THE SKULL OF HEMIRHAMPHUS XANTHOPTERUS CUV. & VAL.

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(Communicated by Dr. B. C. Mahendra, F.A.SC.)

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I. INTRODUCTION

The morphology of the skull of Indian Teleosts has not attracted attention of many workers. Sarabhai (1932) described the endoskeleton of the common edible fish *Labeo rohita*. In the same year, Bhimachar published a detailed account of the cranial osteology of *Ophicephalus striatus*, which actually is an improvement upon an old paper by Day (1914) on the osseous system of *Ophicephalus striatus*. In the description of the endoskeleton of *Otolithus*
rubera, Dharamraj’s (1936) has included its skull as well. However, greater attention has been drawn to the cranial morphology of fishes by Ramaswami (1945, 1946, 1948, 1951a, 1951b, 1952a, 1952b), who has dealt with the chondrocranium and osteocranium of Gambusia, Oryzias, Aplocheilus, Xiphophorus, Homaloptera, Gyrinocheilus, Psilorhynchus and Balitora. Srinivasaschar (1953) worked out the development of chondrocranium of Ophicephalus and also described the skull of the same (1955).

As far as we have been able to ascertain, none of the skulls of the Indian Hemirhamphidæ has so far been described. Of a few references available, one is from Gregory (1933) who in his comprehensive dissertation on ‘Fish Skull’ has drawn attention to the close similarity between the Cyprinodont fishes and Hemirhamphus of the Synentognathi. The other available account is from Starks (1926) who has included the description of the ethmoid region of Criodorus atherinoides (Hemirhamphidæ) in his account of the bones of the ethmoid region of the fish skull.

II. MATERIAL AND METHOD

Some forty specimens of Hemirhamphus xanthopterus Cuv. and Val. were collected by students of Government College, Ajmer, at Madras beach, in October, 1955. The specimens were kindly made available to us for investigation. The skulls were carefully cleaned by maceration and boiling in 5% solution of ammonium carbonate (Cantuel, 1949). A few Alizarin preparations were also made. The various structures were studied with the help of ‘Bull Eye’ lens and the diagrams were made free hand.

III. OBSERVATIONS

(a) The Ethmoid Region.—In Hemirhamphus xanthopterus the median ethmoid is clearly visible on the dorsal surface of the head and is firmly articulated with the frontals posteriorly. It is divided into a left and a right portion by an antero-posteriorly running ridge continuous with the median line dividing the skull dorsally into bilaterally symmetrical halves. The lateral ethmoids are in the form of small oval depressions on either side of the median ethmoid. The median ethmoid is purely a cartilaginous structure while the lateral ethmoids are osseous. There is no distinction between the anterior and posterior portions of median ethmoid in Hemirhamphus xanthopterus, nor is there any difference in the two regions as far as ossification is concerned. This offers a contrast to Day’s (1914) description of the median ethmoid region of the skull of Ophicephalus striatus. According to his description the ‘supraethmoid’ is a light spongy bone and the ethmoid articulates with the nasals dorsally. But the supraethmoid and ethmoid as present in
Ophicephalus striatus are not distinguished in Hemirhamphus xanthopterus. Bhimachar (1932), however, described Day’s (1914) supraethmoid and ethmoid as only supraethmoid and mentioned it as a poorly ossified bone.

This statement is not correct in the case of Hemirhamphus xanthopterus as the ethmoid bone is purely cartilaginous. Kindred (1919) and de Beer (1937) called the median ossified bone in the nasal region as ethmoid and the intramembranous paired bones as supraethmoids. This description too, will not hold good in the case of Hemirhamphus xanthopterus, as there are no intramembranous paired bones in the ethmoid region of this fish.

The lateral ethmoids are observed as oval bony structures on either side of the ethmoid region. They can as well be called prefrontals or ectoethmoid bones; names usually used by Day (1914) and Bhimachar (1932).

Ventral to the ethmoid and anterior to the parasphenoid in the ethmoid region, lies the median prevomer. The prevomer is essentially a component of the palate. It does not bear prevomerine teeth. The presence of a single median prevomer in Hemirhamphus xanthopterus is an interesting feature. Goodrich (1930) described a single prevomer in Acipenser and some Teleosts.
and is of the opinion that the median prevomer is a derivative of paired fused prevomers. However, Gaupp (1905) has stated that the median prevomer shows signs of paired origin in *Salmo* while Walther (1883) has shown that in *Esox* it arises from paired rudiments. In *Hemirhamphus xantheropterus*, the prevomer directly articulates with the parasphenoid posteriorly and gives out a projection as in *Gyrenocheilus* (Ramaswami, 1952).

![Diagram](image)

**Fig. 3.** Lateral view of the skull.

(b) The **Orbito-temporal Region**.—Posterior to the ethmoid region on the dorsal side of the skull is the frontal region consisting of paired frontals. The frontals are elongate, transparent and cartilaginous structures forming nearly one-third of the total length of the skull. They are not separated from each other posteriorly by the intervention of the supraoccipital as in *Ophicephalus striatus* (Srinivasachar, 1955). The posterior portion of the frontals is broader than the anterior and articulates with the anterior end of the parietals.

The cartilaginous parietals are paired and articulate anteriorly with the frontals. The pterotic bones of the auditory region fuse with the parietals. The anterior end of the supraoccipital penetrates into the mid-parietal region and separates the two parietals in the posterior region.

The orbits are roofed over by the paired frontals. They are separated from each other by a membranous interorbital septum which is connected ventrally with the parasphenoid and posteriorly with the pleurospheonoids. The orbit is not bounded ventrally by sub-orbitals. There is single sub-orbital in *Hemirhamphus xantheropterus* which, in view of its location, be better referred to as post-orbital. The ventral boundary of the orbit is supported by the osseous pterygoid which fuses with the quadrate ventrally and parasphenoid dorsally just below the interorbital septum. Posterior to the
pterygoid is another characteristic bone, the symplectic which constitutes the ventral boundary of the orbit.

The lacrimal is a distinct osseous element at the antero-latemo-dorsal margin of the orbit. A distinct lacrimal foramen is also noticed. Ramaswami (1952) named the anterior sub-orbital as lacrimal in Gyrinocheilus, Garra, and Crossocheilus.

The sphenoid region, consisting of paired basisphenoids, a parasphenoid and paired lateral pleurosphenoids, lies immediately posterior to the orbital region. The basisphenoid is a small bone and lies between the two enlargements of the pro-otic bones. The parasphenoid is truncate and arches over the ventral side of the interorbital septum. Anteriorly the parasphenoid fuses with the prevomer. The pleurosphenoids are the laterally disposed cartilaginous extensions of the basisphenoid and with the help of the latter form the hypophysial fenestra. The pleurosphenoids have been referred to as the alisphenoids by Day (1914) and Bhimachar (1932). Goodrich (1930), however, is of the opinion that this bone in fishes is neither homologous with the mammalian alisphenoid, since it is an ossification in the primitive cranial wall of the cavum epitericum, nor can it be the exact homologue of the pleuro-

FIG. 4  FIG. 5
FIG. 4. Dorsal view of the lower jaw.
FIG. 5. Lateral view of the lower jaw.
sphenoid of reptiles and birds. The true nature of the pleurosphenoid has been described by Goodrich (pp. 436–37, 1930).

(c) The Auditory Region.—The auditory region comprises paired opisthotics, pro-otics, sphenotics, supratemporals, post-temporals, and pterotic bones. The pro-otics form the anteriormost region of the auditory capsule and lie immediately posterior to the basisphenoid. Each pro-otic is oval in outline and has the appearance of tympanic bulla of mammals. The pro-otics are completely ossified and are the most osseous of all the bony elements of the skull. Posterior to pro-otics lie the opisthotics, one on either side and fused with the pro-otics. The fused pro-otics and opisthotics form the auditory capsule. The sphenotic is, however, separated and does not take part in the formation of the auditory capsule. Srinivasachar (1955) mentions that the opisthotic does not associate itself with the sphenotic, pterotic and epiotic in the formation of the auditory capsule in *Ophicephalus striatus*. In *Exocetus* the pterotic and sphenotic ossify in the cartilaginous lateral wall of the auditory capsule and have intramembranous extensions, (de Beer, 1937). The sphenotic in *Hemirhamphus xanthopterus* is arch-shaped and lies ventral to the suborbital process of the frontal of the same side. From the lateral side of each sphenotic extends ventrally a process, the sphenotic process. The sphenotic process has so far not been noticed in any other Teleost. The pterotics are elongated antero-posteriorly and border the parietals on the inner side. Posteriorly the pterotics articulate with the post-temporals and the supratemporals, while anteriorly they articulate with the sphenotics. The epiotics are situated posteriorly near the supraoccipital spine and articulate anteriorly with the parietals.

(d) The Occipital Region.—The supraoccipital does not take part in the formation of foramen magnum. The posterior end of the supraoccipital bears a pair of supraoccipital spines. Ramaswami (1952) in *Garra mullay* and Srinivasachar (1955) in *Ophicephalus striatus* describe only a single median supraoccipital spine. As has already been mentioned, the supraoccipital penetrates into the posterior portion of the parietals. The exoccipitals extend dorsally to cover the foramen magnum. The occipital condyle is a bony enlargement and situated at the postero-ventral end of the foramen magnum. The basioccipital is a small bony extension of the parasphenoid.

(e) The Opercular Region.—The opercular region consists of paired operculars, suboperculars, interoperculars and preoperculars. The opercular is oval in outline and forms the postero-lateral part of the head. The antero-dorsal extremity of the opercular is in contact with the pterotic of the corresponding side. The ventral and ventro-lateral borders of the oper-
cular form dense cartilaginous portions which have been recognised as sub-operculars in *Hemirhamphus xanthopterus*. The interopercular is triangular and lies between the opercular and preopercular. It forms the postero-ventral boundary of the skull. The preopercular which is also triangular in outline extends dorsally up to the pterotic of the temporal region while anteriorly it articulates with dentary below the quadrate.

(f) The Upper Jaw.—The upper jaw composed of fused premaxillaries is a triangular structure. The base of the triangle lies parallel to the median ethmoid. The premaxillary bears small conical projections which are not arranged in definite linear rows. These maxillary denticles are more numerous on the anterior side than the posterior. Two ramii of the maxillary bone are united by a continuous extension of the cartilage. At the base of the premaxillary triangle, distal to the ethmoid bone, are present paired nasals which extend outwards laterally and fuse with the lateral ethmoids.

(g) The Lower Jaw.—In the lower jaw of *Hemirhamphus xanthopterus* only two elements, the articular and the dentary, are distinct. Of these two the dentary is very conspicuous. It is much elongate and forms with its counterpart, a long beak-like structure. There is no mento-mecckelian ossification on the dentary. The posterior parts of the two ramii, which border the mouth, bear conical denticles. The articular is relatively small and elongated. It articulates with the quadrate posteriorly which gives a short process anteriorly for this articulation. The posterior portion of the quadrate lies in contact with the anterior end of the preopercular and the hyomandibular. The hyomandibular is cartilaginous and articulates dorsally with the lateral surface of the auditory region, the major portion of the articulation being shared by sphenotic and the pterotic. The posterior edge of the hyomandibular cartilage articulates with the anterior edge of the preopercular. The hyomandibular, being in articulation with the quadrate anteriorly, supports the lower jaw.

IV. Summary

The authors give a detailed description of the skull of the fish *Hemirhamphus xanthopterus* Cuv. and Val. The more important points described are as follows:—

1. The median ethmoid and the lateral ethmoids are alone present, the supraethmoid is not differentiated.

2. The prevomer is edentulous and gives out a posterior projection which articulates with the parasphenoïd.
3. The elongated and paired cartilaginous frontals are not separated from each other.

4. The parietals are partly separated from each other by the intervention of the supraoccipital.

5. The interorbital septum is membranous.

6. The suborbitals are absent.

7. The ventral boundary of the orbit is formed by an osseous pterygoid and symplectic.

8. The sphenoid region comprises paired basisphenoids, a median parasphenoid and paired lateral pleurosideanoids.

9. The small supraoccipital bears posteriorly a pair of supraoccipital spines.

10. The opercular region consists of paired operculars, suboperculars, interoperculars and preoperculars.

11. The upper jaw is formed only of the premaxillaries which bear small, irregularly disposed conical teeth.

12. The lower jaw is prolonged to form a long slender half-beak. The angular is absent. The Meckel’s cartilage is not ossified.

V. ACKNOWLEDGMENTS

We express our gratitude to Shri Bhim Sen, Principal, Government College, Ajmer, for research facilities. Our thanks are also due to Shri Bhanwar Lal Garg for assistance in the preparation of the illustrations.

VI. REFERENCES


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VII. ABBREVIATIONS

art., articular
boc., basioccipital
bsp., bassiphenoid
cor., coronary process
den., dentary
eoc., exoccipital
epo., epiotic
eth., ethmoid
fm., foramen magnum
fr., frontal
hy., hyomandibular
iop., interopercular
ios., interorbital septum
lac., lacrimal
let., lateral ethmoid
max., premaxillary
mc., Meckel's cartilage
mpt., pterygoid
nas., nasal
op., opercular
or., orbit
osp., occipital spine
p., parietal
plp., pleurosphenoid
pob., postorbital
pop., preopercular
pro., prootic
psp., parasphenoid
pt., post-temporal
ptr., pterotic
q., quadrate
sob., suborbital
soc., supraoccipital
sop., subopercular
sph., sphenotic
spr., sphenotic process
st., supratemporal
sym., symplectic
th., teeth