Taxonomic Studies on the Puffers (*Tetraodontidae, Teleostei*) from Japan and Adjacent Regions - VII. Concluding Remarks, with the Introduction of Two New Genera, *Fugu* and *Boesemanichthys*

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In the previous reports of the present series, the variation in broader sense as well as in narrower sense (*vide* ABE, 1944, p. 201) of the vertebral column and fins was dealt with in order to satisfy the real needs for such studies. As they proceeded, new subgenera and new forms were perceived, and it became necessary for further reports to give a synopsis of the members of *Tetraodontidae* examined by the present writer. It was published in 1949 when the situation became much improved, and since then he continued to gather additional specimens and publications from abroad for comparison. But the outbreak in 1950 of the Korean Affairs has made it very difficult for him to obtain further material of Sino-Korean puffers. In view of the difficulty in receiving them in the near future, and in view of the recent general progress in the taxonomy of the gymnodont fishes of the world, it is thought advisable to present here some of the concluding remarks on the taxonomic studies of the puffers from Japan and adjacent regions leaving for the present the more detailed study of the Sino-Korean puffers.

Besides the structures treated in considerable detail in the previous reports of the present series, the following items are of taxonomic importance: i) bones of the head region, ii) pectoral girdle, iii) dermal spine, iv) lateral cutaneus fold or ridge, v) lateral line, vi) nasal organ, vii) air-bladder, viii) coloration, ix) swelling, x) toxicity and xi) habitat and distribution range. These items were mostly studied by a host of ichthyologists, morphologists and toxicologists among whom may be mentioned DARESTE (1850), HOLLARD (1857)*, BLEEKER (1865), GÜNTHER (1870), GILL [1885 (1884), 1892 (1891)], WIEDERSHEIM (1887, 1887a), TAKAHASHI & INOKO (1892), THILO (1899, 1914), REGAN (1902), ROSÉN (1913, 1916), KASCHKAROFF [1914 (1913)], GREGORY (1933), FRASER-BRUNNER (1943)**, KURONUMA (1943), TANI (1945) and BREDER & CLARK (1947). The present writer also touched upon the majority of these items in his previous papers, and under the present circumstances there remains but a little to be added to, or, to be corrected in the works of the observers mentioned above. But these additional or correcting observations have been of great assistance in reaching the conclusions which are here presented.

1. Erection of a new genus, *Fugu*, for the reception of the common Sino-Japanese puffers hitherto placed in *Sphoeroides* or *Torguigener*

It was suggested at times in the previous papers of the present series that the

* HOLLARD utilized the skeletons collected by BIBRON [according to GILL, 1892 (1891)].

** FRASER-BRUNNER has provided a "skeleton" upon which more detailed studies on species or forms, like those of KURONUMA and those of the present writer, should be based.

adoption of *Sphoeroides* as the generic name of the common Sino-Japanese puffers was only provisional or for the sake of convenience. As was decidedly pointed out by FRASER-BRUNNER (1943), the genotype of *Sphaeroides* (often written *Sphoeroides* or *Spheroides* by authors), *Tetrodon spengleri* BLOCH, and its allies of the Atlantic markedly differ in the meristic and cranial features* from the common Sino-Japanese puffers previously placed in *Sphoeroides*. But for the latter puffers there seem to have been no valid generic names, and even FRASER-BRUNNER erred in adopting *Torquigener* WHITLEY as their generic name (*vide* ABE, 1950–1951, pp. 198 and 199).

Diagnosis of *Fugu*, gen. nov.

Genotype.–*Tetraodon rubripes* TEMMINCK et SCHLEGEL.

This new genus is characterized by combining the following: The nostrils are paired on each side. The frontals are expanded laterally, much wider behind the prefrontals (or lateral ethmoids) than between them, and prolonged forward, the anterior tips reaching farther forward than the anterior edges of the prefrontals**. The ethmoid is wide. The parasphenoid is expanded dorsally, reaching the orbital roof***. The upper jaw has no tubercles on its inside****. The lower post-clavicle is a thin rod.

The total number of the vertebrae† is (rarely 19) 20 to 24 (rarely 25), usually 21 or 22. The number of the precaudals is (rarely 6.5†† or 7) 7.5 to 10, usually 8 or 9. The number of the anterior precaudals bearing befid divergent neurl spines is mostly 3.5 to 4.5 (in *pardalis* 3.5 to 6).

The total number of the dorsal fin-rays is usually 12 to 18 (in *pardalis* 11 to 14; in *chrysops* 11 to 13; in *rubripes rubripes* 15 to 19). The number of the anteriormost unbranched fin-rays of the dorsal is (very rarely 1) 2 to 6 (only in *xanthopterus* 4 to 7). The 1st fin-ray of the dorsal is not hidden beneath the skin. The total number of the interneural spines in the majority of the species or forms is 1+10 to 1+17. The 2nd interneural is mostly between the neural spines of the 7th and 8th vertebrae; in *pardalis* and *chrysops* it is mostly between the neural spines of the 8th and 9th vertebrae. The total number of the anal fin-rays is 9 to 16. The number of the anteriormost unbranched fin-rays of the anal is 1 to 6 (rarely 7). The 1st fin-ray of the annal is not hidden beneath the skin. The total number of the interhaemal spines is 6 to 12 (rarely 13.) The fin-formula of the caudal is usually i/8/ii. The total

* The present writer has also compared these features of the common Sino-Japanese puffers mentioned above with those of an Atlantic species, *Spaeroides maculatus* (BLOCH et SCHNEIDER).

** The anterior tips of the frontals in the subgenus *Takifugu* is not far forward in position than the anterior edges of the prefrontals.

*** This is one of the most important features which distinguish this new genus from *Sphaeroides maculatus* of the Atlantic and *Liosaccus cutaneus*.

**** In this point this new genus differs from *Sphaeroides maculatus* and *Liosaccus cutaneus*.

† The vertebral counts have not been made on *Fugu ocellatus ocellatus* (LINNAEUS), *F. basilevskianus* (BASILEWSKY) and *F. pseudommus* (CHU). In *F. exascurus* (JORDAN ef SNYDER), of which the present writer has recently skeletonized a specimen, the total number of the vertebrae is 22 (=8+14).

†† For the method of counting, *vide* ABE, 1942.

number of the fin-rays in each of the pectorals is (rarely i+12) i+13 to i+19. The uppermost fin-ray of the pectoral in the adult is rudimentary and hidden beneath the skin. The 2nd fin-ray from above of the pectoral is long and usually unbranched. The 3rd from above and the lower pectoral fin-rays are usually branched (with the exception of the lowermost ray).

The dermal spines, if present, are two- to five-rooted; usually there are no spinulose areas before and behind the gill-opening. In some species or forms the dermal spines are seemingly lacking*. The lateral cutaneus fold or ridge below is very conspicuous on each side from the chin to the base of the caudal fin. The lateral lines are distinct (*vide* JORDAN and SNYDER, 1901g, p. 238). The majority of the members of this genus have a dark humeral blotch oppostie to the posterior end of the pectoral fin.

Except for the subgenus *Takifugu* in which the air-bladder is kidney-shaped and concave posteriorly**, the air-bladder is globular or oval, narrowed posteriorly.

The liver and ovary are invariably poisonous.

With the exception of the aberrant species *oblongus* (of the subgenus *Takifugu*) which is distributed from East Africa to southern China and Australia, this genus seems to be confined to Sino-Japanese area in distribution range†.

Named *Fugu* in reference to the Japanese name "fugu" applied to the members of this genus and the other members of *Gymnodontes*. Some of the members of the genus *Fugu* are among the commonest shore fishes of Japan, and a few members, such as *F. rubripes rubripes*, *F. vermicularis porphyreus*, *F. vermicularis vermicularis* and *F. vermicularis radiatus*, are landed in considerable quantity for food, the two former being highly prized as delicacy.

Interrelation

The members of the genus *Fugu* are grouped into the five subgenera, *Torafugu* ABE [(1939)1949], *Shosaifugu* ABE (1949), *Higanfugu* ABE (1949), *Liosarcus* HILGENDORF (1897) and *Takifugu* ABE (1949). To each of the first two belong several closely-related species or forms*, and the first named approaches the second through *niphobles* (*vide* ABE, 1949b, p. 115). The most important feature which distinguishes these two subgenera from one another is the shape of the frontal (*vide* ABE, 1949b, pp. 90 and 92; Figs. 1 and 2 of the present paper).

Higanfugu, *Liosarcus* and *Takifugu* are well-defined subgenera, each comprising a single species, and the last is the most aberrant, differing from the other subgenera of the genus *Fugu* in the extent of the spinulose areas in front of the gill-opening and

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* Even in those puffers in which the dermal spines are seemingly lacking, the vestiges of the dermal spines are present (according to KURONUMA, 1939?).

** In this respect *Takifugu* resembles *Amblyrhynchotes hypselogeneion*, *A. tuberculiferus* and *Sphaeroides maculatus*.

† If *Tetraodon honckenii* of BLEEKER (Atl. Ichth.) is identical with *F. niphobles*, or, if *Tetraodon alboplumbeus* of BLEEKER (Atl. Ichth.) is identical with *F. poecilonotus*, the distribution range of *Fugu* is a little wider.

†† In some cases it is difficult to decide to which species or form a specimen to be identified should be referred.

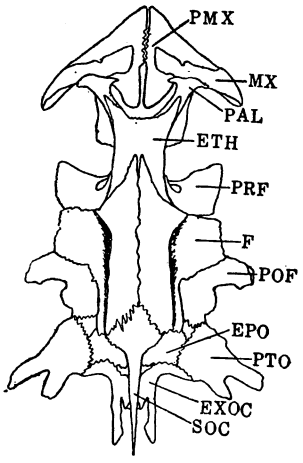

Fig. 1. Dorsal view of skull of *Fugu* (*Torafugu*) *rubripes rubripes* (TEMMINCK et SCHLEGEL). Length of skull (from anterior end of upper jaw to posterior end of supraoccipital) 112mm. EPO:Epiotic. ETH: Ethmoid. EXOC:Exoccipital. F: Frontal. M:Maxillary. PAL: palatine. PMX:Premaxillary. POF:Postfrontal. PRE: Prefrontal. PTO:Pterotic. SOC:Supraoccipital.

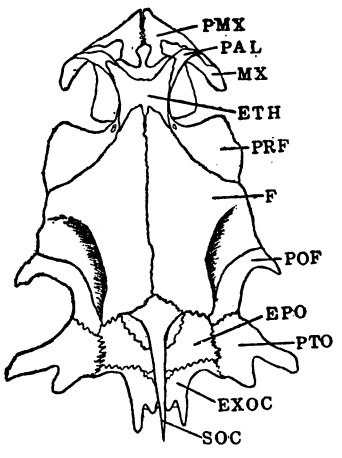

Fig. 2. Dorsal view of skull of *Fugu* (*Shosaifugu*) *stictonotus* (TEMMINCK et SCHLEGEL). Length of skull 76 mm. Lettering as in Fig. 1.

behind the base of the pectoral fin*, the shape of the air-bladder, the coloration** and distribution range. In *Takifugu*, the shape of the frontal, especially the position of its longitudinal ridge, is suggestive of that of the subgenus *Torafugu*. *Higanfugu* is remarkable in its unusual variability of the meristic features and the position of the interneural or interhaemal spines. Lastly, the characteristic features of the vertebral column in *Liosarcus* were pointed out by the present writer (1942) and those of the skull were described by KURONUMA (1943). This subgenus is known only from the Pacific coast of central Japan.

2. Recognition of *Amblyrhynchotes* TROSCHEL as the generic name of *Tetrodon honckenii* BLOCH and its allies

According to FRASER-BRUNNER (1943), the genotype of *Amblyrhynchotes* is *Tetrodon honckenii* BLOCH. In so far as the present writer has examined the specimens preserved in formalin, this species† resembles *Tetraodon hypselogeneion* BLEEKER and

* In these features *Takifugu* resembles *Sphaeroides maculatus* of the Atlantic and some of the members of the genus *Amblyrhynchotes* which will be dealt with below.

** The dark humeral blotch is never present in the subgenera *Takifugu*, *Higanfugu* and *Liosarcus* whereas it is conspicuous in some of the members of the subgenus *Shosaifugu* and the majority of the members of the subgenus *Torafugu*. It is also of interest to see that in *Higanfugu* and *Liosarcus* the young as well as the adult never have white or pale spots on the back and sides, which are invariably present in the other three subgenera of the genus *Fugu* as well as in *Amblyrhynchotes honckenii* and *Chelonodon patoca*. Further, *Takifugu* differs from the other subgenera of the genus *Fugu* in having the dark vertical bands separated by the white vertical bands on the sides of the trunk and head.

† Recently two specimens of *A. honckenii* (BLOCH) have been received from Prof. J. L. B. SMITH of Rhodes University, Grahamstown, South Africa. The present writer wishes to express here his sincere thanks for Prof. SMITH's kindness and effective cooperation.

Spheroides tuberculiferus OGILBY in many features. Taking cognizance of the act of FRASER-BRUNNER (1943)*, some remarks on the genus *Amblyrhynchotes* will be given below.

The lack of well-skeletonized specimens of the three species mentioned above coupled with the lack of the specific name of the skull depicted by FRASER-BRUNNER (1943, Fig. 1, V) of *Amblyrhynchotes* hes made it very difficult for the present writer to describe exactly the differences in the osteological features between the members of this genus and those between this genus and the other genera such as *Sphaeroides*, *Fugu* and *Lagocephalus*. Yet, judging from the external features, the dorsal and lateral aspects of the skull, and the shape of the lower post-clavicle, it may be said that the three species mentioned above form a compact group by combining the following: The nostrils are paired on each side. The frontals are evenly narrowed forwards, not expanded at the hind edges of the prefrontals, and the anterior tips of the frontals are farther forward in position than the anterior edges of the prefrontals. The ethmoid is short, much smaller than in *Sphaeroides maculatus*. The bony interorbital space is narrow. The parasphenoid is expanded dorsally, reaching the orbital roof as in *Fugu*. The lower post-clavicle is a thin rod.

The total number of the vertebrae is 20 in *hypselogeneion* and *honckenii*, the number of the precaudals being 7 in the former and 8 in the latter (after GÜNTHER, 1870). The total number of the dorsal fin-rays is 8 to 10. The number of the anteriormost unbranched fin-rays of the dorsal is 1 or 2. The 1st fin-ray of the dorsal is not hidden beneath the skin. The total number of the anal fin-rays is 7 or 8. The number of the anteriormost unbranched fin-rays of the anal is 1 or 2. The 1st fin-ray of the anal is not hidden beneath the skin. The fin-formula of the caudal is i/8/ii. The total number of the fin-rays in each of the pectoral is i+13 to i+15. The uppermost fin-ray of the pectoral is rudimentary and hidden beneath the skin. The 2nd fin-ray from above of the pectoral is long and unbranched; the 3rd and the lower finrays (excepting the lowermost ones) are usually branched.

The dermal spines are rather large, and two- to five-rooted. The dorsal and ventral spinulose areas are connected by a transverse spinulose area before the gill-opening and by another behind the pectoral base. The lateral cutaneus fold or ridge is conspicuous from the chin to the base of the caudal fin. The lateral lines are as in *Fugu*.

The air-bladder of *hypselogeneion* and *tuberculiferus* is kidney-shaped and concave posteriorly as in *Sphaeroides maculatus* and *Fugu* (*Takifugu*) *oblongus*, and in *honckenii* it is globular and somewhat narrowed posteriorly as in the other members of the genus *Fugu*.

A. hypselogeneion and *A. tuberculiferus* seem to be dwarfed forms reaching maturity at such a small size as 12 to 15 cm. total length; *A. honckenii* is said to attain 30 cm. in total length.

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* The original description of *Amblyrhynchotes* by TROSCHEL has not been seen by the present writer.

Of the three species mentioned above, *hypselogeneion* is distributed in the tropical and subtropical Indo-Pacific, from East Africa to southern Japan and Polynesia, north to Hawaii; *honckenii* is distributed from the Cape of Good Hope eastwards to southern China; *tuberculiferus* is known only from Australia.

3. Erection of a new genus, *Boesemanichthys*, for the reception of *Tetraodon firmamentum* TEMMINCK et SCHLEGEL

Although some of the peculiarities of *Tetraodon** *firmamentum* TEMMINCK et SCHLEGEL in the structure of the dorsal, anal and pectoral fins were noticed (*vide* ABE, 1944, 1949, 1949b and 1950–1951), lack of the skeletonized specimens of this species precluded the further study of the present writer on its taxonomic position. Recently he has dissected and skeletonized two specimens of this puffer collected by him on November 15, 1950, at Ōiso, Kanagawa-ken. The both measured 330 mm. in total length prior to the boiling. They were taken by hook and line along with *Lagocephalus lunaris* (BLOCH et SCHNEIDER) and *Branchiostegus japonicus* (HOUTTUYN) from depths of some 100 m or shallower water off Ōiso, in northern part of Sagami Sea. Close examination of these specimens has revealed many features of taxonomic importance which are believed not to have been reported upon by previous writers. These findings have led the present writer to erect a new genus, *Boesemanichthys*, named in honor of Dr. M. BOESEMAN who in 1947 published "Revision of the fishes collected by BURGER and von SIEBOLD in Japan". The genotype of this new genus, *Tetraodon firmamentum*, was first described by TEMMINCK and SCHLEGEL based on the material collected by BURGER.

Diagnosis of *Boesemanichthys*, gen. nov., and its affinity with the other puffers

Genotype.– *Tetraodon firmamentum* TEMMINCK et SCHLEGEL.

a. External features. The nasal sac is open, forming two skinny flaps. The total number of the dorsal fin-rays is 14 or 15. The number of the anteriormost unbranched fin-rays of the dorsal is 2 to 4. The total number of the fin-rays of the anal is 13 or 14. The number of the anteriormost unbranched fin-rays of the anal is 2 to 4. The 1st fin-ray of the dorsal and anal is not hidden beneath the skin. The fin-formula of the caudal is ii/7/ii, or i/8/ii, or, i/9/i. The total number of the fin-rays in each of the pectorals is i+13 to i+15. The uppermost fin-ray of the pectoral is short, but not hidden beneath the skin. The 2nd fin-ray from above of the pectoral is long and unbranched. The 3rd from above and the lower fin-rays of the pectoral are usually branched; the lowermost fin-ray is sometimes unbranched.

The dermal spines are close-set, usually four-rooted and distributed almost all over the head and trunk leaving the snout and the lower and posterior parts of the caudal peduncle naked. The lateral cutaneus fold or ridge is lacking. The lateral lines are indistinct; the main line reaches below the dorsal fin and is lacking on the caudal

* In his previous papers, the present writer tentatively adopted the generic name *Chelonodon* for *firmamentum* only for the sake of convenience.

peduncle; there is no lateral line on the ventral side of head and trunk. The coloration is suggestive of *Tetraodon hispidus* LINNAEUS; the color in formalin is dark brown above with pale roundish spots. The pale spots on the belly are larger than on the back, and the dark interspaces look like reticulations. Unlike *T. hispidus*, there are no markings on the dorsal fin and the posterior half of the caudal fin.

In the majority of the features mentioned above, the genus *Boesemanichthys* is nearer to the genus *Tetraodon* than to the genus *Fugu*. But the higher number of the fin-rays of the dorsal and anal in the first named than in the second is remarkable.

b. Vertebral column. In *Boesemanichthys* the total number of the vertebrae is 20, of which 8 are the precaudals (namely, N=20=8+12)*. In *Tetraodon hispidus* LINNAEUS and its allies with which *Boesemanichthys* was usally placed in the same genus, *e. g.*, in *Arothron* MÜLLER, by FRASER-BRUNNER (1943), N is 18 (=8+10). The other examined puffers with broad head and two nasal tentacles or flaps on each side of the snout, namely, *Dichotomycter fluviatilis* (HAMILTON-BUCHANAN) and *Chelonodon patoca* (HAMILTON-BUCHANAN), also have fewer vertebrae than *Boesemanichthys*, N being 18 (probably 8+10) in the first named and 19 (=8+11) in the second. If the comparison will be extended to the puffers with broad head and paired nostrils on each side which are referable to the genera *Fugu*, *Amblyrhynchotes* and *Sphaeroides*, it will be found that *Boesemanichthys* approaches the first two at least in N (*vide* ABE, 1942, p. 479 and Table 1). It is of interest to see that N in the Japanese populations of *Lagocephalus lunaris* (BLOCH et SCHNEIDER) is 19(=8+11) or 20 (=8+12) while it is 17 (=8+9) in the population of the same species from Borneo. Further, it should be recalled in this connection that, even among the puffers with two nasal tentacles on each side, *Tetraodon pustulatus* MURRAY from the west coast of Africa has 22 vertebrae (N=8+14) (after GÜNTHER, 1870).

Correlated with the fact that the number of the precaudals usually varies only a little from member to member of the family *Tetraodontidae* (*vide* ABE, 1942, pp. 481–485 and Table V), the statement given above well applies to the number of the caudals. In this meristic feature *Boesemanichthys* again approaches the genera *Amblyrhynchotes* and *Fugu*, or, the Japanese populations of *Lagocephalus lunaris*. But in regard to the number of the anterior precaudals bearing the bifid divergent neural spines (a_1), *Boesemanichthys* is nearer in this meristic character to *Tetraodon hispidus* and its allies than it is to *Fugu* or the other genera examined. In *Boesemanichthys* a_1 is 6**; in *T. hispidus* and its allies a_1 is 4.5 to 5.5; in *Chelonodon patoca* a_1 is 3.5 to 4.5; in *Dichotomycter fluviatilis* a_1 is probably 4.5; in *Lagocephalus lagocephalus*

* This statement is based on the specimens of *B. firmamentum* mentioned above.

** This high value of a_1 reminds the writer of the condition found in the family *Diodontidae*. In a specimen of *Diodon holacanthus* LINNAEUS and another of *D. histrix* LINNAEUS, both collected by him in the Palau (or Pelew) Islands, a_1 is 10, N being 20 (=11+9). In a specimens of *Chilomycterus affinis* GÜNTHER taken by him at Uchiura, Shizuoka-ken, Japan, a_1 is 11, N being 22 (=13+9).

oceanicus, *L. laevigatus inermis* and *L. lunaris* a_1 is 3.5; in *Fugu ocellatus obscurus* (ABE) a_1 is 4.5; in *F. rubripes chinensis* (ABE) a_1 is 4; in *F. exascurus* (JORDAN et SNYDER) a_1 is 3.5; and in all the other puffers mentioned in Table X of ABE, 1942, a_1 is 3.5 to 4.0 with the exception of *Fugu* (*Higanfugu*) *pardalis* (TEMMINCK et SCHLEGEL) in which a_1 varies between 3.5 and 6 and in which N or the number of the precaudals is most variable among the puffers examined.

On the other hand, the bifid divergent neural spines of the anteriormost vertebrae are flattened and rather broad in *Boesemanichthys*, and in this respect this genus is nearer to *Fugu* or *Chelonodon patoca* than to *Tetraodon hispidus* and its allies (*cf.* ABE, 1942, p. 488). But the haemal spines of the 2nd and the subsequent caudals of *Boesemanichthys* markedly differs from that of the other puffers. In the former these spines are neither compressed (unlike those of *T. hispidus* and its allies, those of *Ch. patoca* and those of the subgenus *Liosarcus* of the genus *Fugu*) nor depressed (unlike those of the subgenera *Torafugu*, *Shosaifugu*, *Higanfugu* and *Takifugu* of the genus *Fugu*); the spines are weak and directed backwards, lying prallel to the longitudinal axis of the body. Concerning the shape and position of the pre-zygapophyses of the posterior precaudals and anterior caudals of *Boesemanichthys*, it may be pointed out that they flare out laterally and directed forwards as pointed spines and that they are placed lower down than in the other puffers with pointed pre-zygapophyses.

Despite the apparent similarity in the total number of the vertebrae between *Boesemanichthys* and the Japanese populations of *Lagocephalus lunaris*, the texture and shape of the posterior vertebrae distinctly differs from each other; those of the former are not thin and have no lateral longitudinal keels above and below which are characteristic of the latter species and its close ally, *L. lagocephalus oceanicus**.

c. Interneural and interhaemal spines. As might be expected from the higher number of the dorsal and anal fin-rays in *Boesemanichthys* than in the other puffers with broad head and nasal tentacles or flaps (*vide* ABE, 1944 and 1949), the number of the interneurals (Δ) and the number of the interhaemals (A) in the former ($\Delta=1+11$; $A=7$ or 8) are distinctly higher than in the majority of the latter. But here an exception to this generalization seems to be provided by *Dichotomycter fluviatilis*, in which Δ and A are not smaller than in *Boesemanichthys* while the total number of the dorsal and anal fin-rays are smaller.

In regard to the problem whether *Boesemanichthys* is nearer to *Tetraodon hispidus* and its allies, or, whether the former has some signs of closer affinity to *Fugu*, it may be said that *Boesemanichthys* approaches the last named in Δ and A as in the other meristic features of the vertebral column, dorsal and anal fins.

It would be of interest that the proximal part of the 1st interhaemal of *Boesemanichthys* is unique among the puffers examined in being very widely expanded towards theboth sides of the body.

d. Bones of the head region and pectoral girdle. The bones of the head region of *Boesemanichthys* are intermediate in several features between the puffers referable

* In *L. laevigatus inemis* these keels are not well developed (*vide* ABE, 1949a, p. 25).

to *Fugu* and those referable to *Tetraodon.* On the other hand, *Chelonodon patoca* is also intermediath between the two latter genera in some of the features of these bones. But the resemblance in these bones between *Boesemanichthys* and *Ch. patoca* is by no means very close. i) These bones in the latter are thinner than in the former. ii) The prominent ridge of the frontal in *Boesemanichthys* curves anteriorly outwards, not meeting the prefrontal, and ends in the lateral free edge of the frontal itself. In this respect *Boesemanichthys* resembles the subgenera *Shosaifugu, Higanfugu* and *Liosarcus* of the genus *Fugu* and the genus *Tetraodon.* In *Ch. patoca* this ridge runs longitudinally and meets anteriorly the prefrontal as in the subgenera *Torafugu* and *Takifugu* of the genus *Fugu.* iii) The shape of the anterior part of the frontal and the position of its anteriormost tip in relation to the anterior free margin of the prefrontal in *Ch. patoca* are nearer to the conditions found in the genus *Fugu* than do those of *Boesemanichthys,* in which these features are nearer to those of *Tetraodon.* In *Fugu* the frontals are narrowed forwards*, usually reaching beyond the anterior margins of the prefrontals, and the prefrontals are separated by the ethmoid and the anterior part of the frontals lying upon it; in *Ch. patoca* the frontals, though narrowed forwards, do not reach anteriorly beyond the anterior edges of the prefrontals. In *Tetraodon* the anterior margins of the both frontals are nearly in straight line which is vertical to the longitudinal axis of the body, and the prefrontals are separated by the ethmoid; in *Boesemanichthys* the anterior tips of the frontals are far behind the anterior margins of the prefrontals, and the latter are separated by the ethmoid as in *Tetraodon,* but the frontals are narrowed anteriorly for a very short distance. iv) The shape of the antero-dorsal corner of the prefrontal in *Boesemanichthys* is again nearer to that of *Tetraodon* in which the bone is curved down before the eye (especially strongly arched in *hispidus*) than does the shape of this part of the prefrontal of *Ch. patoca.* v) The shape of the parasphenoid of *Boesemanichthys* is again nearer to that of *Tetraodon,* and *Ch. patoca* is again nearer in this respect to *Fugu.* In *Fugu* and *Ch. patoca* the parasphenoid has a vertical wall attached above to the roof of the orbit (forming the bony interorbital septum) while the wall in *Boesemanichthys* and some members of *Tetraodon* does not reach the roof of the orbit and has a groove along its mid-dorsal edge.

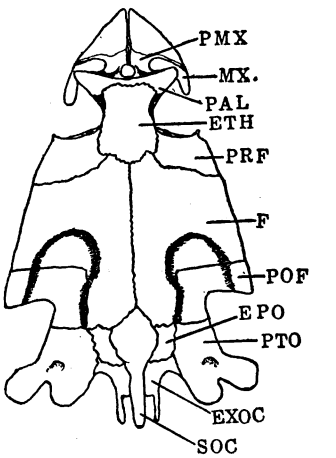

Fig. 3. Dorsal view of skull of *Boesemanichthys firmamentum* (TEMMINCK et SCHLEGEL). Length of skull 85 mm. Lettering as in Fig. 1.

* Their frontals are more or less pointed at their anterior angle. The individual variation in the angle at this anterior corner is considerable.

On the other hand, the lateral margin between the prefrontal and the postfrontal (sphenotic of FRASER-BRUNNER) is almost linear in *Boesemanichthys*, and in this respect this genus approaches the subgenus *Liosarcus* of the genus *Fugu*, while *Ch. patoca* approaches the other members of *Fugu* in the contour of the lateral margin just mentioned, and more especially close to *Fugu* (*Torafugu*) *niphobles* (resembling also in the texture of the skull),

Turning to the other side of the relationships of *Ch. patoca* and *Boesemanichthys*, it may be said that in the relative width of th ethmoid they are nearer to the genus *Fugu* than to the genus *Tetraodon;* this bone is much wider in the former three than in the last. Moreover, it may be worth mentioning that *Ch. patoca* and *Boesemanichthys* differ from *Fugu* in having minute tubercles on the inner surface of the upper jaw which seem to correspond to the distinct ridges on the inner side of the upper jaw of *Liosaccus cutaneus*, *Sphaeroides maculatus* (of the Atlantic), *Lagocephalus*, *Diodontidae* and *Molidae*. In *Dichotomycter fluviatilis* and *Tetraodon reticularis* the upper jaw has no tubercles on its inner surface, but *T. hispidus* has very small tubercles on that part of the upper jaw.

Finally, the pectoral girdle of *Boesemanichthys* resembles that of *Fugu*, *Tetraodon*, *Chelonodon patoca*, *Dichotomycter fluviatilis* and *Canthtigaster rivulatus* in having an attenuated, elongated, rod-rike, lower postclavicle. In *Sphaeroides maculatus*, *Liosaccus cutaneus*, *Lagocephalus lunaris* and *L. laevigatus inermis*, the lower post-clavicle is much expanded and flattened; in *L. lagocephalus oceanicus* the bone is flattened but not so much expanded,

e. Air-bladder. The present writer erred in mentioning (ABE, 1949b, p, 3) that the air-bladder of *Boesemanichthys firmamentum* is kidney-shaped and concave posteriorly as in *Chelonodon patoca*. Examination of the fresh specimens of the former has revealed that the air-bladder is dilobed behind as in *Tetraodon*.. In this feature *Boesemanichthys* differs from *Fugu* and *Ch. patoca*.

f. Habitat and distribution range. Boesemanichthys is known only from Japan, Australia and New Zealand. It is instructive to see that this genus seems to inhabit deeper waters than the other Japanese puffers (with the exception of *Liosaccus cutaneus* which is known from the deep seas of the warm parts of the world) and that it seems not rare in Sagami Sea where such an archaic shark as *Scapanorhynchus owstoni* (JORDAN) was rather common some fifty years ago.

(To be concluded)