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Comparative Osteology of the Sciaenid Fishes from Japan and Its Adjacent Waters—I. Neurocranium

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Abstract Based on the characters of the neurocranium, 16 species of the sciaenid fishes are classified into *Megalonibea-, Nibea-, Johnius-, Argyrosomus-* and *Pseudosciaena*-forms. The *Megalonibea*-form comprises the genera *Megalonibea, Miichthys* and some species of *Nibea*; the *Nibea*-form the remaining species in the genus *Nibea*; the *Johnius*-form the genera *Johnius* and *Wak*; the *Argyrosomus*-form the genera *Argyrosomus* and *Atrobucca*; the *Pseudosciaena*-form the genera *Pseudosciaena* and *Collichthys*. Of these five forms, the *Megalonibea*- and *Nibea*-form are probably the most generalized, and the *Pseudosciaena*- and *Johnius*-form specialized. The *Argyrosomus*-form is considered to be intermediate between the *Nibea*-form and *Pseudosciaena*-form. The neurocranium is proved to be an important character as well as the sagitta for the speculation of phylogeny of the sciaenid fishes.

Introduction

Most of the taxonomical studies of the sciaenid fishes of Japan and its adjacent regions have been made based nearly always on the external features (e.g., Richardson, 1845; Jordan and Thompson, 1911; Lin, 1935; Matsubara, 1937; Lin, 1938: Chu, 1956). Recently, Chu et al. (1963) published the comprehensive taxonomical and phylogenetical studies of this particular group of fishes of China based on the characters of the gasbladder, sagitta and mental pores, in which they classified them into 37 species, 13 genera and seven subfamilies.

As to the osteological study of the sciaenid fishes of Japan and China, Shaw (1948) described the vertebral column of two sciaenid fishes, *Pseudosciaena crocea* and *Pseudosciaena manchurica* (=*P. polyactis*). Hotta (1961) made the observation of the axial skeletons of five species of the family Sciaenidae, *Nibea mitsukurii*, *Miichthys imbricatus* (=*Mi. miiuy*), *Argyrosomus argentatus, Pseudosciaena crocea* and *P. manchurica* (=*P. polyactis*). He made up the key to these species based on the characters of axial skeletons in order to identify the prey fishes in the stomach content of predatory fishes. Takahashi (1962) made a study for the identification of the species of the Teleostei based on the vertebral column, and described the vertebral characters of five sciaenid fishes: *Nibea mitsukurii, N. albiflora, Argyrosomus argentatus, Atrobucca nibe* and *Pseudosciaena manchurica* (=*P. polyactis*). Recently, Kim and Kim (1965) examined the endoskeletons of seven Korean sciaenid fishes and divided them into two groups, the one represented by the genera *Pseudosciaena* and *Collichthys* and the other the genera *Argyrosomus*, *Nibea* and *Miichthys*.

Since the taxonomical and phylogenetical studies of the sciaenid fishes have not yet been made satisfactorily, the author felt the importance of more circumstantial studies. To clarify the taxonomy and phylogeny of the sciaenid fishes of Japan and its adjacent regions, the results of the observation of the neurocranium are presented here, which, the author believes, will present a contribution to ichthyology. Comparative studies of vertebral column, etc. will be published in the succeeding papers of the present series.

Material and method

The present study is based mainly upon materials caught by trawlers operated by Japanese commercial fishing vessels in various fishing grounds of the China Sea and Japanese waters. These specimens were sampled mainly at landing places: Nagasaki, Nagasaki Prefecture; Totoro, Miyazaki Prefecture; Shimonoseki, Yamaguchi Prefecture; Maizuru, Kyoto Prefecture; Chôshi, Chiba Prefecture. The author also examined some specimens of *Nibea diacanthus* from Tongking Bay, *N. semifasciata* from southern part of East China Sea, and two cranial specimens of *Megalonibea fusca* sampled from East China Sea. The various parts of the endoskeletons cleared by boiling or soaking in potassium hydroxide solution were measured with slide calipers. The species names used in this paper followed Chu et al. (1963).

Material examined.——*Nibea albiflora* (Richardson); a specimen, 188 mm in standard length, East China Sea, Jun. 1965, two specimens, 370 mm, 390 mm, East China Sea, Oct. 1965,——*N. mitsukurii* (Jordan and Snyder); five specimens, 191–233 mm, off Totoro, Oct. 1965,——*N. semifasciata* Chu, Lo and Wu; a specimen, 247 mm, East China Sea, May 1967,——*N. diacanthus* (Lacépède); a specimen, 260 mm, locality and data unknown, two specimens, 297 mm, 321 mm, Tongking Bay, Jun. 1965,——*N. japonica* (Temminck and Schlegel); a specimen, 1000 mm, East China Sea, Oct. 1965, Two specimens, standard length unknown, East China Sea, Oct. 1957,——*Miichthys miiuy* (Basilewsky); a specimen, 216 mm, East China Sea, Jun. 1965, two specimens, 280 mm, 270 mm, East China Sea, Oct. 1965, a specimen, standard length unknown, East China Sea, Mar. 1965,——*Megalonibea fusca* Chu, Lo and Wu; two specimens, standard length unknown, East China Sea, Oct. 1957, a spceimen, 1140 mm (Total length), East China Sea, May 1967,——*Johnius belengerii* (Cuvier and Valenciennes); a specimen, 134 mm, East China Sea, Jun. 1965, three specimens, 121–125 mm, East China Sea, Feb. 1966,——*Wak tingi* (Tang); two specimens, 262 mm, 264 mm, East China Sea, Jun. 1965,——*Argyrosomus argentatus* (Houttuyn); a specimen, 225 mm, off Maizuru, May 1965, a specimen, 198 mm, East China Sea, Jun. 1965, three specimens, 260–299 mm, East China Sea, Oct. 1965, two specimens, 184 mm, 183 mm, off Chôshi, Dec. 1965,——*A. macrocephalus* (Tang); two specimens, 137 mm, 186 mm, East China Sea, Aug. 1963, a specimen, 148 mm, South China Sea, Jun. 1957,——*Atrobucca nibe* (Jordan and Thompson); a specimen, 192 mm, East China Sea, Jun. 1965, Two specimens, 190 mm, East China Sea, Oct. 1965,——*Pseudosciaena crocea* (Richardson); two specimens, 196 mm, 340 mm, East China Sea, Jun. 1965,——*P. polyactis* (Bleeker); a specimen, 314 mm, East China Sea, Jun. 1965, Six specimens, 265–310 mm, East China Sea, Oct. 1965,——*Collichthys niveatus* Jordan and Starks; two specimens, 119 mm, 137 mm, East China Sea, Aug. 1965,——*C. lucidus* (Richardson); Two specimens, 62 mm, 74 mm, East China Sea, Aug. 1961.

Description and comparison of the neurocranium

The bony elements and configuration of the neurocranium are shown in Fig. 1. The neurocraniums of the sciaenid fishes are basically similar to those of the serranid fishes. As to the general form of the neurocranium and ridges protecting the cephalic sensory canal system, however, marked differences were observed in the present 16 species.

The olfactory region of the neurocranium has the unpaired mesethmoid, the paired lateral ethmoids and the unpaired edentate vomer. The mesethmoid is covered dorsally by the frontals, the lateral ethmoid posteriorly and the vomer ventrally. The frontals serve as a roof of olfactory region anteriorly. When viewed laterally, the roof projects anteriorly, and covers the olfactory region completely in the genera *Wak* and *Johnius* in which the lower jaw is shorter (Fig. 6). In the genera *Pseudosciaena* and *Collichthys* in which the lower jaw is slightly longer and oblique, the roof covers the olfactory region incompletely and the mesethmoid and vomer can be seen when viewed dorsally (Fig. 8). In the remaining

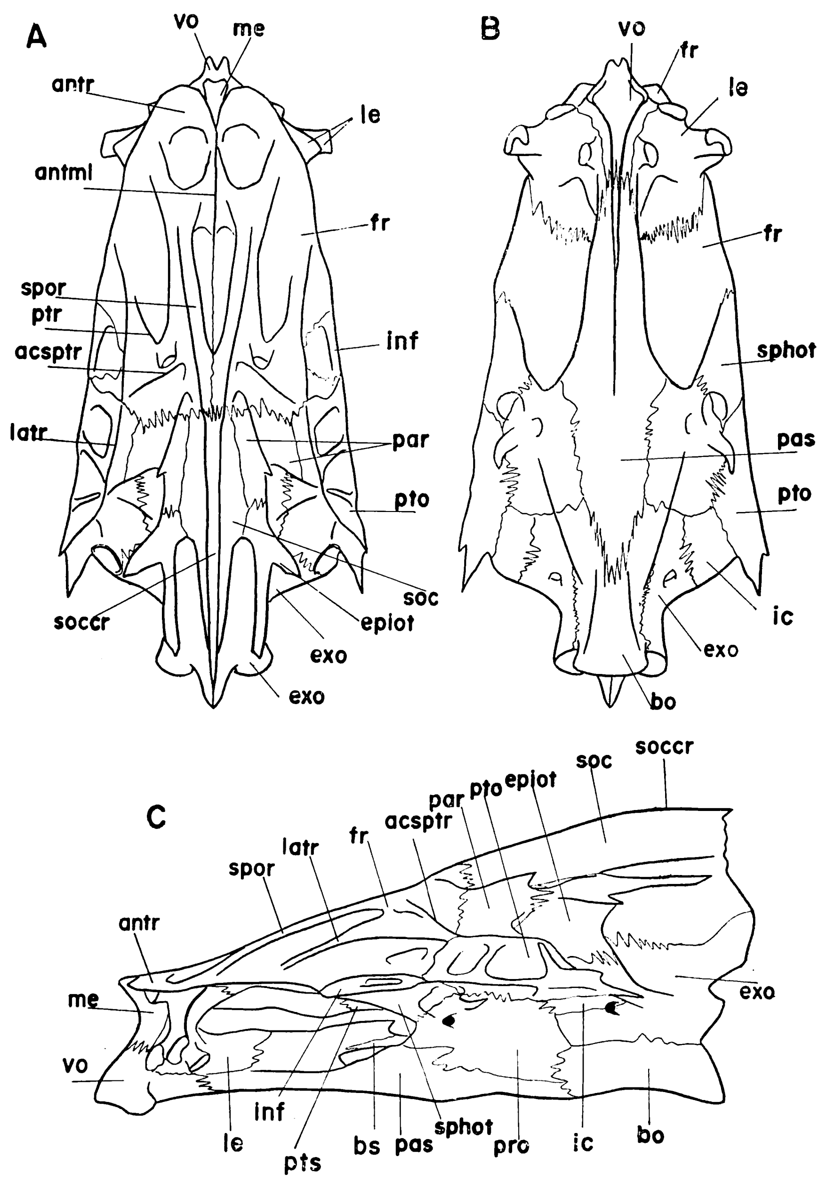

Fig. 1. Bony elements and configuration of *Megalonibea fusca*. A, Dorsal view; B, Ventral view; C, Lateral view. acsptr, accessory posterior transverse ridge; antml, anterior median line; antr, anterior transverse ridge; bo, basioccipital; bs, basisphenoid; epiot, epiotic; exo, exoccipital; fr, frontal; ic, intercalar; inf, infraorbital; latr, lateral ridge; le, lateral ethmoid; me, mesethoid; par, parietal; pas, parasphenoid; pro, prootic; pto, pterotic; ptr, posterior transverse ridge; pts, pterosphenoid; soc, supraoccipital; soccr, supraoccipital crest; sphot, sphenotic; spor, supraorbital ridge; vo, vomer.

genera *Nibea, Megalonibea, Miichthys, Argyrosomus* and *Atrobucca*, the roof is intermediate in its feature between the former two genera and latter two (Figs. 4, 5 and 7).

The orbital region consists of the paired pterosphenoids and frontals. The pterosphenoids are covered by the frontals dorsally, the sphenotics dorsoposteriorly, the prootics posteriorly and the basisphenoid ventrally. The interorbital window is surrounded by the uppermedian longitudinal keel of the parasphenoid, the posteromedian part of the lateral ethmoid, the lower median part of the frontal, the anterior part of the pterosphenoid and the basisphenoid; it is comparatively large and approximately elliptical in shape, when viewed laterally. But in *Wak tingi* (Fig. 6–D) and *Nibea japonica* (Fig. 4–B), the bone surrounding the orbital window develops vertically to form the interorbital septum. In *W. tingi*, the septum consists of the lateral ethmoid, frontal, parasphenoid, basisphenoid and pterosphenoid with two small openings. On the other hand, in *N. japonica* the pterosphenoids do not take part in an integral part of the septum, and the interorbital septum has a small window dorsoposteriorly.

The otic region consists of the paired sphenotics, pterotics, prootics, epiotics, intercalars, parietals and exoccipitals and the unpaired basisphenoid and supraoccipital. The auditory bulla, consisting of the prootic, intercalar and basioccipital, is swelled out roundly containing the large sagitta. Generally in the sciaenid fishes, the prootic is comparatively large and provided with an intraosseous opening or prootic foramen. This foramen is small except for the fishes of the genera *Wak* and *Johnius*, in which it is large (Fig. 6). Thus the genera *Wak* and *Johnius* are different from the genera *Nibea, Megalonibea* and *Miichthys*. The intercalar forming the posterodorsal part of the auditory bulla, usually ankyloses sutually with the prootic anteroventrally and the exoccipital posteriorly. In *Nibea albiflora, N. mitsukurii, N. semifasciata* and *Argyrosomus argentatus*, the intercalar extends ventrally and ankyloses also with basioccipital posteriorly (Figs. 4–B, 4–D, 4–F and 5–B). Thus these four species are strikingly different from the remaining species in the character of the intercalar. The epiotic projects posteriorly to form a slender spine. However, in the fishes of the genera *Wak, Johnius, Pseudosciaena* and *Collichthys*, the spine tends to degenerate.

The basicranial region consists of the unpaired basioccipital and parasphenoid. The basioccipital ankyloses with the exoccipitals dorsally, the prootics and parasphenoid anteriorly, sometimes also with the intercalar dorsally. The parasphenoid projects posteriorly and ankyloses with the vomer anteriorly, the lateral ethmoids dorsoanteriorly, the basisphenoid dorsally and the basioccipital posteriorly.

Generally the cephalic sensory canals and the ridges protecting these canals are well developed as shown in Fig. 1. Of the neurocranium elements, the pterotics and frontals carry ridges protecting the cephalic sensory canal system. As shown in Fig. 2, the ridges

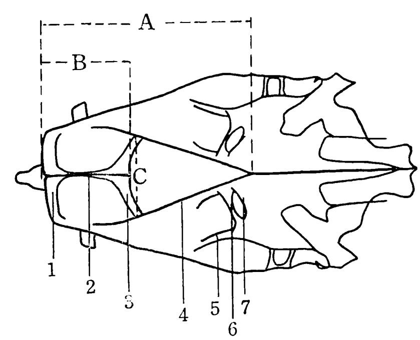

Fig. 2. Dorsal view of neurocranium showing frontal ridges and the parts measured. 1, anterior transveres ridge; 2, anterior median line; 3, accessory supraorbital ridge; 4, supraorbital ridge; 5, lateral ridge; 6, posterior transverse ridge; 7, accessory posterior transverse ridge. A, length of frotal along dorsal median line; B, length of anterior median line of frontal; C, width between right and left supraorbital ridges at the point of intersection of supraorbital and acccesory supraorbital ridge.

on the frontals are respectively termed the anterior transverse ridge (1), anterior median line (2), accessory supraorbital ridge (3), supraorbital ridge (4), lateral ridge (5), posterior transverse ridge (6) and accessory posterior transverse ridge (7). The frontal ridges form various cavities on top of the frontals. These cavities are joined together through the supraorbital canals. Of these cavities, the largest quadriangular one surrounded by right and left supraorbital ridges and accessory supraorbital ridges is rather small in space in the fishes of the genera *Nibea, Megalonibea, Miichthys, Johnius* and *Wak* (Figs. 4, 5 and 6). But it is large in those of the genera *Pseudosciaena* and *Collichthys* (Fig. 8). The fishes of the genera *Argyrosomus* and *Atrobucca* are intermediate between the former two types in this character (Fig. 7).

In order to make out these cranial differences satisfactorily in these species, the measurements of some parts of the neurocranium were made (see Fig. 2): length of the frontal along dorsal median line (A), length of the anterior median line of the frontal (B), and width between the right and left supraorbital ridges at the point of intersection of supraorbital ridge and accessory supraorbital ridge (C). Based on the ratios B/A and C/A (Table 1),

Table 1. Ratios B/A and C/A calculated on the craniums of 16 species of sciaenid fishes giving the average and in parentheses the range. See Fig. 2 for the parts (A, B and C) measured.

Species	B/A	C/A	No. of Specimens
Nibea albiflora	0.43 (0.41–0.45)	0.18 (0.14–0.20)	3
Nibea mitsukurii	0.40 (0.38–0.45)	0.20 (0.18–0.21)	3
Nibea diacanthus	0.46 (0.44–0.47)	0.12 (0.11–0.13)	2
Nibea semifasciata	0.42	0.18	1
Nibea japonica	0.53 (0.52–0.55)	0.08 (0.07–0.09)	3
Megalonibea fusca	0.44 (0.44–0.45)	0.11 (0.11)	2
Miichthys miiuy	0.40 (0.37–0.41)	0.19 (0.19–0.21)	4
Johnius belengerii	0.47 (0.45–0.49)	0.18 (0.14–0.20)	4
Wak tingi	0.52 (0.46–0.55)	0.20 (0.16–0.21)	3
Argyrosomus argentatus	0.42 (0.37–0.46)	0.32 (0.30–0.34)	7
Argyrosomus macrocephalus	0.33 (0.32–0.34)	0.37 (0.32–0.39)	3
Atrobucca nibe	0.38 (0.36–0.40)	0.31 (0.30–0.32)	3
Pseudosciaena crocea	0.19 (0.18–0.20)	0.35 (0.34–0.38)	3
Pseudosciaena polyactis	0.24 (0.22–0.26)	0.37 (0.33–0.39)	8
Collichthys niveatus	0.12 (0.12)	0.40 (0.33–0.48)	3
Collichthys lucidus	0.19 (0.19)	0.46 (0.45–0.47)	2

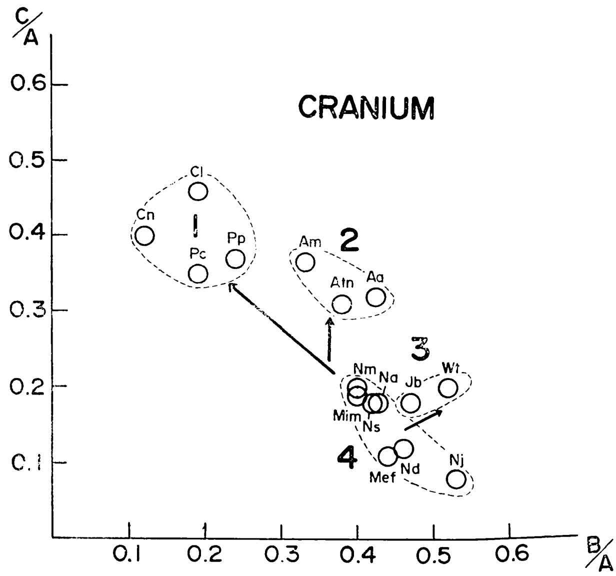

Fig. 3. Allocation of the sciaenid fishes based on the measurements of three parts (see Fig. 2) of frontal. Arrows show speculated direction of specialization. 1, *Pseedosciaena*-form; 2, *Argyrosoma*-form; 3, *Johnius*-form; 4, *Nibea*-form and *Megalonibea*-form. Cn, *Collichthys niveatus*; Cl, *C. lucidus*; Pc, *Pseudosciaena crocea*; Pp, *P. polyactis*; Am, *Argyrosomus macrocephalus*; Aa, *A. argentatus*; Atn, *Atrobucca nibe*; Nm, *Nibea mitsukurii*; Na, *N. albiflora*; Ns, *N. semifasciata*; Nj, *N. japonica*; Nd, *N. diacanthus*; Mef, *Megalonibea fusca*; Mim, *Miichthys miiuy*; Wt, *Wak tingi*; Jb, *Johnius belengerii.*

the species of the sciaenid fishes can be divided into the three groups; *Pseudosciaena-*, *Argyrosomus-*, and *Nibea-Johnius*-group (Fig. 3). The *Nibea-Johnius*-group is further divided clearly into three groups; *Nibea-*, *Megalonibea-* and *Jonhius*-group, based on the character such as the prootic foramen and intercalar (The *Johnius*-group differs from the *Nibea-*, and *Megalonibea*-group in having large foramen on the prootic; the *Nibea*-group differs from the *Megalonibea-*, and *Johnius*-group in having large intercalar which reaches the basioccipital). Therefore, the sciaenid fishes examined here are eventually divided into five forms, which are called: (1) *Megalonibea-*, (2) *Nibea-*, (3) *Johnius-*, (4) *Argyrosomus-*, and, (5) *Pseudosciaena*-form.

(1) *Megalonibea*-form (Fig. 4): The present form includes following 4 species: *Nibea japonica, N. diacanthus, Megalonibea fusca* and *Miichthys miiuy*. In the *Megalonibea*-form, the ridges on the frontal are not well developed and the cavities enclosed by these ridges are small. The angle formed by the right and left supraorbital ridges is acute and the anterior median line is markedly long. The supraorbital ridges are markedly thick and elevated low from the bottom of the frontal. The posterior transverse ridge intersects the supraorbital ridge forming an arch. The prootic foramen is small. Two and half clear ridges are present on the pterotic. The posteroventral margin of the interorbital window curves upward smoothly, when viewed laterally. The intercalar never meet the basioccipital ventrally. The *Megalonibea*-form is distinguished from the *Nibea*-form in having following three characters: (1) the curved posterior transverse ridge, (2) the posteroventral margin of the interorbital window curving smoothly, and (3) the intercalar separated from the basioccipital. The *Megalonibea*-

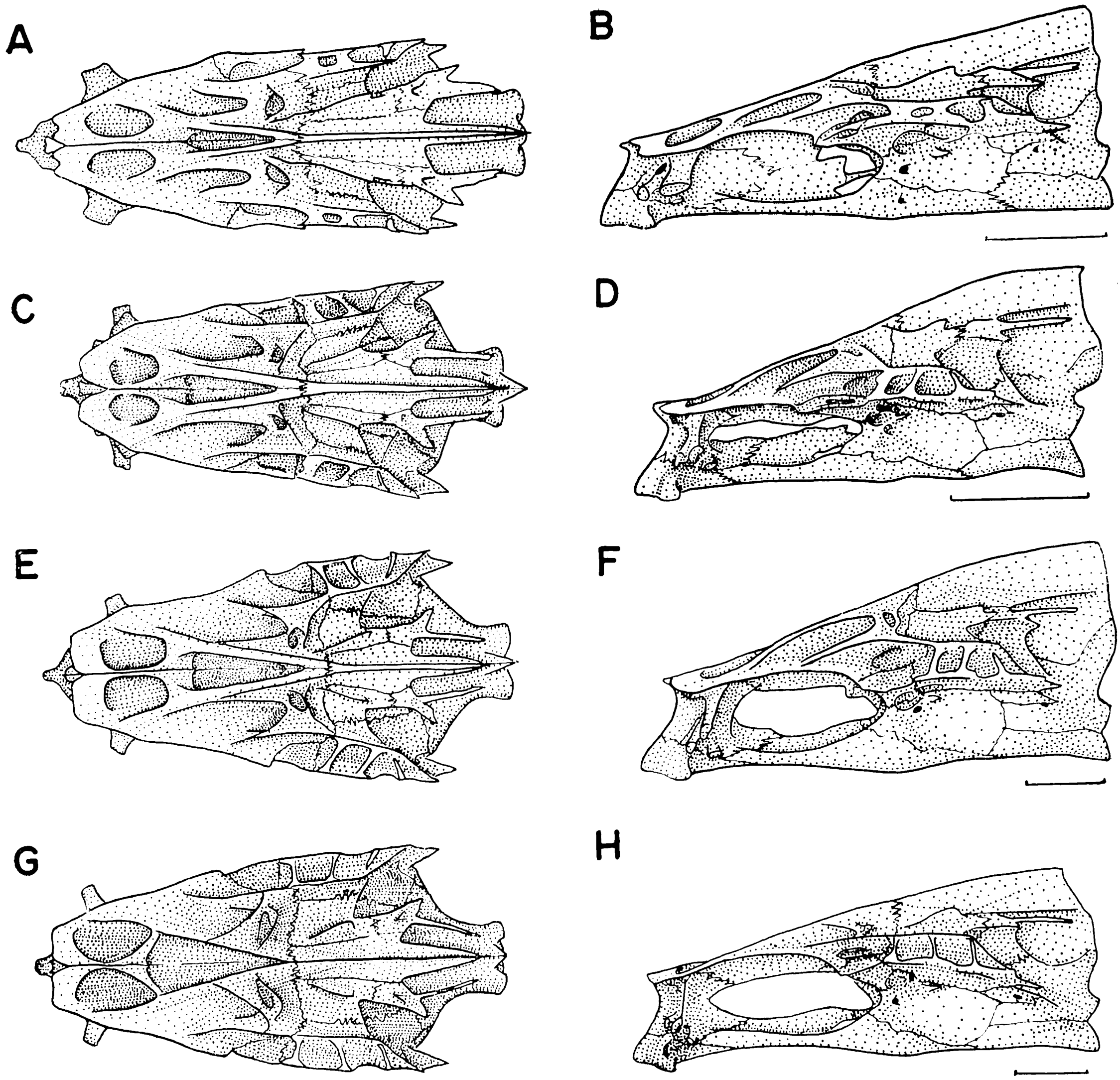

Fig. 4. Dorsal and ventral view of neurocraniums of the sciaenid fishes in the *Megalonibea*-form. A–B, *Nibea japonica*; C–D, *Megalonibea fusca*; E–F, *Nibea diacanthus*; G–H, *Miichthys miiuy*. Each scale indicates 10 mm.

form is also distinguished from the *Johnius*-form in lacking a large foramen on the prootic. *Miichthys miiuy* has fundamental characteristics of the *Megalonibea*-form in the neurocranium, but the supraorbital ridges are markedly slender. Therefore, *M. miiuy* is not considered typical *Megalonibea*-form, but it is more specialized in strict sense.

(2) *Nibea*-form (Fig. 5): This form covers following three species, *Nibea mitsukurii*, *N. albiflora* and *N. semifasciata*. The ridges on the frontal are similar to those of the *Megalonibea*-form. The ridges of the frontal are not developed and the cavities enclosed by these ridges are small. The angle formed by the right and left supraorbital ridges is acute, and the anterior median line is long. The supraorbital ridges are comparatively thick and low. Generally the posterior transverse ridge is straight and intersects the supraorbital ridge by right angle. The prootic foramen is small. There are two and

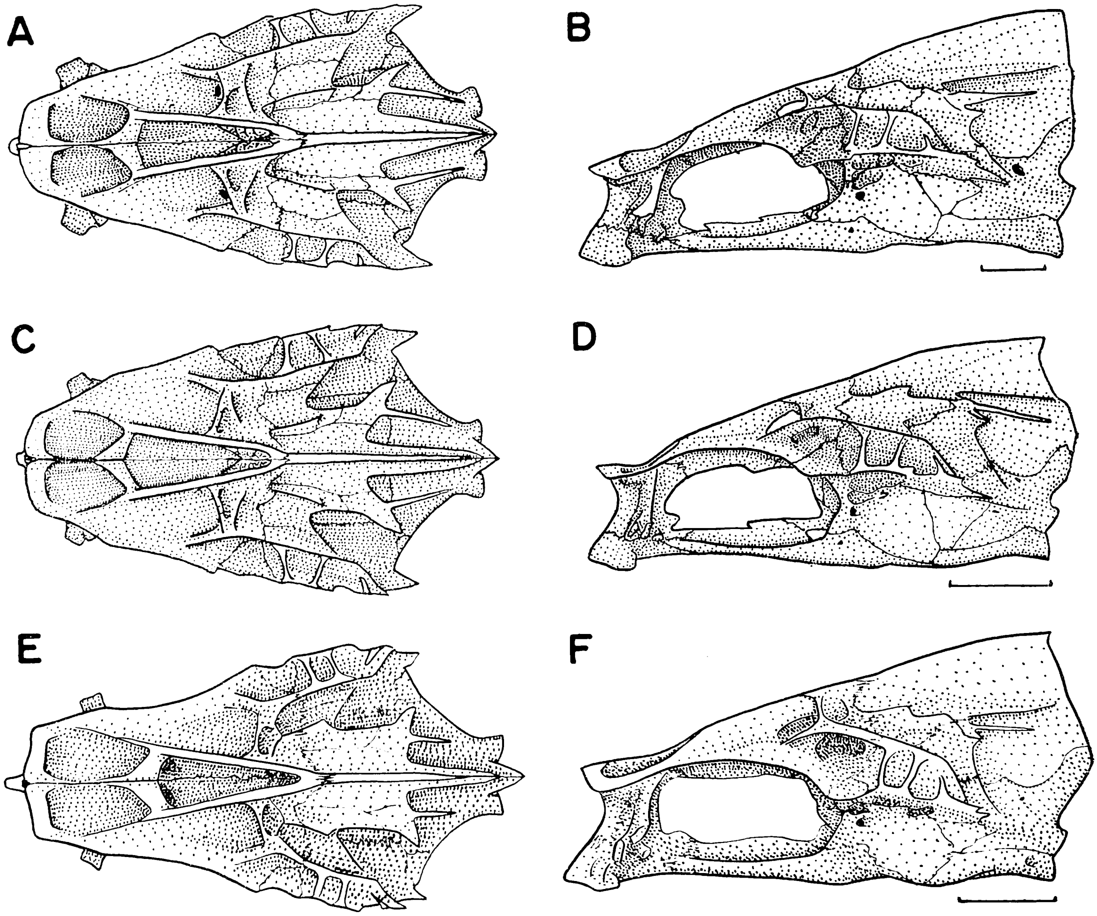

Fig. 5. Dorsal and ventral view of neurocraniums of the sciaenid fishes in the *Nibea*-form. A–B, *Nibea albiflora*; C–D, *N. mitsukurii*; E–F, *N. semifasciata*.

half clear ridges on the pterotic. The posteroventral margin of the interorbital window where the anterior part of the prootic and dorsoposterior part of the parasphenoid are joined, forms an obtuse angle, when viewed laterally. The intercalar extends ventrally and ankyloses with the basioccipital.

(3) *Johnius*-form (Fig. 6): This form includes two species, *Johnius belengerii* and *Wak tingi*. It seems that the present form resembles the *Nibea*- and *Megalonibea*-forms in proportional measurements of A, B and C (Fig. 3). The supraorbital ridge on the frontal bone is comparatively low and flat in comparison with that in the *Nibea*-form. And the right and left supraorbital ridges run approximately parallel with each other. Further, the form is distinguishable from the *Nibea*- and *Megalonibea*-forms in having a large prootic foramen and smaller pterotic ridges and lacking epiotic process. The anterior part of the frontal projects forward and covers over the olfactory region. The posteroventral margin of the interorbital window near the symphysis of the parasphenoid and prootic is obtusely angled when viewed laterally. The posteroventral part of the parasphenoid has a sharp ventral median keel which projects downwards. *Wak tingi* differs from *Johnius belengerii* in possessing an interorbital bony septum. The interorbital bony septum of *W. tingi* is distinguished from that of *Nibea japonica* in the elements

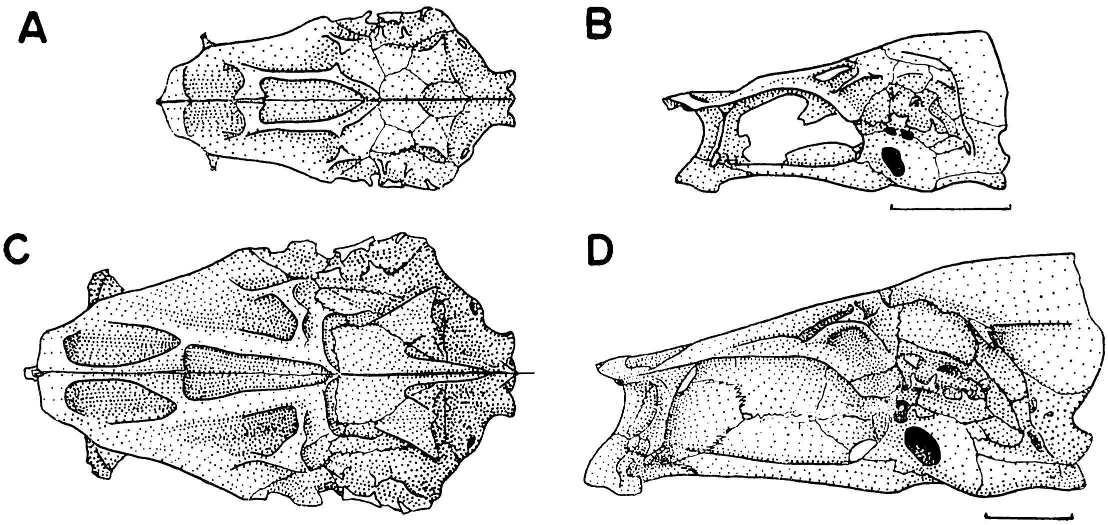

Fig. 6. Dorsal and ventral view of neurocraniums of the sciaenid fishes in the *Johnius*-form. A–B, *Johnius belengerii*; C–D, *wak tingi.*

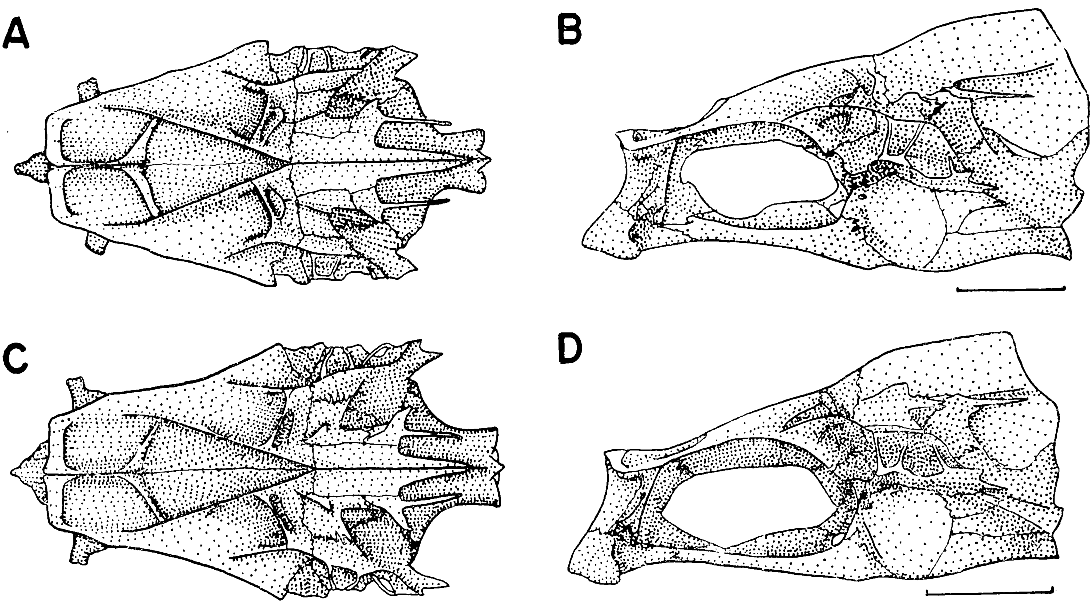

Fig. 7. Dorsal and ventral view of neurocraniums of the sciaenid fishes in the *Argyrosomus*-form. A–B, *Argyrosomus argentatus*; C–D, *Atrobucca nibe*.

consisting of the septum. Therefore, the interorbital septum shown in these two species are not considered to be in direct relation, despite of the superficial similarity observed.

(4) *Argyrosomus*-form (Fig. 7): In this form, three species, *Argyrosomus argentatus*, *A. macrocephalus* and *Atrobucca nibe* are referred. The angle formed by the right and left supraorbital ridges is larger here than in the *Nibea*-, *Megalonibea*- and *Johnius*-forms though anterior median line is as long as that in the fishes of the *Nibea*-, *Megalonibea*- and *Johnius*-forms. The supraorbital ridges are narrow and comparatively high. The

supraorbital ridges meet the posterior transverse ridges by right angle. The posterior transverse ridges are straight. The prootic foramen is small. The posteroventral margin of the interorbital window makes up an obtuse angle near the symphysis of the parasphenoid and the prootic. In *Argyrosomus argentatus*, the intercalar reaches the basioccipital. But the intercalar does not reach the basioccipital in *A. macrocephalus* and *Atrobucca nibe*. The posteroventral part of the parasphenoid has a sharp ventral median keel which projects downwards.

(5) *Pseudosciaena*-form (Fig. 8): In this form, the fishes of the genera *Pseudosciaena* and *Collichthys* are included. The angle formed by the right and left supraorbital ridges is the largest and the anterior median line is the shortest among the fishes of the family Sciaenidae. The supraorbital ridge is slender and its height on the frontal marks the highest among the sciaenid fishes. The posterior transverse ridge is straight and meets the supraorbital ridge by right angle. The accessory posterior transverse ridges are markedly reduced in size or disappeared. The

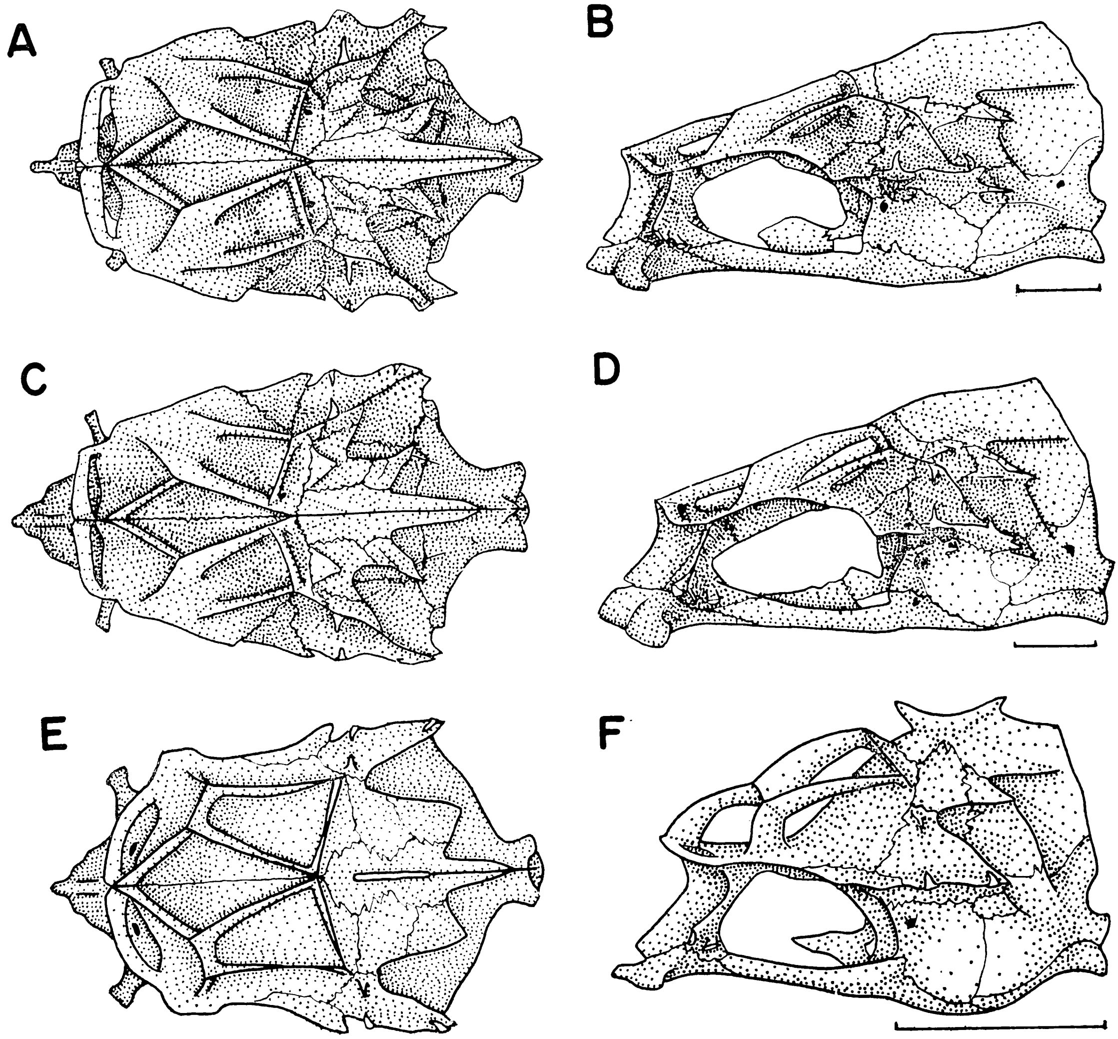

Fig. 8. Dorsal and ventral view of neurocraniums of the sciaenid fishes in the *Pseudosciaena*-form. A–B, *Pseudosciaena polyactis*; C–D, *P. crocea*; E–F, *Collichthys niveatus*.

pterotic ridges are reduced in size and composed of one and half ridges. The anterior part of the frontal covers over the olfactory region incompletely. Therefore, when viewed dorsally, the vomer and mesethmoid are seen. The posteroventral margin of the interorbital window makes up an obtuse angle near the symphysis of the parasphenoid and the prootic. The prootic foramen is small. The epiotic spine degenerates. The intercalar does not meet the basioccipital. The cavities enclosed by the frontal ridges are comparatively large in the genus *Collichthys*. The genus *Collichthys* differs from the genus *Pseudosciaena* in possessing a crown-like process on top of the supraoccipital.

Discussion

The author found the distinct interspecific variation in the shape of the frontal ridges, the prootic foramen and the intercalar, as well as minor variation in other characters, for example the shape of the pterotic ridges, parasphenoid and interorbital window. As the result of the present study, the distinct five types in the neurocraniums of the sciaenid fishes were recognized.

Kim and Kim (1965) working on 7 species found that by the characters of the vomer, frontal, the median process of the basisphenoid, parasphenoid, supraoccipital, the median process of the basioccipital, etc., two groups can be clearly distinguished: the one comprised of the genera *Pseudosciaena* and *Collichthys* and the other the genera *Argyrosomus*, *Nibea* and *Miichthys*. They also stated that the genus *Argyrosomus* carries a number of intermediate characters between the former and the latter. The observation made by them is compatible to the present study with substantial significance. The minor difference between their findings (7 species) and the present study (16 species) might be reflected from the number of the species observed.

Chu *et al.* (1963) observed the sagitta and gasbladder of 37 sciaenid fishes finding four types of the sagitta and five types of the gasbladder. But these two characters are not necessarily developed in parallel. In their classification of the sciaenid fishes, these authors weighed more importance in the characters of the gasbladder than in the sagitta, and apprised the former as basic character of the subfamily. In the present study of the neurocranium, it is found that the five forms of the neurocraniums recognized are principally parallel with the four forms of the sagitta. In the least, the present author may raise some questions about their system, in which the genera *Miichthys, Atrobucca, Pseudosciaena* and *Collichthys* are included in the subfamily Pseudosciaeninae, and the *Argyrosomus* and *Nibea* are referred to the subfamily Argyrosominae respecting the following reasons: (1) The five forms recognized based on the neurocraniums are basically corresponding to the four forms they found in the sagitta (The *Sciaena*-form of sagitta vs. the *Nibea*- and *Megalonibea*-forms of the neurocranium, the *Otolithes*-form & of sagtita vs. the *Argyrosomus*-form of the neurocranium, and the *Pseudosciaena*-form of sagitta vs. the *Pseudosciaena*-form of the neurocranium); (2) Tadpole imprint of sagitta is observed among the almost all the families in the order Percida, so that the character is believed to be rather generalized one; (3) The diverticula in the gasbladder of the sciaenid fishes are characteristic only to the family Sciaenidae, hence its character is considered more variable in comparison with the characters of the sagitta and neurocranium; (4) The gasbladder found in the genera *Miichthys, Atrobucca, Pseudosciaena* and *Collichthys* are markedly different form each other, although they are undifferentiated in respect to the development of dorsal and ventral diverticula. Judging from these facts, it may be stated that the sagitta and neurocranium are more significant character than the gasbladder in the classification and interpretation of phyletic relation of these fishes. Furthermore, there is a possibility that the five groups in the family Sciaenidae categorised by the characters of the neurocranium and sagitta may become the ranks of subfamily. The problem will be solved by the further studies on other characters and more species.

Topp and Cole (1968), in the osteological study of the genus *Sciaenops*, described the whole endoskeleton of a species, *S. ocellata* which distributes in the coastal waters of eastern North America from Texas to New York. Judging from their illustration of the neurocranium, *S. ocellata* probably belongs to the typical *Megalonibea*-form, and the sagitta is close to Asian genera *Megalonibea* and *Nibea*. Then, it seems probable that the genus *Sciaenops* and the genus *Megalonibea* carry a close affinity.

As to the genus *Nibea*, *N. mitsukurii*, *N. albiflora* and *N. semifasciata* are markedly different from *N. japonica* and *N. diacanthus* in having the large intercalars reaching the basioccipital and the straight posterior transverse ridge. In the external features, the latter two species also differ from the former three in having comparatively low and elongated body. Thus, the author considers that these two species should be excluded from the genus *Nibea*, however, his experience on the sciaenid fishes which yet lacks the examination of such genera as *Cynoscion*, *Otolithoides*, *Bahaba* and others makes it unable to name the genus in which those two species are properly placed.

In the present study, the author was also able to trace a trend in the differentiation of the neurocranium (Fig. 3). Since the frontal ridges are characteristic in the fishes of the family Sciaenidae, the neurocraniums of the *Nibea*-, *Megalonibea*- and *Johnius*-form provided with undeveloped cephalic sensory canals, are considered unspecialized or generalized. However, the neurocranium in the *Johnius*-form, having large prootic foramen, degenerated pterotic ridges and lacking the epiotic process is suggested to be specialized compared to those of the *Megalonibea*- and *Nibea*-forms. The neurocranium of the *Pseudosciaena*-form with large cavities and very slender ridges on the frontals is believed most specialized among the sciaenid fishes. The neurocranium of the *Argyrosomus*-form is considered to be transitional from the *Nibea*-form to the *Pseudosciaena*-form. The direction in the divergence of neurocranium will be shown by the arrows drawn in Fig. 3. Such trend traced in the morphology of neurocranium is paralleled to the types of the sagitta, a fact calling particular attention. The biological meaning of the cephalic sensory canals of the sciaenid fishes which are elaborated by large cavities has not be well understood, nor has the function of these cavities been made clear. But it appears very clear that these characters had played very important roles in the speciation of the sciaenid fishes in same way as witnessed in its osteological characters.

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Literature cited

Chu, K. Y. 1956. A review of sciaenoid fishes of Taiwan. Rep. I. Fish. Biol. Mins. Econo. Aff. Nat. Taiwan Univ., 1 (1): 13–44, pl. 5.

Chu, Y., Y. Lo and H. Wu. 1963. A study on the classification of the sciaenoid fishes of China, with description of new genera and species. Shanghai Scientific and Technical Publ. Co., Shanghai: i–ii, 1–100, pls. 1–40.

Hotta, H. 1961. Comparative study of the axial skeleton of Japanese Teleostei. Norin-Suisan Gijutsu Kaigi, Contr., (5), 1–155, pls. 1–70.

Jordan, D. S. and W. F. Thompson. 1911. A review of the sciaenoid fishes of Japan. Proc. U. S. Nat. Mus., 39: 241–261, figs. 1–4.

Kim, Y. and I. Kim. 1965. Osteological study of fishes from Korea (1), Comparative osteology of family Sciaenidae. Bull. Pusan Fish. Coll., 6 (2): 61–76, pls. 1–8.

Lin, S. 1935. Notes on some important sciaenid of China. Bull. Chekiang Prov. Fish. Exp. St., 1 (1): 1–30, figs. 1–12.

————. 1938. Further notes on sciaenid fishes in China. Lingnan Sci. J., 17 (2): 161–173; 17 (3): 367–381; 17 (4): 539–550.

Matsubara, K. 1937. Sciaenoid fishes found in Japan and its adjacent waters. J. Imp. Fish. Inst., 32 (2): 27–92, figs. 1–28.

Richardson, J. 1845. Ichthyology of the sea of China and Japan. Rep. British Association for Advancement of Science for 1845: 223–226.

Shaw, T. H. and S. V. Yu. 1948. Preliminary notes on the vertebral column of two important sciaenoid fishes, *Pseudosciaena crocea* Richardson and *Pseudosciaena manchurica* Jordan and Thompson. Quart. J. Taiwan Mus., 1 (4) 1–13, figs. 1–4.

Takahashi, Y. 1962. Study for the identification of species based on the vertebral column of teleostei in the Inland Sea and its adjacent waters. Bull. Nankai Regional Fish. Res. Lab., 16, i–viii, 1–62, pls. 1–22.

Topp, R. W. and C. F. Cole. 1968. An osteological study of the sciaenid genus, *Sciaenops* Gill. Bull. Mar. Sci., 18 (4): 902–945, figs. 1–13.

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日本およびその近海産ニベ科魚類の骨格の比較研究
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谷口順彦

ニベ科魚類の類縁ならびに分類体系を明らかにするため骨格系統の比較研究を行なった．本報ではニベ科魚類16 種の頭蓋骨の形態についての観察結果を記述し，二・三の考察を行なった．ニベ類の頭骨にみられる著しい特徴は頭部感覚管の発達にともなって生じた額骨および翼耳骨上の骨質隆起である．頭蓋骨において著しく変異のみられる形質は額骨隆起，前耳骨孔，後耳骨の位置等であり，これらの形質から判断するとニベ科魚類の頭蓋骨は明瞭に区別される 5 つの類型，シナオオニベ型，ニベ型，コニベ型，シログチ型およびキングチ型に分けられる．シナオオニベ型にはシナオオニベ属 1 種・ニベ属 2 種およびホンニベ属 1 種が，ニベ型にはニベ属 3 種が，コニベ型にはコニベ属 1 種とアブラグチ属 1 種が，シログチ型にはシログチ属 2 種およびクログチ属 1 種が，キングチ型にはキングチ属 2 種およびカンダリ属 2 種がそれぞれ含まれる．シナオオニベ型とニベ型は比較的普遍的形質をそなえ，コニベ型とキングチ型は特化形質をそなえている．シログチ型はニベ型とキングチ型との中間的形質をそなえている．耳石にみられる 4 つの類型 (Chu, 他，1963) に属す種と頭蓋骨の 5 つの類型に属す種とを比較すると，それぞれの類型に含まれる種の組成は基本的にはよく類似していることが判明した．したがって，頭蓋骨および耳石は亜科または属の分類形質として重要と考えられる．

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