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Description of the Cephalic Sensory Canals of *Lophiogobius ocellicauda* (Perciformes: Gobiidae)

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The suborder Gobioidei (Perciformes), containing approximately 500 nominal genera and 2000 nominal species (Hoese, 1984), Akihito et al. (1984) into two families, Rhyacichthyidae and Gobiidae.

Miller (1973) reported that *Rhyacichthys aspro* (Kuhl and Van Hasselt), one of the two species of Rhyacichthyidae, possessed a infraorbital canal. On the other hand, Takagi (1988) noted that a infraorbital canal was absent in the Gobiidae.

Lophiogobius ocellicauda Günther occurs along the coasts of the East China Sea, Yellow Sea and Po-Hai. Hoese and Gill (1993) mentioned that an infraorbital canal extending below the eye, occurred only in this goby and *R. aspro* (within the Gobioidei), although they did not give any detailed description. This paper describes in detail the cephalic sensory canal system of *L. ocellicauda*, and seek to clarify the existence or otherwise, of any relationship with *R. aspro*.

Materials and Methods

Measuring procedures followed those of Hubbs and Lagler (1958). The terminology of the cephalic sensory system and sensory canal pores followed Akihito et al. (1984) and Takagi (1988), except for the infraorbital canal pores (R). The sensory systems were observed by staining specimens with suminol cyanine ($C_{29}H_{35}IN_2$). Infraorbital pores numbers (Table 1) were counted on the left side of the head. Specimens for osteological observation were cleared and stained for bone and cartilage following Dingerkus and Uhler (1977). Sketches were made with a camera lucida attached to a binocular microscope (Nikon SMZ-10).

Specimens examined. Institutional abbreviations are as follows: BLIH, Biological Laboratory, Imperial Household, Tokyo; SMWU, Sang-Myung Women's University, Seoul.

Lophiogobius ocellicauda: BLIH 19891234, 10 (77.4–91.0mm SL), 25 July 1989; BLIH 1990979, 3 (110.9–118.6), 13 Mar. 1990; BLIH 19891236, 10 (specimen 1 sketched, specimens 2 and 3 cleared and stained) (62.3–71.3), 23 Oct. 1989; SMWU 6670, 3 (45.4–55.1), date as for BLIH 19891234, collection locality of the above-mentioned specimens is Songdok-ri, Chollabuk-do, Korea. BLIH 1990980, 2 (all cleared and stained) (105.6–105.7), 3 Mar. 1990; SMWU 7919, 3 (102.2–107.6), 13 Mar. 1990, collection locality of the above-mentioned specimens is Kuam-dong, Chollabuk-do, Korea. SMWU 3169, 4 (56.3–76.5), 9 Nov. 1985; SMWU 3218, 2 (100.8–113.1), 11 May 1985, collection locality of the above-mentioned specimens is Outer port of Kunsan, Chollabuk-do, Korea. BLIH 1985497, 20 (1 specimen cleared and stained) (30.0–58.3), Napo-ri, Chollabuk-do, Korea, 25 July 1989; BLIH 1985498, 4 (23.8–31.5), Kochang-ri, Chollabuk-do, Korea, 30 July 1985; SMWU 6654, 3 (40.1–50.9), Okgon-ri, Chollabuk-do, Korea, 25 July 1989; SMWU 3232, 13 (31.4–57.3), Ibpo-ri, Yanghwa-myon, Puyo-gun, Chungchongnam-do, Korea, 30 July 1985.

All collection localities were the estuary and lower reaches of the Kum river.

Results

Supraorbital canal.—The supraorbital canal began medially from between the anterior and posterior nostrils, and had a medially-directed notch level with the posterior nostril, before running posteriorly roughly parallel with the dorsal axis to apoint slightly posterodorsal to the eye. At this point, the left and right supraorbital canals were bridged medially by a short canal, at right angles to the dorsal axis, before continuing laterally to the opercular region.

Sensory canal pores A′ (ETH, ethmoidal pore), C (ITOA, anterior interorbital pore) and E (SOT, supraotic pore) were absent in all of the specimens examined. Pore D (ITOP, posterior interorbital pore) was present in 16.5% of the specimens. Its presence or absence bore no relation to standard length (Table 1).

Postorbital portion of infraorbital canal.—The infraorbital canal began from the lower end of the supraorbital canal, being divided into three portions. The postorbital portion was a short branch running postero-ventrally, with pore F (POR, postorbital pore) opening at its lower end.

Suborbital portion of infraorbital canal.—The suborbital portion of the infraorbital canal was a long branch running antero-ventrally from the lower end

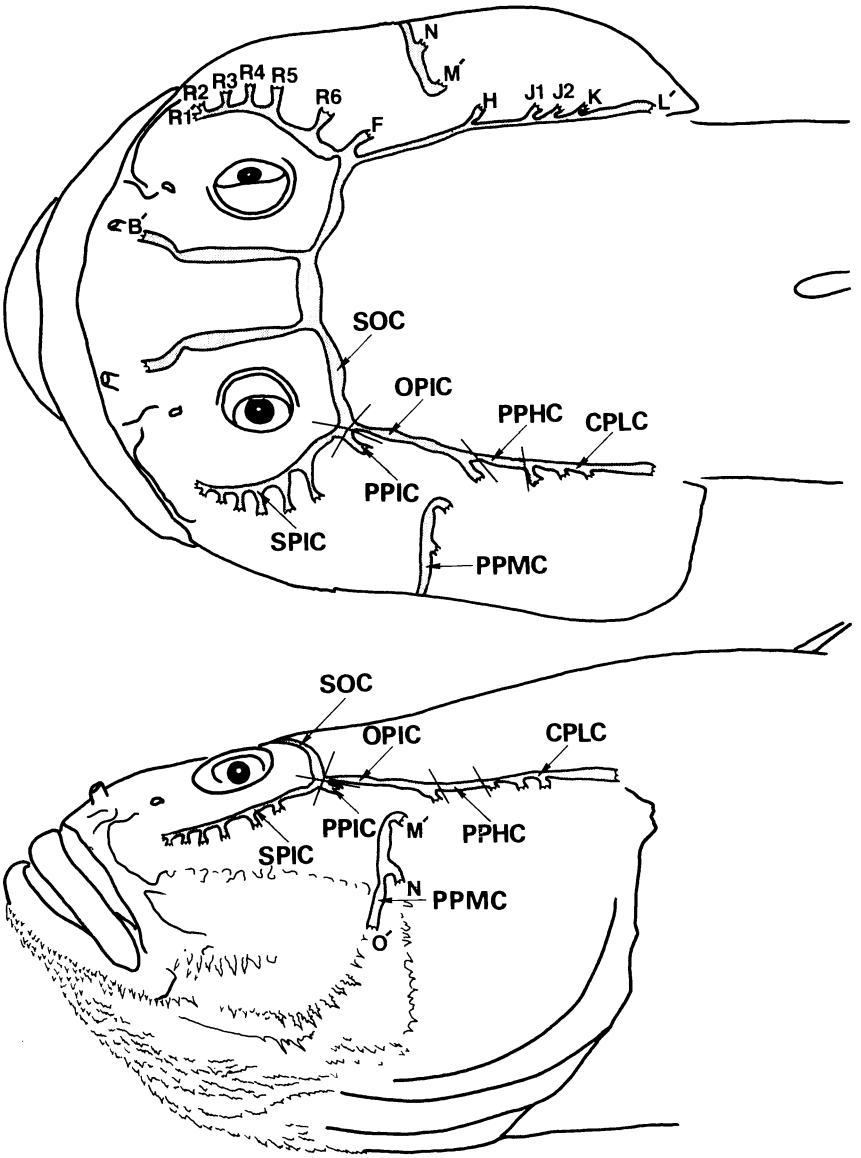

Fig. 1. The cephalic sensory canal system of *Lophiogobius ocellicauda*. *CPLC*—cephalic portion of lateral canal; *OPIC*—otic portion of infraorbital canal; *PPHC*—post otic portion of horizontal canal; *PPIC*—post orbital portion of infraorbital canal; *PPMC*—preopercular portion of preopercular-mandibular canal; *SOC*—supraorbital canal; *SPIC*—suborbital portion of infraorbital canal. *B'–R6*—sensory pores. The short bars indicate the limits of each canal or portion. This specimen (BLIH 19891236-1) lacks pore D.

of the postorbital portion to near the upper part of the anterior corner of the cheek, curving gently anteromedially and having several short branches, which became progressively shorter anteriorly. The suborbital pore opened at its outer end. The suborbital portion is abbreviated SPIC and the suborbital pore indicated as R in Figure 1; suborbital pores are numbered posteriorly from the anteriormost. The latter not only varied in number with body size class (increasing with growth) (Table 2), but also between right and left sides of the same specimen (50.6% of the specimens examined had a different number of suborbital pores on each side).

Otic portion of infraorbital canal.—The otic por-

tion arose from the posterior end of the postorbital portion, running roughly parallel with the dorsal axis. A short branch running postero-ventrally was present at the posterior end of this portion. Pore G (OTM, intermediate otic pore) was absent, but pore H (OTE, extreme otic pore) present being at the terminal part of the short posterior branch.

Postotic portion of horizontal canal.—The postotic portion of the horizontal canal was continuous with the posterior end of the otic portion of the infraorbital canal. It had no sensory pores.

Supratemporal commissure of cephalic portion of lateral canal.—The supratemporal commissure of the cephalic portion of the lateral canal was absent in this species.

Cephalic portion of lateral canal.—The cephalic portion of the lateral canal was continuous with the posterior end of the postotic portion of the horizontal canal, having three short posteroventrally orientated branches. Two pores (CELA, anteriorcephalo-lateral pore) indicated as J1 and J2 in Figure 1, open terminally on the two anterior branches, with that on the third branch corresponding to pore K (CELP, posterior cephalo-lateral pore). At the posterior end of the canal was terminal pore L′ (CELE, extreme cephalo-lateral pore).

Preopercular portion of preopercular-mandibular canal.—The preopercular portion of the preopercular-mandibular canal ran along the upper corner of the preoperculum, being located at right angles to the otic portion of the infraorbital canal. The upper end of the canal curved downward posteriorly. A short branch, also running downward posteriorly, occurred on the posterior side in the middle of the canal. The upper end pore corresponded to M′ (PODU, upper dorso-preopercular pore), the middle pore to N (PODM, intermediate dorso-preopercular pore) and the lower end pore to O′ (PODL, lower

Table 1. Number of individuals in each length group (standard length in mm) possessing pore D

Length group	20.0–29.9	30.0–39.9	40.0–49.9	50.0–59.9	60.0–69.9
Sample number	3	21	20	10	9
Number of individuals	0	8	2	1	0
Length group	70.0–79.9	80.0–89.9	90.0–99.9	100.0–100.9	110.0≦
Sample number	7	1	3	7	4
Number of individuals	2	0	1	0	0

Table 2. Number of suborbital pores in individuals in each length group (standard length in mm)

Length group		20.0–29.9	30.0–39.9	40.0–49.9	50.0–59.9	60.0–69.9
Sample number		3	21	20	10	9
Number of suborbital pores	2	1	—	—	—	—
	3	1	1	—	—	—
	4	1	9	4	3	—
	5	—	7	9	2	3
	6	—	4	5	3	3
	7	—	—	2	2	2
	8	—	—	—	—	1
Length group		70.0–79.9	80.0–89.9	90.0–99.9	100.0–100.9	110.0≦
Sample number		7	1	3	7	4
Number of suborbital pores	2	—	—	—	—	—
	3	—	—	—	—	—
	4	1	—	—	2	—
	5	2	—	1	2	—
	6	—	—	1	1	2
	7	3	1	—	2	1
	8	1	—	1	—	1

dorso-preopercular pore).

All of the cephalic sensory pores had a single triangular process on their mid-dorsal margin.

Discussion

The sensory canals of *Lophiogobius ocellicauda* generally resemble those of common gobiid fishes, except for the following characters. Most notable is the presence of a suborbital portion of the infraorbital canal and suborbital pores, such being absent from all other gobiids. In addition, all of the sensory pores, except for the terminal pores, open at the tips of short branch canals, two anterior cephalolateral pores (J1 and J2) are present and all of the sensory canal pores have a triangular process on their mid-dorsal margin.

Although perciforms generally have a suborbital canal, which is supported by infraorbital bones, examination of cleared and stained specimens of *L. ocellicauda* revealed the absence of the latter.

Among the Gobioidei, *Rhyacichthys aspro* and *L. ocellicauda* are the only species possessing a suborbital portion of the infraorbital canal and suborbital pores, with *R. aspro* being the most primitive species of the group (Hoese and Gill, 1993). A number of *L. ocellicauda* differ from those of *R. aspro*: viz. branchiostegal rays number five (vs. six in *R. aspro*), an ectopterygoid is absent (present), the scapula is small and the cleithrum attached to the uppermost proximal radial of the pectoral fin (large scapula separates cleithrum from uppermost proximal radial of pectoral fin), the middle radial of the first pterygiophore of the second dorsal fin is absent (present), a bony canal is absent on the ventral surface of the preoperculum (present), transforming cteni are absent (present), the penultimate branchiostegal ray articulates with the anterior ceratohyal (attached to posterior ceratohyal), a lateral line on the body is absent (present), a preopercular mandibular canal is absent (present), a infraorbital bone is absent (present), a urohyal shelf is absent (present) and an interneural gap is present (absent). Judging from these characters, *L. ocellicauda* is clearly a member of the Gobiidae, being widely divergent phylogenetically from *R. aspro*. Accordingly, the presence of a suborbital portion of the infraorbital canal and suborbital pores are apparently an example of convergence, although why the phenomenon has occurred in the two species is not clear. *R. aspro* inhabits the torrential upper reaches of rivers, whereas *L. ocellicauda* is an estuarine or coastal species, prefering shallow muddy bottoms. On the other hand, many other gobiids, lacking a suborbital canal are found in the habitats of *R. aspro* (e.g. *Rhinogobius* and *Stiphodon* spp.) and *L. ocellicauda* (e.g. *Chaeturichthys* and *Acanthogobius* spp.).

L. ocellicauda was included in the *Acanthogobius* group on the basis of the positional relationship between the dorsal pterygiophores and neural spines, and the number of vertebrae (Birdsong et al., 1988). The pattern of the cephalic sensory canal system of *L. ocellicauda*, however, is quite different from those of the other members of the group. Pezold (1993) recently described 69 different oculoscapular canal pore configurations, based on 129 gobioid genera, although he did not show the suborbital canal pore patterns. Because the oculoscapular canal pore configuration of *L. ocellicauda* does not conform to any of the patterns of Pezold (1993), the systematic position of *L. ocellicauda* is not clear, at least on the basis of the cephalic sensory canal system. Examination of the cephalic sensory canal system in other gobiids may help clarify the situation.

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ワニハゼ *Lophiogobius ocellicauda*（ハゼ科）の頭部感覚管の記載

岩田明久・田　祥麟

ワニハゼ *Lophiogobius ocellicauda* の頭部感覚管の記載を行った．本種の頭部感覚管の最大の特徴は眼下管眼下部と，それに伴う開孔が存在することである．その他の特徴として，末端開孔を除く他の全ての開孔が短い枝部の先端に位置すること；開孔 J がふたつあること；全ての開孔にひとつの小さな三角形の突起があることがあげられる．

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