fin rays	116–120	113–119
Anal-fin rays	94–99	92–101
Pectoral-fin rays	23–25	23–25
Caudal-fin rays	8	7–9
Long gill rakers	1 + 1 + 13–16 = 15–18	15–18
Short gill rakers	4–5 + 2–5 = 6–10	6–9
Oblique scales	23–26	ca. 25–30
Total vertebrae	63–65	63–66
Abdominal vertebrae	12–13	13–14
Caudal vertebrae	50–52	ND
Vertebral ordinal numbers		
Just below dorsal-fin origin	3–4	3–4
Just above anal-fin origin	14–15	14–17
Measurements (% of SL)		
Head length	17.9–19.4	16.5–22.0
Greatest body depth	13.7–15.5	ND
Body depth at anal-fin origin	10.0–11.0	8.1–11.0
Snout length	3.7–4.5	ND
Eye diameter	1.9–2.1	ND
Upper jaw length	8.5–9.4	8.1–11.5
Preanus length	30.5–34.8	ND
Predorsal length	16.6–18.7	14.5–20.5
Preanal length	31.7–35.9	29.5–35.5
Prepelvic length	14.5–19.1	ND
Distance between pelvic fin to anal fin	18.0–21.8	14.5–20.0
Tail length	65.6–68.5	ND
Pectoral-fin length	10.0–11.2 [b]	ND
Pelvic-fin length	7.4 [c]	5.7–8.8

ND no data

[a] Data from Rass (1955) and Nielsen and Merrett (2000)

[b] Based on two specimens

[c] Based on one specimen

論文の内容の要旨

論文題目

Taxonomic studies of the deep-sea assfish, genus *Bassozetus* Gill 1883

(Ophidiiformes: Ophidiidae)

（アシロ科フクメンイタチウオ属魚類の分類学的研究）

学位申請者　冨山　晋一

キーワード：新種・シノニム・性的二型・分布・深海

フクメンイタチウオ属 *Bassozetus* は Gill（1883）によって提唱されたアシロ科シオイタチウオ亜科の一属である。本属は基鰓骨歯帯が 0–1 個、腹鰭が 1 軟条および側線を欠くことなどで特徴づけられる。全世界の熱帯域から亜寒帯域に広く分布し、漂泳性の *Bassozetus zenkevitchi* Rass 1955 を除いて主に水深 1,000–5,500 m の深海底付近に生息するが、生物学的知見は乏しい。本属最初の種は Günther (1878)により *Bathynectes compressus* として記載され、以降 1989 年までに計 11 種が報告されたが、属の定義や各種の識別的特徴は不明確であった。これらの問題は Nielsen and Merrett (2000)による世界的な分類学的再検討によって著しく進展し、既知 11 種に 2 新種を加えた 13 有効種が認められた。しかし近年、著者は本属魚類の複数標本を観察し、従来の識別形質では同定が困難な既知種、さらに複数の未記載種と日本初記録種の存在を確認した。そこで、本研究では本属の分類学的混乱を解決し、さらに性的二型と北西太平洋における分布に関する知見を充足することを目的とした。

材料には、世界各地の 12 研究機関が所蔵する 176 標本を用いた。計数・計測方法は Hubbs and Lagler (1958)や Tomiyama et al. (2015)などに従い、前鋤骨歯帯の計測方法は新たに定義した。脊椎骨の計数には軟 X 線写真を使用し、扁平石と生殖腺の観察は解剖により行った。

本研究の結果、フクメンイタチウオ属に 14 有効種を認めた。既知 13 種のうち 12 種は有効であり、*Bassozetus compressus* (Gunther 1878)を *Bassozetus elongatus* Smith and Radcliffe in Radcliffe 1913 のシニアシノニムとして再記載した（Tomiyama et al. 2015）。さらに、*Bassozetus mozambiquensis* Tomiyama, Takami and Fukui 2016 と *Bassozetus nielseni* Tomiyama, Takami and Fukui 2018 を新種記載した。本研究では *Bassozetus oncerocephalus* Vaillant (1888) と *Bassozetus werneri* Nielsen and Merrett 2000 を除く既知 9 種についても詳細に再記載し、識別的特徴を更新した。ホロタイプのみが知られる *B. oncerocephalus* と *B. werneri* は観察

できなかったが、Nielsen and Merrett (2000)が記載した両種の特徴は他 12 種と明確に異なるため有効種とした。以上により、各種の識別的特徴が明確化され、確実な種同定が可能となった。この結果に基づき作成した 14 種の検索表では、背・臀鰭条数、長い鰓耙数、脊椎骨数、横列鱗数、頭長と腹鰭の各体長比、基鰓骨歯帯の有無などのほか、正常な状態で保存されている扁平石も重要な識別形質とされた。これまで胸鰭条数、臀鰭条数および長い鰓耙数に基づく多変量解析により別種とされていたが有効な識別法がなかった *Bassozetus glutinosus* (Alcock 1890)、*Bassozetus nasus* Garman 1899 および *Bassozetus normalis* Gill 1884 の同定には、前鋤骨歯帯の後突出部における幅／長さ比および背鰭前長／臀鰭起部体高比が有効であることを明らかにした。

本研究でシノニム関係を指摘した *B. compressus* と *B. elongatus* は、Nielsen and Merrett (2000)においてインド・西太平洋さらに前者は大西洋にも分布するとされ、腹鰭長（*B. compressus* では 12.0–17.5 % SL vs. *B. elongatus* では 18.0–25.0 % SL）と扁平石の小突起の位置（後縁 vs. 前縁）によって互いに識別されていた。しかし、*B. compressus* のレクトタイプと *B. elongatus* のホロタイプを含む西太平洋産の標本を精査した結果、腹鰭長と扁平石の違いは記載の誤りに起因していたことが判明し、他に明確な形態的差異もないことから全て *B. compressus* に統一された（Tomiyama et al. 2015）。本種は西太平洋のみに分布し、他海域産の標本は *B. mozambiquensis*（西インド洋）および *B. nielseni*（北大西洋と西インド洋）として新種記載された（Tomiyama et al. 2016, 2018）。*Bassozetus compressus* は、2 新種とは鰭が黒褐色か褐色であること（vs. 淡黄褐色）、さらに *B. mozambiquensis* とは横列鱗数が少なく（18–20 vs. 30）で最大体高が低いこと（10.8–14.8 % SL vs. 18.0 % SL）、*B. nielseni* とは大型個体において尾部長が長く（346 mm SL 以上で 67.9–72.6 % SL vs. 342 mm SL 以上で 62.7–67.4 % SL）、小型個体において腹鰭が長いこと（216 mm SL 以下で後端部が肛門を超える vs. 常に肛門に達しない）で区別される。上記に加え、本研究では大西洋から *Bassozetus robustus* smith and Radcliffe in Radcliffe 1913 として報告されていた標本が未記載種であることを明らかにした。

フクメンイタチウオ属では初となる外部形態の性的二型が *B. nielseni* において観察された。本種の体長 500 mm 以上のメスは、ほぼ同体長のオスより頭長、背鰭前長、最大体高および臀鰭起部体高が有意に大きく、尾部長も短い傾向がある。外部形態の性的二型に関する報告は、深海に生息する近底層性シオイタチウオ亜科の他属においてもほとんど例がない。

本研究では日本初記録のフクメンイタチウオ属魚類として *B. compressus* と *B. glutinosus* を報告し（冨山ほか 2011； Tomiyama et al. 2015）、さらに髙見ほか（2011）では共著者として *B. robustus* も報告した。日本産の本属魚類は、既知の *Bassozetus levistomatus* Machida 1989 および *B. zenkevitchi* と併せて 5 種となった。上記の報告以降も、本研究では駿河湾から琉球列島にかけての海域から多数の *B. glutinosus* と *B. robustus* の標本を発見しており、両種は日本産フクメンイタチウオ属の中では比較的一般的な種であると考えられた。

上記の通り、本研究ではフクメンイタチウオ属に関する過去の分類学的混乱を解決し、確実な種同定を可能にした。さらに性的二型と分布に関する知見を補足した。