

## INTRODUCTION OF NEW TERMINOLOGY IN THE SKELETON OF THE FISHES BELONGING TO THE ORDER HETEROSOMATA (PLEURONECTIFORMES)

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A detailed osteology of the flat fishes (Heterosomata) shows false orbit locating the migrated eye. The term pseudoorbit is suggested for such a false orbit. The five families of the order Heterosomata have the characteristic feature of possessing the pseudoorbit. A detailed study of the pseudoorbit in each family shows variation in the surrounding bones forming the boundary of the pseudoorbit.

Kyle<sup>3</sup> and William<sup>7</sup> stated that the juvenile flat-fishes bear the two eyes on either side of the chondrocranium; during metamorphosis one eye migrates to other side, assuming a characteristic feature of two eyes on the same side. The migrated eye is lodged in a bony socket formed by a somewhat rounded gap between the two frontals. This bony socket does not fulfil the conditions of an orbit which is usually made up by the frontals at the dorsal surface, parasphenoid at the ventral surface, alisphenoid or basisphenoid at the posterior surface, and lateral ethmoid and vomer at the anterior surface. In case of flat-fishes the migrated eye lies in a socket formed by the frontals on the lateral and posterior sides, parasphenoid at the floor and lateral ethmoids at the anterior side. These bones altogether form a false orbit for the location of the migrated eye. The term pseudoorbit is here assigned to such a false orbit. The present paper deals with the term pseudoorbit and its variations in the families of the order Heterosomata or Pleuronectiformes.

### Materials and Methods

The material studied include the chondrocrania of the families Psettodidae, Bothidae, Pleuronectidae, Cynoglossidae and Soleidae.

As specimens of family Pleuronectidae have not been recorded from the Arabian Sea they were obtained from the National Museums of Canada in Ottawa through the courtesy of Dr. D.E. McAllister. They are, *Lyopsetta exilis* NMC65-200, *Platichthys stellatus* NMC64-683-E, and *Reinhardtius hippoglossoides* NMC64-756.

The other fish specimens studied were collected from Karachi harbour, and include: (1) *Psettodes erumei*; (2) *Pseudorhombus arsius*; (3) *Synaptura orientalis*; (4) *Cynoglossus sindensis*.

Specimens of small sizes were stained in alizarin red according to Hollister's method. Large alcohol preserved specimens were boiled in KOH to remove the flesh and were treated with hydrogen peroxide to clarify different sutures. The crania were finally stained with alizarin. Diagrams have been made with a proportional divider and are

enlarged 2-4 times from original size of the specimen; photographs were reduced half the length of the sketches.

### Discussion

At the early developmental stage of an eye a hollow outgrowth the 'optic vessel' is given off from each side of the forebrain. It project out further and touches the ectoderm at the sides of the head. This ectoderm becomes thickened and invaginates. Eventually, it forms a closed sac and is separated from the rest of the ectoderm. During the development of the chondrocranium, cartilaginous investment is formed around the optic capsules. The cartilaginous investment takes the shape of an orbit in the adult stage.

The eye in an orbit is moved by six muscles, four of these arise from the inner wall of the orbit and pass to their insertion over the equator of the eye. One of them is dorsal, the superior rectus; a second ventral, the inferior rectus; a third anterior or internal rectus; and the fourth the posterior or external rectus. The two remaining are superior and inferior oblique muscles arising from the anterior region of the orbit and inserting into dorsal and ventral surface of the eye ball.

Gregory<sup>2</sup> describes the orbit in these words: "the adult teleost endocranium is a complex of four intergrading parts surrounding the orbits; these may be named ethmovomer block, the interorbital bridge, the cranial vault, and the keel bone or parasphenoid". Thus the orbits are the two excavations anterior to the auditory region, lying on the lateral sides of the cranium. They are bounded by the frontals at the roof, parasphenoid at the floor, vomer and lateral ethmoids at the anterior end, while the alisphenoids or basisphenoids form the posterior boundary.

Osteological studies on the fishes of the order Heterosomata revealed that an abnormal condition exists for the socket of the migrated eye. The migrated eye is lodged in a bony socket formed by a gap between the two frontals and the circumorbital bones are also absent. A pseudo-mesial bar<sup>3,6</sup> is present running between the two



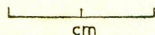
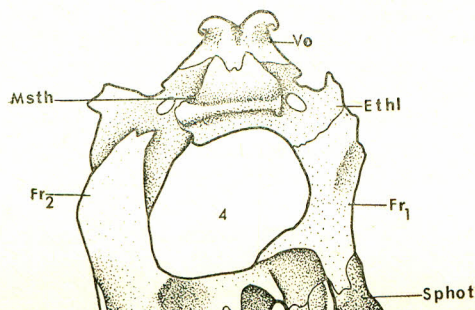


Fig. 1.

Fig. 1.—Pseudoorbit of *Psettodes erumei*, VO, Vomer; Msth; mesethmoid; Ethl, lateral ethmoid; Fr 1, Right frontal; Fr 2, left frontal; 4, pseudoorbit. Fig. 2.—Pseudoorbit of *Pseudorbombus arsius* Fig. 3.— Pseudoorbit of *Lyopsetta exilis*. 8, pseudomesial bar; R. ethl, right lateral, ethmoid; l. ethl, left lateral ethmoid.

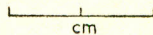
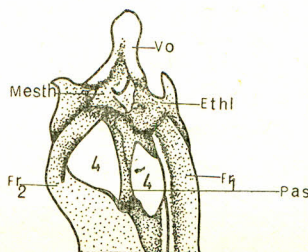


Fig. 2.

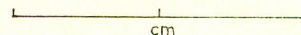
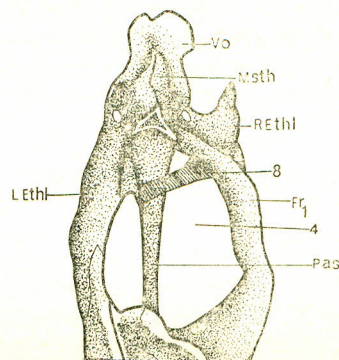


Fig. 3.

eyes to separate them internally. The conditions of the socket for the migrated eye in these fishes differ from the structure of a true orbit. The term pseudoorbit is used here for such a bony socket.

The presence of a pseudoorbit has been noted in every specimen of the order Heterosomata studied. A detailed study of pseudoorbit in the individuals of each of the five families show variations in the structure of the pseudoorbit.

In case of *Psettodes erumei* (Fig. 1) a representative of family Psettodidae, the pseudoorbit is on the dorsal surface of the chondrocranium. The pseudoorbit is bounded by the frontals on the lateral and posterior sides, and the two lateral ethmoids at the anterior side, each forming half the anterior boundary. The parasphenoid forms the floor of pseudoorbit. The curved anterior portion of the frontal (Fr2) forms an interorbital bar running between the two eyes. The eye in the pseudoorbit is devoid of any circumorbital bones, but a single lacrimal is present on the blind side of the fish.

Of the family Bothidae two species i.e. *Pseudorbombus arsius* and *P. annulatus* were studied. In *Pseudorbombus arsius* (Fig. 2) the anterior boundary of pseudoorbit, unlike that of *Psettodes*, is formed partly by the right lateral ethmoid and mesethmoid. The other boundaries of the pseudoorbit are formed by the same bones as in *Psettodes erumei*.

The pseudoorbit in *Lyopsetta exilis* (Fig. 3), (family Pleuronectidae) is formed as in *Pseudorbombus arsius* but the left lateral ethmoid extends little posterior, decreasing the length of the left frontal (Fr. 2) while the posterior boundary is evenly formed by two frontals.

In case of *Synaptura orientalis* (Fig. 4), (family Soleidae) the pseudoorbit is formed only by the

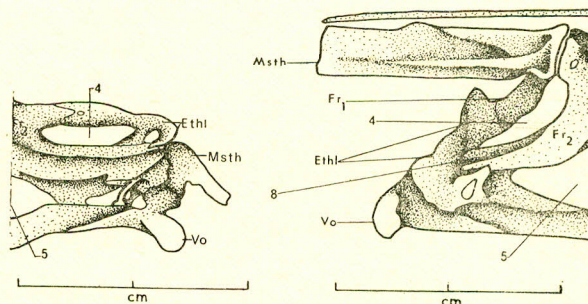


Fig. 4.

Fig. 5.

Fig. 4.—Pseudoorbit of *Synaptura orientalis*. Fig.— 5. Pseudoorbit of *Cynoglossus sindensis*. 8, Pseudomesial bar; 5, interorbital foramen.

two bones the left lateral ethmoid at the anterior and lateral side and the left frontal (Fr2) at the posterior and medial sides. The right frontal does not take part in the formation of the pseudoorbit. The right and the left frontal both lie between the two eyes forming the interorbital bar.

*Cynoglossus sindensis*, (Fig. 5) (family Cynoglossidae) is sinistral. The pseudoorbit is formed by the frontals at the lateral and posterior sides and lateral ethmoids at the anterior side, a condition similar to *Psettodes erumei*.

The present study based on the specimen of different families of the order Heterosomata has made it clear that a false orbit comes into existence to make room for the migrated eye. The name pseudoorbit has been proposed for the space locating the migrated eye.

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