The Morphology of Abnormal Lateral-line Canals in the Centrarchid Fish Lepomis humilis (Girard)[1]

MILTON R. CURD, Oklahoma State University, Stillwater

Examination of a large collection of fishes from the Verdigris River in Oklahoma revealed many specimens of *Lepomis humilis* with varying portions of the lateral-line canals represented by open grooves. An investigation was undertaken to determine the morphology and, if possible, the cause of this anomolous condition. Observed skeletal and histological differences between the canals of normal and abnormal specimens are presented.

Of all the centrachids, *L. humilis* is the most logical species to display this type of abnormality. The cephalic canals are proportionately much larger than in any other member of the family. Hubbs, on the basis of the enlarged, cavernous cephalic canals, proposed the genus *Allotis* to accommodate this form (Ortenburger and Hubbs, 1927). Lateral-line systems in the form of open grooves are normally present in several species of teleosts, but no mention of abnormally open canals has been found.

The fish were collected by means of minnow seines or rotenone and dip nets. Ten-percent formalin was employed as the fixing agent and 50% isopropanol as the final preservative. The specimens used for making sections were decalcified for three days in 70% ethanol containing 3%

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hydrochloric acid. Tissue blocks were taken from the supraorbital, infraorbital, and opercular arm of the operculomandibular canal regions of both normal and abnormal specimens. Ten-micron celloidin sections were stained in haematoxylin and eosin or Mallory's connective tissue stain. Skeletal material was prepared using Evans' (1948) modification of the Schultze method and alizarin red S.

Examination of 2215 specimens revealed 127 (5.73%) with abnormal areas characterized by the absence of epithelial covering at least in some area. The incidence of abnormal fish in collections from 67 sites on the Verdigris River and its tributaries varied erratically from zero to 33%, and distribution did not indicate an area of concentration or any particular habitat.

The extent of the abnormality varies from a small area lacking epidermis only, to broadly open canals affecting approximately 90% of the system. The infraorbital, the opercular arm and the lateralis at its junction with the supratemporal are the canals most frequently open. The epidermis is frequently absent from the area between the operculomandibular and lateral canals even though there is no canal connecting them. The mandibular arm and the anterior portion of the supraorbital seem to be the least affected, being abnormal only when a large portion of the system is open. The lateralis, usually continuous to the hypural and frequently interrupted above the anal fin or occasionally absent posteriad, is completely open in some specimens; the ridge-like sides of the canal remain on the scales and the roof of the canal is missing. The size of the fish seems to have little bearing on the presence of open areas, specimens as small as 19 mm. in standard length being affected. However, extremes of the abnormal condition are present in adult specimens only.

The histology of the cephalic lateral-line system of normal *L. humilis* is similar to that described for other species with enclosed canals. The innermost structure is an epithelial tube containing numerous mucous cells (Fig. 1). The sensory organs, which were described in detail by Moore (1956), are on the inner surface of this tube. A low cupula, not found by Moore, was observed on one of the organs. The tube is surrounded by connective tissue which is largely replaced by bone in much of the system. Except for the canal-pores, the system is covered by dermis and epidermis which is slightly thinner immediately external to the canals than elsewhere. Scales are not present over the canals.

The ossified portions of the cephalic lateral-line canals in *L. humilis* sufficiently resemble those of *Archoplites interruptus* (Girard), as described by Dineen and Stokely (1956), that a complete description of the bony canals in *L. humilis* is unnecessary here. However, the following discussion of the osteology seems pertinent to the abnormal condition under consideration.

The extent to which bone covers the outer portion of the canal is quite variable and somewhat dependent on the age of the individual. Open channels of bone are probably of common occurrence in larval and juvenile fishes as shown in *Amia* (Allis, 1889) and *Archoplites* (Dineen and Stokely, 1956).

The specimens of *L. humilis* examined for ossification varied in standard length from 22 mm. to 65 mm. Although a younger specimen probably would show the "open channel" condition more completely, several areas on the 22 mm. specimen fit this term. At this stage the supraorbital canal has nearly reached mature ossification on the frontal bones, but the nasals are still open (Plate I, Fig. 1). The mandibular arm of the operculomandibular canal is still partially open (Plate I, Fig. 3) and the opercular arm shows a similar stage of ossification. Except for the

anterior end of the infraorbital canal which lies in the lacrimal bone (Plate I, Fig. 2), the remainder of the system is considerably less ossified. The infraorbital series, except for the lacrimal, is the slowest to ossify. The first element posterior to the lacrimal is completely absent and the next element is in the form of a small, flat disc. The remaining three elements have advanced to a shallow channel shape. The bones which house the lateral and supratemporal canals are still open, but have begun to curve over the outer surface.

The supraorbital canal, lacrimal and mandibular canal of an adult (57 mm.) specimen are shown in Plate I, Figs. 7, 8 and 9 for comparison. The other parts of the system are so variable, in their degree of ossification, that it is impossible to determine what constitutes an average, normal-adult condition. The infraorbital series, excluding the lacrimal, displays the greatest variation. The elements may be nearly flat, or with sides almost meeting exteriorly, and occasionally two or more elements are fused together. In no observed specimen did they become completely closed to form tubular "pipe-like" bones as found in *Amiurus (sic)* by Kindred (1919).

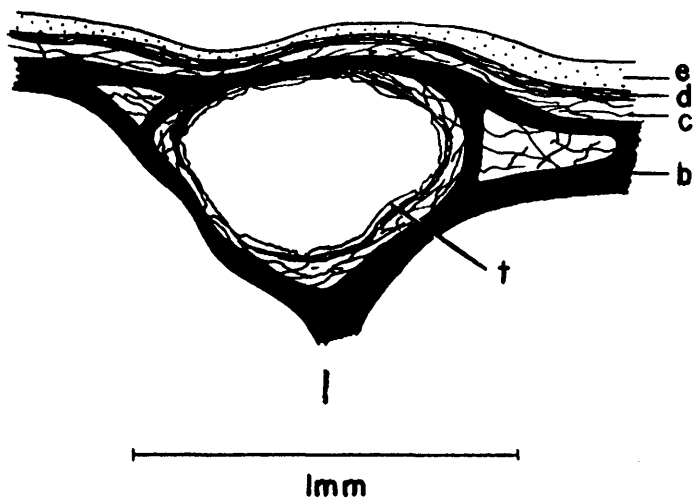


Figure 1. Cross section of a normal supraorbital canal of *Lepomis humilis*.

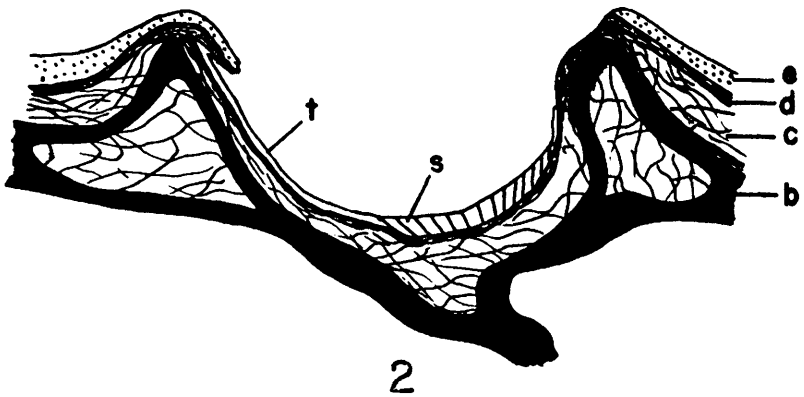
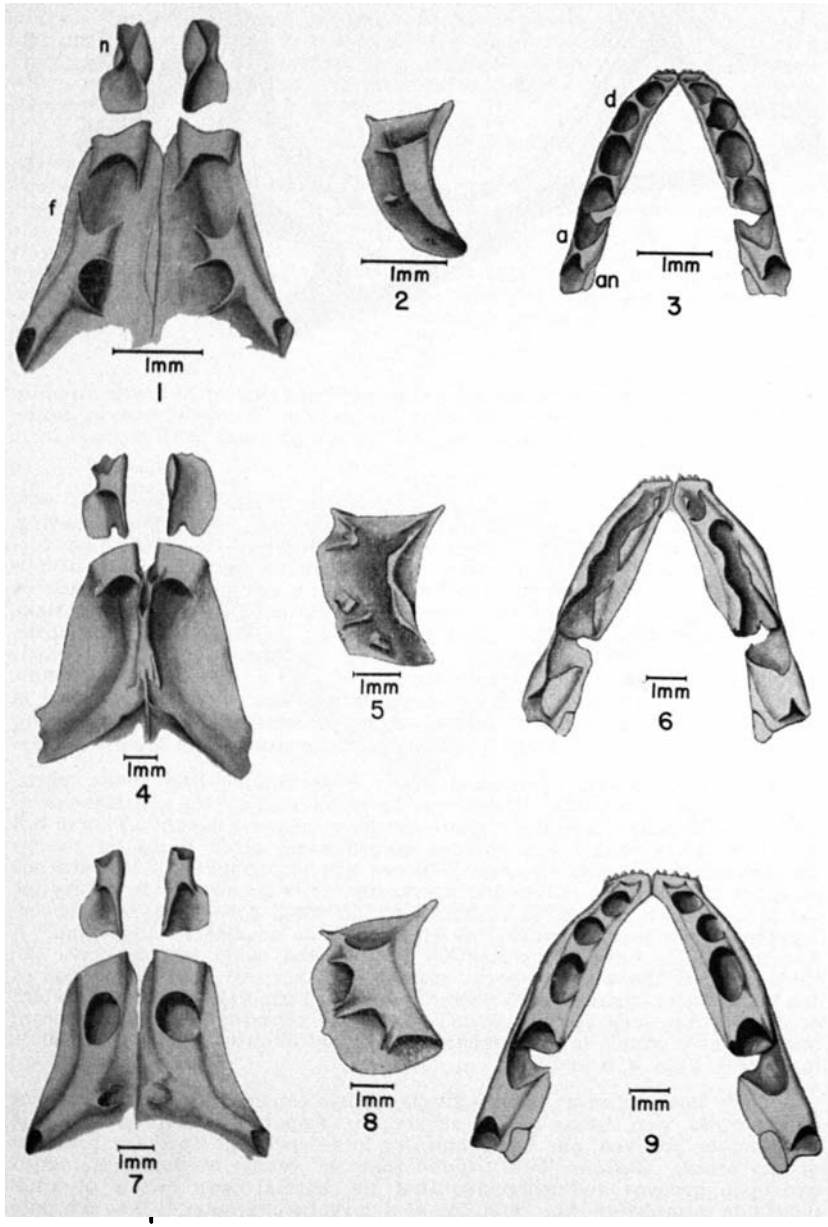


Figure 2. Cross section of an open supraorbital canal of *Lepomis humilis*. Bone, b; connective tissue, c; dermis, d; epidermis, e; sense organ, s; epithelial tube, t. Drawings made with the aid of a camera lucida.

In abnormal specimens the tissues which normally cover the epithelial tube, and the outer portion of the tube itself, are absent, leaving an open groove (Fig. 2). The epidermis and some of the dermis are frequently missing from the borders of open canals tending to accentuate the width of the grooves. The portion of the tube remaining in the grooves is partially disintegrated. This may be explained as an artifact of fixation since a similar condition was found in normal specimens; the sense organs are apparently normal in both. All specimens examined, regardless of the abnormal lateral line, appeared to be in good physical condition. Undoubtedly the efficiency of the lateral-line organs is lessened in the open areas, especially if the structures associated with the covering of the canal function to amplify vibrations as postulated by Moore (1956).

Specimens having open canals also have channel-like bones, particularly in the open areas. Those regions which display the greatest variation in ossification have the highest incidence of open canals. This is not meant to imply that where channel-shaped bones occur the outer tissues are absent, but that open-grooved bones are prerequisite to the absence of outer tissues. As mentioned previously, it is impossible to determine the normal with respect to ossification. In some specimens, bone covering the canals is so meager that they must be considered abnormal. A few individuals have approximately 90% of the canal system open. In these most of the supratemporal, mandibular arm and lacrimal portion of the infraorbital canals, which normally exhibit little variation in the extent of ossification, lack both bone and soft-tissue coverings. The absence of bone in these canals in an extremely abnormal 53-mm. specimen is shown in Plate I, Figs. 4, 5 and 6.

There does not seem to be a single, simple cause to which the presence of abnormal open canals can be attributed. Apparently there are at least two factors involved, one being more or less dependent upon the presence of the other. Gosline (1949) found that the canals of young *Fundulus* are open grooves and suggested that the normal open canals of adult poeciliids is probably "the retention of a juvenile character." Though only small segments of the entirely open system of the poeciliid *Gambusia affinis* are associated with grooved bones, the hypothesis of Gosline may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apply to the channel bones in *L. humilis*. This explanation does not seem to satisfy the absence of soft tissues which appears to be a secondary loss rather than a failure to develop. Many possible explanations for the abnormal condition have been examined but none of them seem sufficiently plausible to warrant mentioning. Considerable study, directed toward development and genetics may disclose the cause of this abnormality.

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Plate I

Variation in ossification of selected cephalic lateral-line canals in *Lepomis humilis*. Standard length in mm. in parentheses. Drawn with the aid of a camera lucida.

Figure 1. Supraorbital canal, young (22) Nasal, n; frontal, f.
Figure 2. Lacrimal, young (22)
Figure 3. Mandibular arm of the operculomandibular canal, young (22) Articular, a; angular, an; dentary, d.
Figure 4. Abnormal supraorbital canal (53)
Figure 5. Abnormal lacrimal (53)
Figure 6. Abnormal mandibular arm of the operculomandibular canal (53)
Figure 7. Normal supraorbital canal (57)
Figure 8. Normal lacrimal (57)
Figure 9. Normal mandibular arm of the operculomandibular canal (57)