A REVIEW OF THE HEMIBRANCHIATE FISHES OF JAPAN.

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In the present paper is given a review of the Hemibranchiate fishes known to inhabit the waters of Japan. It is based on material in the Leland Stanford Junior University and in the U. S. National Museum, most of it collected by Jordan and Snyder in the summer of 1900. In a previous paper in these Proceedings[a] Mr. Starks has discussed the osteology of the suborder Hemibranchii and of its component families.

Order ACANTHOPTERGII.

Suborder HEMIBRANCHII.

Opisthotics absent; parietals usually absent; exoccipitals never meeting over surface of basioccipitals; myodome usually absent or rudimentary, sometimes well developed; posttemporal never typically forked, sometimes united to cranium suturely; a portion of the hypocoracoid sometimes enamelled, appearing externally as a separate bone on either side (interclavicle); supraclavicle usually absent, small when present; postclavicle when present composed of a single bone; superior pharyngeals and usually elements of branchial arches reduced in number; inferior pharyngeals present, not united; four anterior vertebræ more or less elongate, sometimes united; transverse process present on all abdominal vertebræ; snout more or less produced and tube-like with a small mouth at its end; ventrals abdominal, sometimes anteriorly placed. These fishes are allied to the *Percesoces*, from ancestors of which it is probably descended. Their relations to the Lophobranchii are close, the characters of the Lophobranchii being largely extremes of the same modifications.

(ἥμι, half; βράγχος, gill.)

In the following analysis of families we adopt the arrangement of families as given in Dr. Gill's valuable discussion of "The Mutual Relations of the Hemibranchiate Fishes."[b]

[a] Proc. U. S. Nat. Mus., XXV, 1902, p. 618.

[b] Proc. Acad. Nat. Sci. Phila., 1884, p. 154.

a. Dermal armature absent, or developed only as plates on side or back; vertebræ numerous (30 to 36); pubic bones placed close to scapular arch; spinous dorsal represented by isolated spines.

b. Vertebræ anteriorly little enlarged; ventrals subthoracic, each with a sharp spine.

c. Branchiostegal rays three; ventrals with one soft ray each; snout conic or but slightly tubiform.....GASTEROSTEIDÆ, I.

cc. Branchiostegal rays four; ventrals with four soft rays each; snout tubiform.....AULORHYNCHIDÆ, II.

bb. Vertebræ anteriorly (first four) elongate; ventrals abdominal or near middle of body, without spines, but with 6 (or 5) soft rays.

d. Dorsal spines developed, weak; body compressed, moderately long, with ctenoid scales; no caudal filament.....AULOSTOMIDÆ, III.

dd. Dorsal spines undeveloped; body depressed or subcylindrical, very long without scales; caudal with the two middle rays produced into a long filament.....FISTULARIIDÆ, IV.

aa. Dermal armature superficial, developed anteriorly and especially about the back; four anterior vertebræ much elongate; tail with its axis continuous with that of the abdomen; branchihyals and pharyngeals mostly present (fourth superior branchihyal and first and fourth superior pharyngeals wanting); pubic bones remote from the scapular arch; a spinous dorsal fin developed.

MACRORHAMPHOSIDÆ, V.

aaa. Dermal armature connate with the internal skeleton and developed as a dorsal cuirass in connection with the neuropophyses; six or more anterior vertebræ extremely elongate; tail with its axis deflected from that of the abdomen by encroachment of a dorsal cuirass over the dorsal fin; branchial system usually feebly developed; a spinous dorsal feebly developed under the posterior projection of the dorsal buckler.....CENTRISCIDÆ, VI.

Family I. GASTEROSTEIDAE.

STICKLEBACKS.

Body more or less fusiform, somewhat compressed, tapering behind to a slender caudal peduncle. Head moderate, the anterior part not greatly produced, but all the bones of the suspensory apparatus somewhat lengthened. Mouth moderate, with the cleft oblique, the lower jaw prominent; maxillary bent at right angles and overlapping the premaxillary at corner of mouth. Teeth sharp, even, in a narrow band in each jaw; no teeth on vomer or palatines; premaxillaries protractile. Preorbital rather broad; suborbital plate large, often covering the anterior part of the cheeks, forming a connection with the preopercle. Branchiostegals 3. Gill membranes broadly joined, free from the isthmus, or not; gill rakers moderate or rather long. Toothed superior pharyngeals 2; that of fourth arch missing or united to third. Opercles unarmed. Skin naked or with vertically oblong bony plates; no true scales. Dorsal fin preceded by two or more free spines; anal similar to soft dorsal, with a single spine; ventral fins abdominal, anteriorly placed and overlapped slightly at the side by a process from the shoulder girdle, though not connected to it, consisting of a stout spine and one or two rudimentary rays. Middle or sides of belly shielded by the pubic bones. Pectorals

rather short, unusually far behind the gill openings, preceded by a quadrate naked area, which is covered with shining skin. Caudal fin narrow, usually lunate. Air bladder simple; a few pyloric cæca. Vertebræ 30 to 35; anterior vertebræ little enlarged.

Small fishes inhabiting the fresh waters and arms of the sea in northern Europe and America; noted for their pugnacity. They are exceedingly destructive to the spawn and fry of large fishes.

a. Gill openings restricted, the membranes mesially united to the isthmus; dorsal with two free spines; skin mailed, partly mailed, or naked..... *Gasterosteus*, 1.

aa. Gill openings confluent, the gill membranes forming a broad, free margin across the isthmus; dorsal spines 8 to 11, divergent; skin naked or mailed.

Pygosteus, 2.

1. GASTEROSTEUS (Artedi) Linnæus.

Gasterosteus (Artedi) Linnæus, Syst. Nat., X, 1758, p. 489 (*aculeatus*).
Gasteracanthus Pallas, Mem. Ac. St. Petersb., III, 1811, p. 325 (*cataphractus*).
Leiurus Swainson, Nat. Hist. Class'n Fishes, II, 1839, p. 242 (*gymnurus*).

Sticklebacks with the innominate bones coalescent on the median line of the belly, behind and between the ventral fins, forming a triangular or lanceolate plate. Gill membranes united to the isthmus. Tail slender, and usually keeled. Skin variously covered with bony plates. Dorsal spines 3 in number, strong, with nondivergent bases. Species numerous. Fresh waters and shores of all northern regions; the species highly variable, those found in the sea usually with the body completely mailed, the fresh and brackish water forms variously mailed or even altogether naked. It is probable that the reduction in armature is in some degree connected with life in fresh waters. It is almost certain that the partly naked forms are in each species derived from mailed forms of the same region.

(γαστήρ, belly; ὀστέον, bone.)

1. GASTEROSTEUS CATAPHRACTUS (Pallas).

TOGEUWO (PRICKLY-FISH).

Gasteracanthus cataphractus Pallas, Mem. Acad. Petersb., III, 1811, p. 325; Kamchatka.

Gasterosteus obolarius Cuvier and Valenciennes, Hist. Nat. Poiss., IV, 1829, p. 500; Kamchatka.

Gasterosteus insculptus Richardson, Last Arctic Voyage, 1854, p. 10, pl. xxv, figs. 1, 2, and 3; Northumberland and Puget sounds.

Gasterosteus serratus Ayres, Proc. Cal. Acad. Sci., 1855, p. 47; San Francisco.—Sauvage, Revision des Epinoches, 1874, p. 13.

Gasterosteus intermedius Girard, Proc. Acad. Nat. Sci. Phila., 1856, p. 135; Cape Flattery.

Gasterosteus aculeatus cataphractus Jordan and Gilbert, Synopsis, 1883, p. 396.

Gasterosteus cataphractus Jordan and Evermann, Fishes N. and M. Amer., I, 1898, p. 749.

Gasterosteus aculeatus Ishikawa, Prel. Cat., 1897, p. 58; Hokkaido, Kuriles, Ugo, Yechigo, Shimotsuke, Musashi, Usen, Niigata.

Gasterosteus williamsoni Girard, Proc. Acad. Nat. Sci. Phila., 1854, p. 103; Williamson's Pass, near Saugus, California; naked form.

Gasterosteus microcephalus GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 133; Kaweah R., Tulare Lake; half-mailed form.

Gasterosteus plebeius GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 147; Presidio; half mailed.

Gasterosteus inopinatus GIRARD, Proc. Acad. Nat. Sci. Phila., 1854, p. 147; Presidio; half mailed.

Gasterosteus pugetti GIRARD, Proc. Acad. Nat. Sci. Phila., 1856, p. 135; Fort Steilacoom, Washington; half mailed.

The following description is taken from a specimen 85 mm. long from Ugo, northwest Japan:

Head $3\frac{1}{2}$; depth $4\frac{1}{2}$; eye $3\frac{1}{5}$. Dorsal 11–1, 13; anal 1, 10. Body slender, compressed; head small and pointed; mouth oblique, maxillary not reaching eye; caudal peduncle depressed, keeled. Processes from shoulder girdle slightly divergent, leaving a narrow, naked area on breast; naked area in front of pectorals equal to length of snout. Dorsal spines long and slender, the length equaling distance from snout to pupil; third dorsal and anal spines very small, curved; ventral spines long, slender, as long as snout and eye, or even longer in some specimens; serrate at base and with basal cusp; ventral plate as long as spine in many specimens, narrow, the greatest width $3\frac{1}{2}$ in length. Lateral armature complete, the plates gradually reduced in size posteriorly, forming a distinct caudal keel. Dark grayish or bluish black above, silvery below, with a few dark punctulations, thickest on caudal peduncle and near tip of ventral spines. Alaska, Kamchatka, and Japan. Very abundant northward; the mailed form rarely or never entering fresh water.

We have also marine specimens from Kushiro and northern Japan, which we have compared with specimens from Alaska and Puget Sound, and have found them to be similar.

Specimens from Ibi and Mino rivers near Ogaki in Mino seem to be inseparable from the naked specimens from Colton, California (called "*Gasterosteus williamsoni*"). They differ greatly from the marine form in being deeper, in having the ventral plate broad and short, in being only partially armed, in being conspicuously mottled, and in exhibiting all of the differences which fresh-water specimens at the extreme of variation from California and Alaska exhibit. Since it has not been possible to satisfactorily separate the Western American fresh-water species from those found in the sea, we can not consider these as distinct even though we have no intergrading forms at hand.

Formulæ of soft rays of dorsal and anal:

Locality.	Ugo.			Kushiro.		N. Japan.			Puget Sound.					Ibi River.					Mino, Japan.		
Dorsal	14	13	13	12	11	13	14	13	13	12	14	12	14	12	11	13	12	11	11	11	12
Anal	11	10	10	9	8	10	9	9	9	9	10	9	10	10	9	9	9	8	8	9	8

(*κατάφρακτος*, *cataphractus*, mailed.)

2. PYGOSTEUS Brevoort.

Pygosteus (Brevoort) Gill, Cat. Fishes East Coast North America, 1861, p. 39; name only.

Pygosteus Gill, Canadian Naturalist, II, 1865, p. 8 (*occidentalis*).

Gasterosteus Sauvage, Revision des Épinoches, 1874, p. 29 (*pungitius*).

This genus is characterized by the presence of 9 to 11 divergent spines and by the weakness of its innominate bones. The gill membranes form a broad fold across the isthmus. Vertebræ 14 + 18 = 32. (*πυγή*, pubic region; *ὀστέον*, bone.)

a. Dorsal with 8 spines ..... *steindachneri*, 2.

aa. Dorsal with 11 or 12 spines ..... *undecimalis*, 3.

2. PYGOSTEUS STEINDACHNERI Jordan and Snyder.

Gasterosteus japonicus Steindachner, Ichthy. Beitr., IX, p. 27, pl. III, fig. 2; Gulf of Strielok, near Vladivostok. (Not of Houttuyn.)

Pygosteus steindachneri Jordan and Snyder, Proceedings U. S. Nat. Mus., 1901, p. 747, after Steindachner.

Gasterosteus pungitius Ishikawa, Prel. Cat., 1897, p. 59; Lake Inokashiro, near Tokyo.

Gasterosteus sp. Ishikawa, Prel. Cat., 1897, p. 59; Yamashiro.

The following description is taken from 4 specimens from Yamashiro:

Head $3\frac{3}{5}$ in length; depth $4\frac{1}{4}$. Dorsal VIII–11; anal I–8, or 9. Diameter of eye equal to snout or slightly greater, contained $3\frac{1}{2}$ times in head; width of interorbital two-thirds diameter of eye; maxillary barely reaching to under anterior edge of the eye in the males, slightly shorter in the females.

Length of ventral spines equal to distance from tip of snout to middle of eye; length of middle dorsal spines two-thirds to three-fourths eye, last spine a little longer, equal to anal spine; length of pectoral equals snout and eye; length of anal base equal to dorsal base and equal to length of head without snout.

Anterior part of body with vertical bony plates which decrease in length posteriorly and become small round plates on posterior half of body; on the caudal peduncle they form a sharp keel; they number from 32 to 35.

Color in spirits very light yellowish brown with only a trace of small dusky punctulations. The membrane of the spinous dorsal dusky or conspicuously black. The soft dorsal and anal ranging from colorless to dusky. Pectoral and caudal without color.

Numerous specimens taken from a pond at Inokashiro, Musashi, near Tokyo, and one specimen from Aomori differ only from these in being entirely devoid of plates and in being much darker or more dusky. The fins are all more or less dusky and the membrane of the spinous dorsal is not darker than the body color. Of 16 specimens counted an equal number have 8 and 9 spines. Both these and the

mailed specimens from Yamashiro were presented by the Imperial Museum from the many examples collected by Dr. Ishikawa.

Steindachner's specimens seem to have been more slender and to have had higher spines than ours.

(Named for Dr. Franz Steindachner.)

3. PYGOSTEUS UNDECIMALIS Jordan and Starks, new species.

Head $3\frac{1}{5}$ to $3\frac{2}{5}$ in length; depth 5 to $5\frac{1}{2}$. Dorsal XI or XII (in an equal number of specimens)—10 or 11; anal 1–9. Eye $3\frac{1}{2}$ in head; snout 4; interorbital slightly less than diameter of eye. Maxillary reaching slightly past anterior margin of eye. Depth of head $1\frac{1}{2}$ to $1\frac{3}{4}$ its length.

Ventral spines very short and slender, equaling in length two-thirds to three-fourths diameter of eye. The dorsal spines are subequal in length to the next to the last and are scarcely half the diameter of the eye in length. The last one is about a third higher and is equal in length to the anal spine.

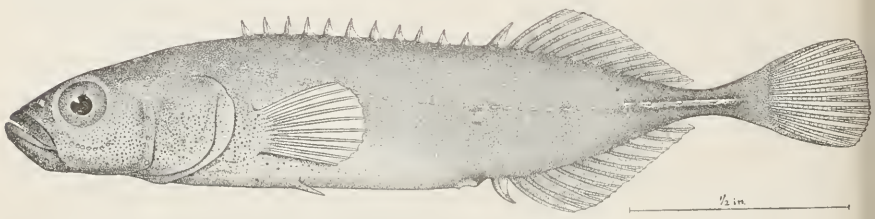

FIG. 1.—PYGOSTEUS UNDECIMALIS.

The body is entirely devoid of bony plates in our specimens, except in one example where a few plates form a keel on the caudal peduncle.

Color dark brown above, lighter below, all of the fins dusky.

This species differs from *Pygosteus steindachneri* in having a more slender form, a slightly longer head, shorter and more slender ventral spines, and particularly in having more numerous and shorter dorsal spines. The mouth appears to be larger and the caudal peduncle to be thicker. The color is darker.

Six specimens, the longest 53 mm. in length, presented by the Sapporo Museum, were taken at Chitose in Hokkaido by Mr. Nozawa. The type is No. 7119, Leland Stanford Junior University Museum.

(*undecim*, eleven.)

Family II. AULORHYNCHIDÆ.

8. AULICHTHYS Brevoort.

Aulichthys (Brevoort) GILL, Proc. Acad. Nat. Sci. Phila., 1862, p. 234, (*japonicus*).

Lateral line with a series of sharply keeled plates, each ending in a spine; pectoral fin not emarginate; ventrals inserted under middle of length of the pectoral fin.

Northern Japan; one species known, well separated from the Californian *Aulorhynchus flavidus*, by the row of lateral spines; the fin rays about the same.

(*αὐλός*, tube; *ἰχθύς*, fish.)

4. AULICHTHYS JAPONICUS Brevoort.

Aulichthys japonicus (Brevoort), Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 234; Shimoda.—Jordan and Snyder, Check List Fishes Japan, 1901, p. 60; Yokohama.

Aulorhynchus japonicus Steindachner Ichth. Beitr., X, 1881, p. 1, pl. v, fig. 1; Yokohama.

Fistulariidæ? Genus? Species? Ishikawa, Prel. Cat., 1897, p. 31; Nos. 551, 552; Boshu.

The following description is from a specimen from Tokyo, 15 cm. long.

Head $3\frac{3}{4}$ in length; depth 2 in snout. Dorsal XXV–9; anal 1–10. Lateral plates 55. Postcaudal plates 13. Eye 4 in snout, 2 in postorbital part of head.

The mouth is small, the maxillary is contained $2\frac{1}{2}$ times in the mandible, which is about half the length of the snout. From the backward-extending process from the maxillary a shallow channel runs backward on top of the snout to within a distance of the eye equal to the diameter of the eye. From the supraorbital rim a short channel runs forward to each side of the termination of the anterior median channel. The interorbital space is slightly convex and somewhat rugose. The length of the opercle is twice that of the rest of the postorbital part of the head.

The pectoral fin is inserted a distance equal to the length of the opercle from the edge of the opercle. The lower rays are the longest; their length is equal to their distance from the posterior orbital margin. The front of the dorsal is midway between the base of the caudal and the middle of the opercle. The anal is directly under the soft dorsal and about equal to it in length. Where the anal and the dorsal are depressed the tips of the longest rays just reach to the base of the last ray. The length of the caudal equals the length of the postorbital part of the head. The lower edge of the shoulder girdle is rough and is only covered by thin skin; it appears as a line of dermal bone and runs back nearly to a similar but wider line formed by the edge of pubic bones. The length of the ventrals equals the diameter of the eye.

Caudal slightly dusky, other fins colorless; top of head dark; opercles dusky above with fine brown points; a dark brown streak runs along preorbital region to middle of eye.

We have specimens from Tokyo, Matsushima, and Boshu. The species is not rare in northern Japan on sandy shores.

Family III. AULOSTOMIDÆ.

Body compressed, elongate, covered with small, ctenoid scales. Lateral line continuous. Head long; mouth small, at the end of a long, compressed tube. Lower jaw prominent, with a barbel at the symphysis. Premaxillary feeble, not protractile; maxillary broad, triangular, with a supplemental bone. Teeth minute, in bands on lower jaw and vomer. Branchiostegals 4. Gills 4, a slit behind the fourth. Pseudobranchiæ well developed. Gill rakers obsolete. Gill membranes separate, free from the isthmus. Air bladder large. Post-temporal free from cranium. Spinous dorsal present, of 8–12 very slender free spines; soft dorsal and anal rather long, similar posterior, with 23 to 28 rays each; caudal small, rhombic, the middle rays longest, but not produced into a filament; ventrals abdominal, of 6 rays, all articulated; pectorals broad, rounded, the space in front of them scaly. First four vertebræ elongated. Two pyloric cæca. A single genus, with two species, found in tropical seas.

4. AULOSTOMUS Lacépède.

Aulostomus Lacépède, Hist. Nat. Poiss., V, 1803, p. 357 (*chinensis*).
Aulostoma Schlegel, Fauna Japonica, Poiss., 1845, p. 320; change of spelling.
Polyterichthys Bleeker, Ternate, II, p. 608 (*valentini*=*chinensis*).
Solenostomus Gronow, Cat. Fishes, Ed. Gray, 1854, p. 146 (*chinensis*).

Characters of the genus included above.
(αὐλός, tube; στόμα, mouth.)

5. AULOSTOMUS[a] VALENTINI Bleeker.

Valentijn, Oud- en Nieuw-Oost-Ind., Amboyna, III, 1725, pp. 323, 448, 494.
Polypterichthys valentini Bleeker, Ternate II, about 1850, p. 608; Ternate.
Aulostoma sinensis Schlegel, Fauna Japonica, 1845, p. 520; "Très rare dans les mers du Japon."
Aulostoma chinense Günther, Cat. Fish., III, 1861, p. 538; Amboyna; Aneitum (not *Aulostomus chinensis* Lacépède, which, after Linnæus, is a West Indian species.

The following description is from a specimen 48 cm. in length from Honolulu. Head 3 in length; depth 11. Dorsal XI–26; anal 26; scales about 230.

Body elongate, compressed, the least depth just behind base of pectorals where the body is constricted below. Body expanding vertically somewhat at soft dorsal and anal, and abrupt narrowing at caudal peduncle, which is long and slender with parallel sides.

Eye contained $2\frac{3}{4}$ in post orbital part of head, $7\frac{1}{2}$ in snout. Lower jaw somewhat hooked up at tip over front of premaxillary. Maxillaries very broad, their width a little greater than eye and twice as long.

[a] *Fistularia chinensis* Linnæus is based chiefly in the *Solenostomus cauda rotundata* of Gronow, which is the West Indian species, *Aulostomus coloratus*. The latter species should properly bear the name *chinensis*.

Scales fine, strongly ctenoid, at nape becoming somewhat embedded. Area in front of pectorals closely scaled. Head naked.

Pectorals short and broad; their length equals twice the diameter of eye. Ventrals inserted midway between base of caudal and middle of eye. Dorsal placed directly over anal, which is of equal length. Base of dorsal equal to postorbital part of head and half eye. Length of caudal contained $3\frac{2}{5}$ in length of snout.

Color in alcohol brownish, with 10 or 11 narrow light crossbars, between each of which is a more or less conspicuous broken bar composed of diffused spots. Fins yellowish. A black stripe across base of dorsal and anal rays; a round black spot on upper and lower rays of caudal; a black spot on base of ventrals; and one on middle of maxillary. Other specimens very dark, with scarcely any crossbars. Others show conspicuous longitudinal light bars.

This species, common in the tropical seas from Hawaii to India, is recorded by Schlegel as very rare in Japan. It doubtless belongs to the fauna of the Riukiu Islands.

(Named for its discoverer, Fr. Valentijn, who wrote in 1725 on the "Oud- en Nieuw-Oost-Indien" and the "Waterdieren van Amboina.")

Family IV. FISTULARIIDÆ.

Body extremely elongate, much depressed, broader than deep. Scaleless, but having bony plates present on various parts of the body, mostly covered by the skin. Head very long, the anterior bones of the skull much produced, forming a long tube, which terminates in the narrow mouth; this tube formed by the symplectic, proethmoid, metapterygoid, mesopterygoid, quadrate, palatines, vomer, and mesethmoid. Both jaws, and usually the vomer and palatines also, with minute teeth; membrane uniting the bones of the tubes below, very lax, so that the tube is capable of much dilation. Post-temporal coössified with the cranium. Branchiostegals 5 to 7; gills 4, a slit behind the fourth. Gill membranes separate, free from the isthmus; gill rakers obsolete. Basibranchial elements wanting. Fourth superior pharyngeal missing or anchylosed to third. Pseudobranchiæ present. Air bladder large. Spinous dorsal fin entirely absent; soft dorsal short, posterior, somewhat elevated; anal fin opposite it and similar; caudal fin forked, the middle rays produced into a long filament; pectorals small, with a broad base, preceded by a smooth area; processes from hypocoracaid greatly lengthened; supraclavicles very small; ventral fins very small, wide apart, abdominal, far in advance of the dorsal, composed of 6 soft rays. Pyloric cœca few; intestine short. Vertebræ very numerous (4+44 to 49+28 to 33); the first four vertebræ very long. Fishes of the tropical seas, related to the sticklebacks in structure, but with prolonged snout and different ventral fins. A single genus, with a few species.

5. FISTULARIA Linnæus.

Solenostomus Klein, Missus, IV, 1740, p. 23 (nonbinomial).
Fistularia Linnæus, Syst. Nat., 10th ed., 1758, p. 312 (*tabacaria*).
Cannorhynchus Cantor, Malayan Fishes, 1850, p. 211 (*tabacaria; Fistularia* being regarded as preoccupied by Donati in 1750 for a pre-Linnæan genus of Polyps).
Flagellaria Gronow, Cat. Fishes, 1854, p. 146 (*fistularis=tabacaria*).

Characters of the genus included above. The bony shields, characteristic of this genus, are the following:

1. The narrow strip along the median line of the back behind the skull (confluent neural spines).

2. The pair of broader lateral dorsal shields. These shields are the longest, provided anteriorly with a ridge, which is prolonged and extends far backward between the muscles of the back. This ridge is flexible, and does not interfere with the lateral movements of the fish. It appears to serve as a base for the attachment of muscular fibers.

3. The narrow shield on the side is the postclavicle, its posterior part being dilated and fixed to the lateral dorsal shields.

4. The ventral shields are the processes from the hypocoracoids. Their posterior half is broadest, much pitted inferiorly. They are narrower before the middle, leaving a free lanceolate space between them, and are again a little widened anteriorly, where they join the clavicle and urohyal. These plates extend as far backward as the anchylosed vertebræ.

(*fistula*, a tube or pipe.)

a. Upper lateral edges on snout sharply serrated.
b. Two middle ridges on snout well separated, diverging on anterior part of snout, converging finally on its foremost part; skin nearly smooth. Color greenish ..... *depressa*, 6.
bb. Two middle ridges on snout close together and parallel on anterior half of its length, slowly converging forward from the middle; skin rough. Color, reddish ..... *petimba*, 7.

6. FISTULARIA DEPRESSA Günther

YAGARA (ARROW-SHAFT).

Fistularia depressa Günther, Shore Fishes Challenger, 1880, p. 69, pl. xxxii, fig. D; Sulu Islands, Natal, Zanzibar, Amboyna, China, New Guinea, New South Wales, Fiji, Lower California.—Jordan and Evermann, Fishes N. and M. Amer., 1, 1898, p. 757; Gulf of California, Panama.

The following description was taken from a small specimen 31 cm. in length (without caudal filament), from Wakanoura.

Head $2\frac{2}{3}$ in length. Depth at pectoral fins equal to long diameter of eye. Width just behind pectorals three-fifths of width at a point just behind ventrals. Dorsal 15; anal 14.

Body elongate, depressed, as viewed from above the sides are nearly parallel for a short distance behind pectorals, where it is narrower

than posterior part of head, but grows abruptly broader at the posterior end of the upper lateral plates and tapers gradually to the caudal.

The jaws are armed with a row of fine teeth. The maxillary is contained $8\frac{1}{4}$ times in the snout, the mandible $5\frac{1}{3}$ times. Eye nearly twice as long as high; extreme length of orbit equal to length of maxillary. Interorbital space somewhat concave, less so than in *F. petimba*, in larger specimens it is flat at the sides with a channel along its middle; the width is one-third of orbit. The median ridges on snout diverge anteriorly; the distance between them is everywhere greater or as great as the distance from them to the upper lateral ridge.

The ventrals are inserted from the pectorals a distance equal to the distance of the pectoral from the anterior margin of the eye. They are separated at their base by a space equal to the long diameter of the eye. The dorsal and anal are directly opposite to each other and similar in shape. The skin is everywhere smooth to the touch.

All of our specimens from Japan are plain brown greenish above, but as specimens from other localities may be either plain brown or with longitudinal stripes and spots of blue, probably blue-spotted examples occur.

The following color description was taken from a fresh specimen from Panama, 69 cm. in length:

Olive brown on upper parts, white below. A pair of narrow blue stripes, interrupted anteriorly and posteriorly, begin at the nape, diverge backward, and cross the lateral line just in front of the point where it becomes straight, then runs just above and parallel to the lateral line as far as the tail. Another pair of streaks, made each of blue spots, run close along each side of mid-dorsal line, from a point above axil of pectorals to front of dorsal. Behind dorsal, a single series of spots occupies the median line of back.

We have compared specimens from Panama, La Paz, Mexico, and from the Hawaiian Islands with our Japanese material and can appreciate no difference. The species occurs also in Samoa.

Several specimens under 32 cm. in length were collected at Wakanoura, Misaki, and Matsushima.

(*depressus*, depressed.)

7. FISTULARIA PETIMBA Lacépède.

YAGARA.

Fistularia Pipe, John White, Voyage New South Wales, pl. LXIV, fig. 2.

Fistularia tabacaria var. Bloch, Ichth., 1794, pl. CCCLXXXVII, fig. 2, "Coll. Linke at Leipzig;" wrongly figured as spotted with blue; snout serrate; 2 caudal filaments.

Fistularia petimba Lacépède, Hist. Nat. Poiss., V, 1803, p. 349 (excl. syn.); New Britain, Isle of Reunion, equatorial Pacific; based on specimens and manuscripts of Commerson; snout serrate; body immaculate.—Jordan and Evermann, Fish N. and M. Amer., I, 1898, p. 758.

Fistularia serrata CUVIER, Règne Animal, 1st ed., 1817, p. 349 (after Bloch).—GÜNTHER, Cat., III, 1861, p. 533.—GÜNTHER, Shore Fishes, Challenger, p. 68, pl. XXXII, fig. C, 1880.—JORDAN and GILBERT, Synopsis, 1883, p. 390.—ISHIKAWA, Prel. Cat., 1897, p. 31; Tokyo, Kii.

Fistularia immaculata CUVIER, Règne Animal, 1st ed., 1817, p. 349; Sea of the Indies; after Commerson and John White.

Fistularia commersonii RÜPPELL, Neue Wirbelthiere, 1834, p. 142; Red Sea.

The following description was taken from a specimen 30 cm. in length from Wakanoura:

Head $2\frac{1}{2}$ in length; depth at pectorals a little less than long diameter of eye. Dorsal 15; anal 14.

This species differs from *F. depressa* in the following characters:

The ridges on the top of snout are close together and parallel. The distance between them is always much less than the distance from them to the upper lateral ridge of snout. The head is more deeply sculptured and the ridges are rougher. The interorbital space is deeply concave and without flat supraorbital areas in the adult. The species may be at once distinguished by the touch, the skin feeling harsh like very fine shagreen. The lateral line is armed posteriorly with sharp bony plates.

Some of our specimens show faint traces of broad cross-bars about as wide as the diameter of the eye; 3 or 4 are on the snout and 12 or 14 on the rest of the body. It is pale or dull reddish brown in life. It seems to be rather less common than *F. depressa*, but neither species is rare in shallow bays of Japan. This species was found at Wakanoura, Misaki, and Nagasaki.

(*petimbuaba*, a Portuguese name.)

Family V. MACRORHAMPHOSIDÆ.

SNIPE-FISHES.

Body compressed, oblong, or elevated, covered with small, rough scales; no lateral line; some bony strips on the side of the back and on the margin of the thorax and abdomen, the former sometimes confluent into a shield. Bones of the skull much prolonged anteriorly, forming a long tube which bears the short jaws at the end; no teeth. Gill openings wide; branchiostegals 4. Branchihyals and pharyngeals mostly present, the fourth superior epibranchial and the first and fourth superior pharyngeals only wanting. Two dorsal fins, the first of 4 to 7 spines, the second of which is very long and strong; soft dorsal and anal moderate; ventral fins small, abdominal, of 1 spine and 4 or 5 soft rays; pectorals short; caudal fin emarginate, its middle rays not produced. Air bladder large; pseudobranchiæ present. Gills 4, a slit behind the fourth; vertebræ about 24, the four anterior ones much lengthened; no pyloric cœca; intestinal canal short. Three or more species, chiefly of the Old World, placed in two genera, *Macrorhamphosus* and *Centriscops*.

6. MACRORHAMPHOSUS Lacépède.

Macrorhamphosus Lacépède, Hist. Nat. Poiss, V, 1803, p. 136 (*cornutus=scolopax*).
Centriscus Cuvier, Règne Anim., 1st. ed., II, 1817, p. 350 (*scolopax*, not *Centriscus*, Linnæus, which was based on *scutatus* alone).
Macrognathus Gronow, Cat. Fishes, 1854, p. 147 (*scolopax*).
Orthichthys Gill, Proc. Ac. Nat. Sci. Phila., 1862, p. 234 (*relitaris*).

Body oblong, graduating into the caudal peduncle; back straight; dorsal spines about 7. Characters otherwise included above.

(μακρός, long; ῥάμφος, snout.)

a. Body deep, the depth 4 in length to base of caudal.....*sagifue*, 8.
aa. Body more slender, the depth 4½ in length to base of caudal.....*japonicus*, 9.

8. MACRORHAMPHOSUS SAGIFUE Jordan and Starks, new species.

SAGIFUE (BIRD FLUTE).

Centriscus sp. Ishikawa, Prel. Cat., 1897, p. 32; Kagoshima.

Head, 2 to 2⅕ in length; depth, 4 to 4¼; eye 5½ to 6 in head, 3½ to 4 in snout; snout 3 to 3⅛ in length.

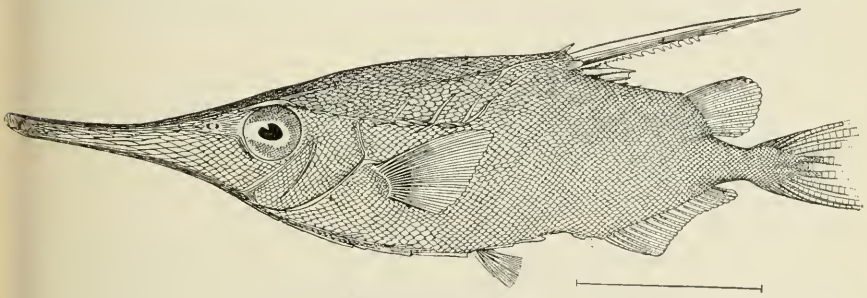

Fig. 2.—Macrorhamphosus sagifue.

Dorsal V–12; anal 18 (or 19, counting the last very small slender ray, which is crowded close to the preceding one.)

Outline of head concave from tip of snout to occiput and from mandible to tip of clavicles. Dorsal outline of body convex from occiput to dorsal spine, nearly level between dorsals dropping steeply oblique at anal base to caudal peduncle, less steep on caudal peduncle. Ventral outline evenly curved from shoulder girdle to caudal peduncle.

Mouth small, toothless; maxillary scarcely as long as the diameter of pupil. A slight ridge runs from above eye along upper lateral edge of snout, conspicuous near eye, growing lower anteriorly. Another ridge runs from the anterior margin of the eye straight forward and unites with the upper ridge. The preopercular ridge touches the posterior margin of the orbit and runs obliquely in a straight line nearly to lower margin of head under anterior margin of eye and is thence continued forward following the contour of snout.

Bony strips along back and armature of abdomen as described for *M. scolopax*.

The length of the second dorsal spine is variable, reaching only to the base of the rudimentary caudal rays in some examples, to above the middle of the longest caudal rays in the others; its insertion is midway between the base of the middle caudal rays and a point midway between the eye and the edge of the opercle. The pectorals equal in length the base of the anal, or the eye and postorbital part of the head.

Color in spirits silvery below, brownish above; fins colorless; pale red in life.

We have compared this species with two specimens of *Macrorhamphosus scolopax* from the Canary Islands. From them it differs in being a little more slender, and in having a slightly smaller eye and longer snout.

Specimens from Misaki and Enoura on Sagami Bay and from deeper water at Sagami and Saruga Bays, where it was dredged by the U. S. Fish Commission steamer *Albatross*. The type from Enoura is numbered 7125 in Leland Stanford, Junior, University Museum. A co-type is in the U. S. National Museum. The species is common in rather deep waters along the coast of Japan.

(*sagifue*, the Japanese name.)

9. MACRORHAMPHOSUS JAPONICUS Günther.

Centriscus japonicus GÜNTHER, Cat. Fish., III, 1861, p. 522; Japan; China.

Dorsal IV or V–11; anal 18 or 19.

The height of the body is contained $2\frac{3}{5}$ to 3 times in distance of operculum from base of caudal. Second dorsal spine very strong, not (or very indistinctly) denticulated posteriorly, the length about one-fourth or two-ninths of the distance of the opercle from the caudal.

The above is Dr. Günther's description of *Macrorhamphosus gracilis* of Europe From this species he differentiates *M. japonicus* in having a shorter dorsal spine.

The species was not seen by Jordan and Snyder. The type of Dr. Günther was doubtless from Misaki.

Family VI. CENTRISCIDÆ.

Form of body elongate, much compressed. Anterior bones of skull much produced and forming a long tube terminating in a small mouth. Body covered with a bony dorsal cuirass which is connate with the internal skeleton. Posteriorly it terminates in a long spine with or without a movable spine at its end. The longitudinal axis of the tail is deflected from that of the trunk by the encroachment of the dorsal cuirass over it. Vertical fins including a spinous dorsal crowded together under the terminal spine of dorsal cuirass. Ventrals

abdominal. Teeth none. Parietals absent. Posttemporal suturally connected to cranium; supraclavicle present. Ribs developed. Postclavicles present. East Indies. Species few and small, fantastically formed, the translucent carapace suggesting that of a shrimp.

7. ÆOLISCUS Jordan and Starks, new genus (strigatus).

This genus differs from *Centriscus* Linnaeus (*Amphisile* Cuvier),[a] chiefly in having the first dorsal spine borne by the spine which terminates the cuirass. The dorsal cuirass of *Centriscus* ends posteriorly in a long unjointed spine. This genus *Æoliscus* includes also *Æoliscus punctulatus* (Bianconi) and perhaps also the fossil species called *Amphisile heinrichi*.

(αἰόλος, moving.)

10. ÆOLISCUS STRIGATUS (Günther).

Amphisile strigata Günther, Cat. Fish., III, 1861, p. 28; Java.

Head 2½ in length to base of soft dorsal rays; depth 3 in head; orbit 11 or 12 in head; 1⅞ to 2 in postorbital part of head; interorbital ⅘ orbit. Dorsal III, 10; anal 12.

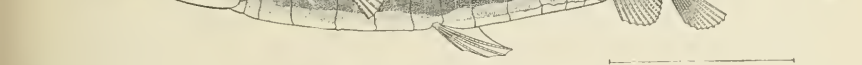

Fig. 3.—Æoliscus strigatus.

Body very much compressed and rather elongate, resembling in transverse section a razor blade—thin and rounded above, tapering below to an extremely thin drawn out cutting edge. Head and body cuirassed with smooth, bony plates; tapering anteriorly into a long bony snout; terminating posteriorly in a long spine.

Outline of head concave above from occiput to tip of snout; the rostral tube bent upward anteriorly and terminating in an extremely small toothless mouth. The length of the mandible is less than half the diameter of the eye. The interorbital is convex and longitudinally striated; its width is equal to the diameter of the eye. The supraorbital margin of the eye is a projecting rim.

The third lateral plate of the body is nearly twice as long as deep; its lower edge is midway between the outline of the back above it and the base of the ventral fin. There are 11 lower ventral plates (ribs), 2 in front of the pectoral and 9 behind.

[a] The name *Centriscus* Linnaeus, was based on *Centriscus scutatus* alone, described after Gronow. It is therefore equivalent to *Amphisile* of Cuvier and *Acentrachme* of Gill, and can be used neither for *Macrorhamphosus* nor for *Æoliscus*.

Directly below the posterior spines the vertical fins are crowded. The spinous dorsal and soft dorsal point nearly straight backward, the caudal obliquely downward, and the anal straight downward. The pectoral is inserted behind the opercle a distance equal to the diameter of the eye and the postorbital part of the head; its posterior margin is slightly concave; the extreme upper and lower rays are the longest, the former a little longer than the latter. The ventrals are inserted midway between a point below the anterior orbital rim and the base of the posterior anal ray. They are in some individuals long (probably a sexual variation) and are contained $1\frac{1}{5}$ in the depth of the body above them; in others they are short, equal to or slightly exceeding the diameter of the eye. The first dorsal spine is equal in length to or slightly exceeds the distance of the pectoral from the edge of the opercle. From the end of the process which bears it a tiny spine projects downward and is connected to the dorsal spine by a membrane. The fish is evidently able to lock the dorsal spine in a horizontal position. When declined it projects downward at right angles to the spine that bears it. The second and third dorsal spines are curved slightly downward. The second reaches about three-fifths of the distance from its base to the base of the first. The tips of the dorsal rays reach a very little past the tip of the second dorsal. The length of the caudal rays are equal to the length of the dorsal rays. The anal rays are shorter and are about equal to the length of the base of the fin.

Color brown, lighter above; a dark streak running through the eye appears as a double streak on opercles, thence takes an irregular course to pectoral base, behind which it is continued along the naked portion of the body below lateral plates, where it widens slightly at each rib; behind it crosses the caudal vertebræ and ends between the spinous and soft dorsals.

Numerous specimens were obtained from Yaeyama, Ishigaki Island, Riukiu, having been collected by Capt. Alan Owston.

(*strigatus*, striped.)

SUMMARY.

Suborder HEMIBRANCHII.

Family I. GASTEROSTEIDÆ.

1. *Gasterosteus* (Artedi) Linnæus.

1. *cataphractus* (Pallas); Kushiro, Ibi River, Mino River.

2. *Pygosteus* Brevoort.

2. *steindachneri* Jordan and Snyder; Yamashiro, Inokashiro, Aomori.
3. *undecimalis* Jordan and Starks; Chitose, Hokkaido.

Family II. AULORHYNCHIDÆ.

3. *Aulichthys* Brevoort.

4. *japonicus* Brevoort; Tokyo, Matsushima, Boshu.

Family III. AULOSTOMIDÆ.

4. *Aulostomus* Lacépède.

5. *valentini* Bleeker.

Family IV. FISTULARIIDÆ.

5. *Fistularia* Linnæus.

6. *depressa* Günther; Wakanoura, Misaki, Matsushima Bay.
7. *petimba* Lacépède; Wakanoura, Misaki, Nagasaki.

Family V. MACRORHAMPHOSIDÆ.

6. *Macrorhamphosus* Lacépède.

8. *sagifue* Jordan and Starks; Misaki, Enoura, Sagami Bay, Saruga Bay.
9. *japonicus* Günther.

Family VI. CENTRISCIDÆ.

7. *Æoliscus* Jordan and Starks.

10. *strigatus* (Günther); Ishigaki Islands.