MORPHOLOGICAL OBSERVATIONS OF THE LARGE PIT ORGAN IN FOUR SPECIES OF FRESHWATER TELEOST, *ORYZIAS*

T. Iwamatsu[1], T. Ohta[1] and O. P. Saxena[2]

[1]*Department of Biology, Aichi University of Education, Kariya City, Aichi 448 and* [2]*Department of Zoology, Multanimal Modi College, Modinagar, India*

ABSTRACT - The large pit organs in the adult fish of four species of *Oryzias (O. celebensis, O. javanicus, O. latipes, O. melastigma)* were examined morphologically using an ordinary light and a scanning electron microscopes. Both "sunken" (canal) and "naked" types of large pit organs were recognized in *O. javanicus* and *O. melastigma* and only the naked type in *O. celebensis* and *O. latipes*. In *O. melastigma*, it was found that shortly after hatching several small pit organs differentiate to the sunken type after transformation to the naked type of large pit organs.

INTRODUCTION

In general, the lateral line system of teleost is characterized by canal oragns in the head and mid-lateral region of the flank and by pit organs on the whole body surface. In the medaka, *Oryzias latipes*, small pit organs in the pits and large pit organs (groove organs named by Yamamoto, 1947) in the head are present, although the lateral line scales with sensory canals are absent in the flank (Yamamoto, 1947, 1975). In *O. latipes* only the naked type in which the top of the sensory cells are exposed on the outer surface has been found (Sato, 1955a) ; no canal system is present. According to Sato (1955c), this organ gives the most remarkable characteristic to the pit line system of this fish. It is of interest to know whether morphological differences exist in the large pit organs among the species of *Oryzias*. The external appearance of the pit organs in *O. celebensis*, *O. javanicus*, *O. melastigma*, *O. latipes* will be compared in this paper.

MATERIALS AND METHODS

Adult fishes of four species of *Oryzias* (5 female and 5 male *O. celebensis* 37-43mm ; 7 female and 6 male *O. javanicus* 27-32mm ; 5 female and 10 male *O. latipes* 34-38mm ; 6 female and 5 male *O. melastigma* 30-35mm) and 12 fry of *O. melastigma* were used. *O. celebensis* were collected on South Celebes Island by Mr. Kenji Hirata, *O. javanicus* in Singapore by Dr. T. J. Lam, *O. latipes* were purchased at a fish farm (Yatomi, Aichi Pref. Japan), and *O. melastigma* were collected in India by O. P. Saxena. Fry of *O. melastigma* hatched in our laboratory from spawned eggs.

These fish were fixed with 10% formaldehyde or 4% glutaraldehyde (4°C) for 18 h, then refixed with cold 1% osmium tetroxide for 90 min. These samples were quickly dried with liquid carbon dioxide and observed under a scanning electron microscope after being coated with gold vapour. Some of adult samples viewed with an ordinary light microscope were fixed with Bouin's fixative (4°C) for 24 h. These samples were examined by a reflexive light after staining with 0.004% fastgreen-eosin (room temp.) for 1 h.

RESULTS

Large and small pit organs of adult fish

Most fish examined possessed 14-15 large pit organs in grooves on the anterior, dorsal and posterior sides of the orbit. These so-called groove organs stained with fastgreen seem to correspond to the organs of the supra- and infra-orbital lines of other fish (Sato, 1955b). In front of the orbit (antorbital line) and in the snout, there are a few clusters of small pit organs. Several clusters of

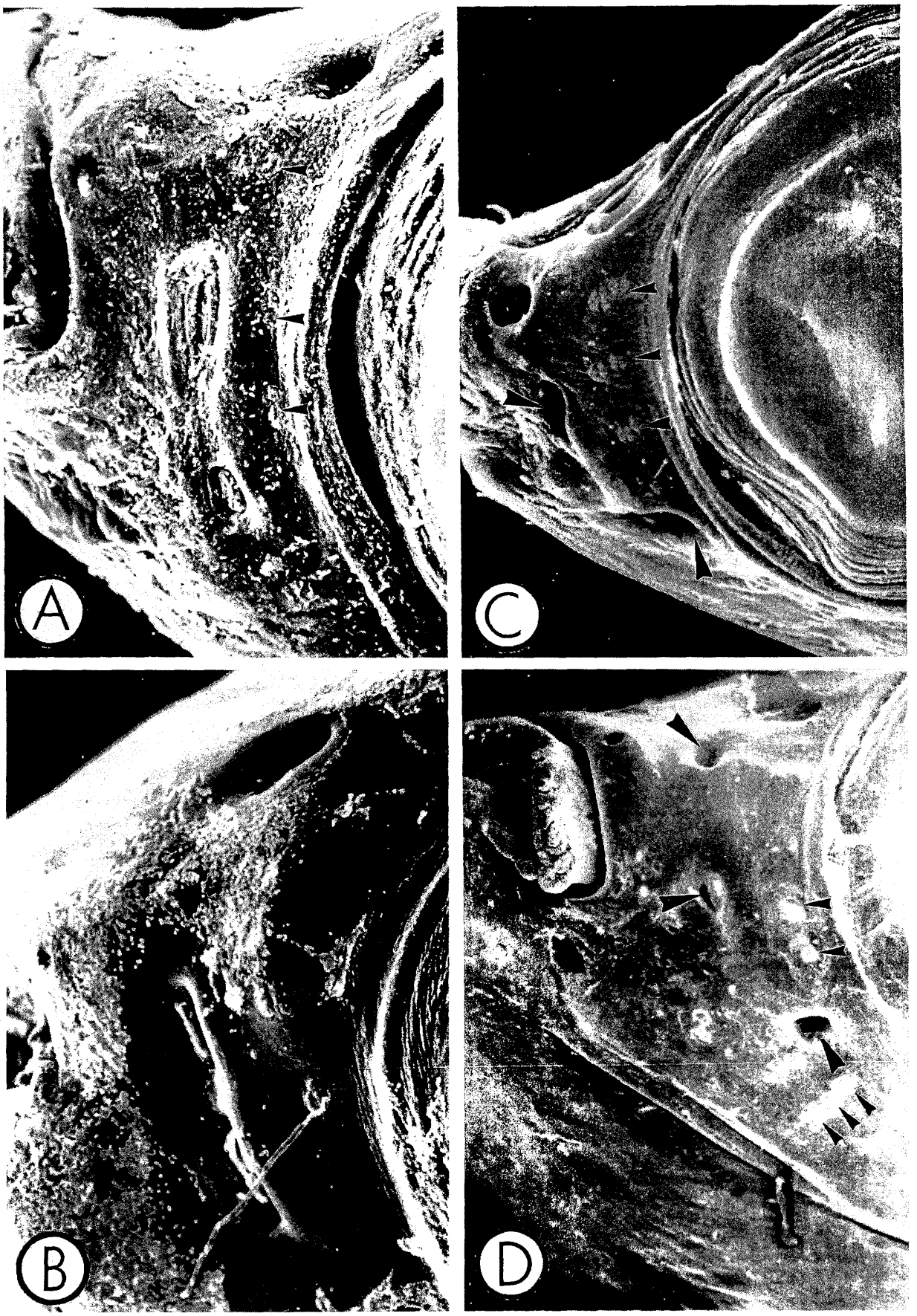


Fig. 1 Antorbital large pit organs of four species of *Oryzias*. ×46. A and B : Naked type of the large pit organs (A, *O. latipes*; B, *O. celebensis*). C and D ; Sunken type of the large pit organs (C, *O. melastigma* ; D, *O. javanicus*). Small arrow heads, small pit organs ; large arrow heads, canal of large pit organs.

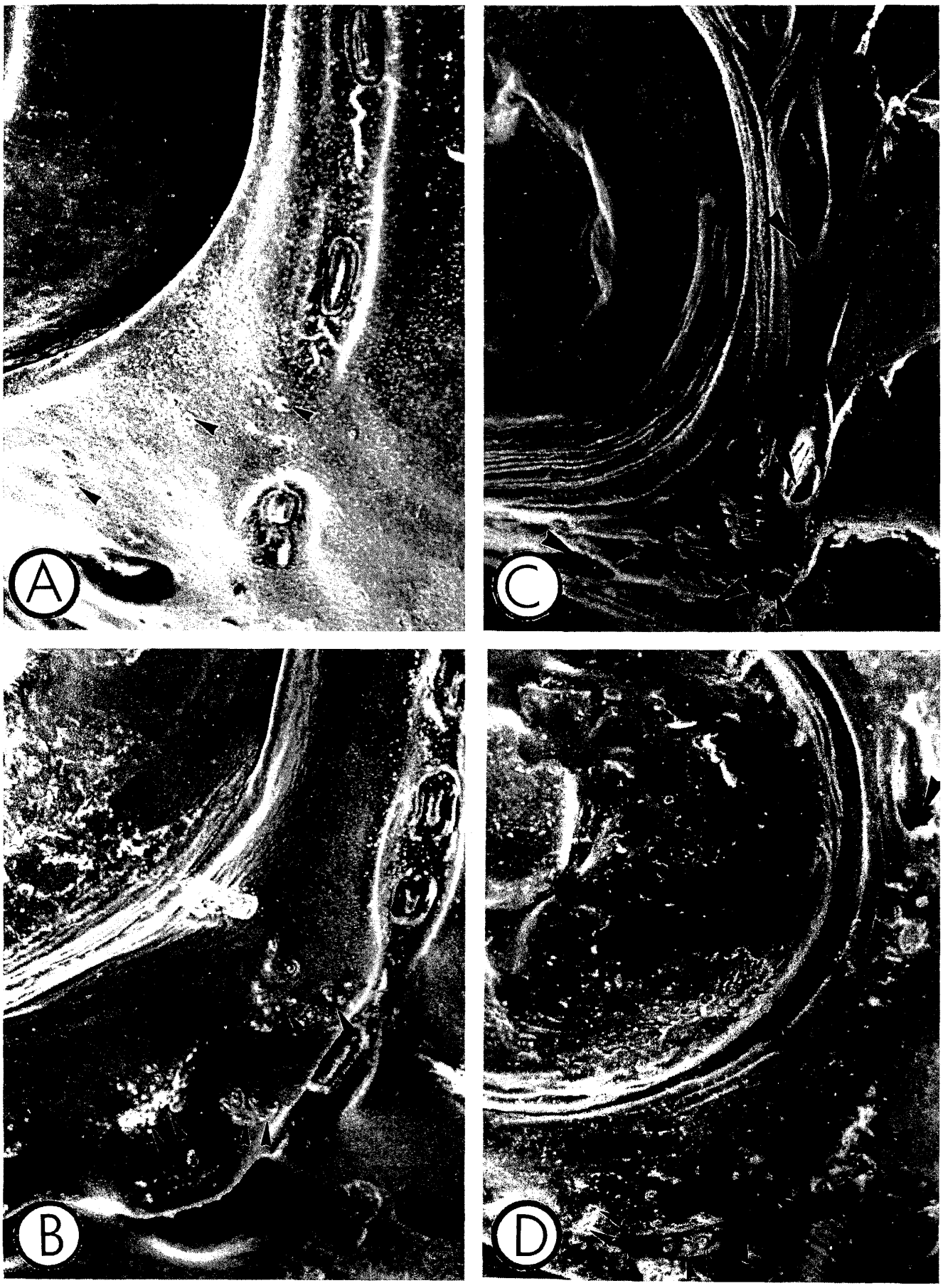


Fig. 2 Post- and infra-orbital large pit organs of four species of *Oryzias*. ×46. A and B : Naked type of the pit organs (A, *O. latipes* ; B, *O. celebensis*). C and D : Sunken type of the large pit organs (C, *O. melastigma* ; D, *O. javanicus*). Arrow heads, see Fig. 1.

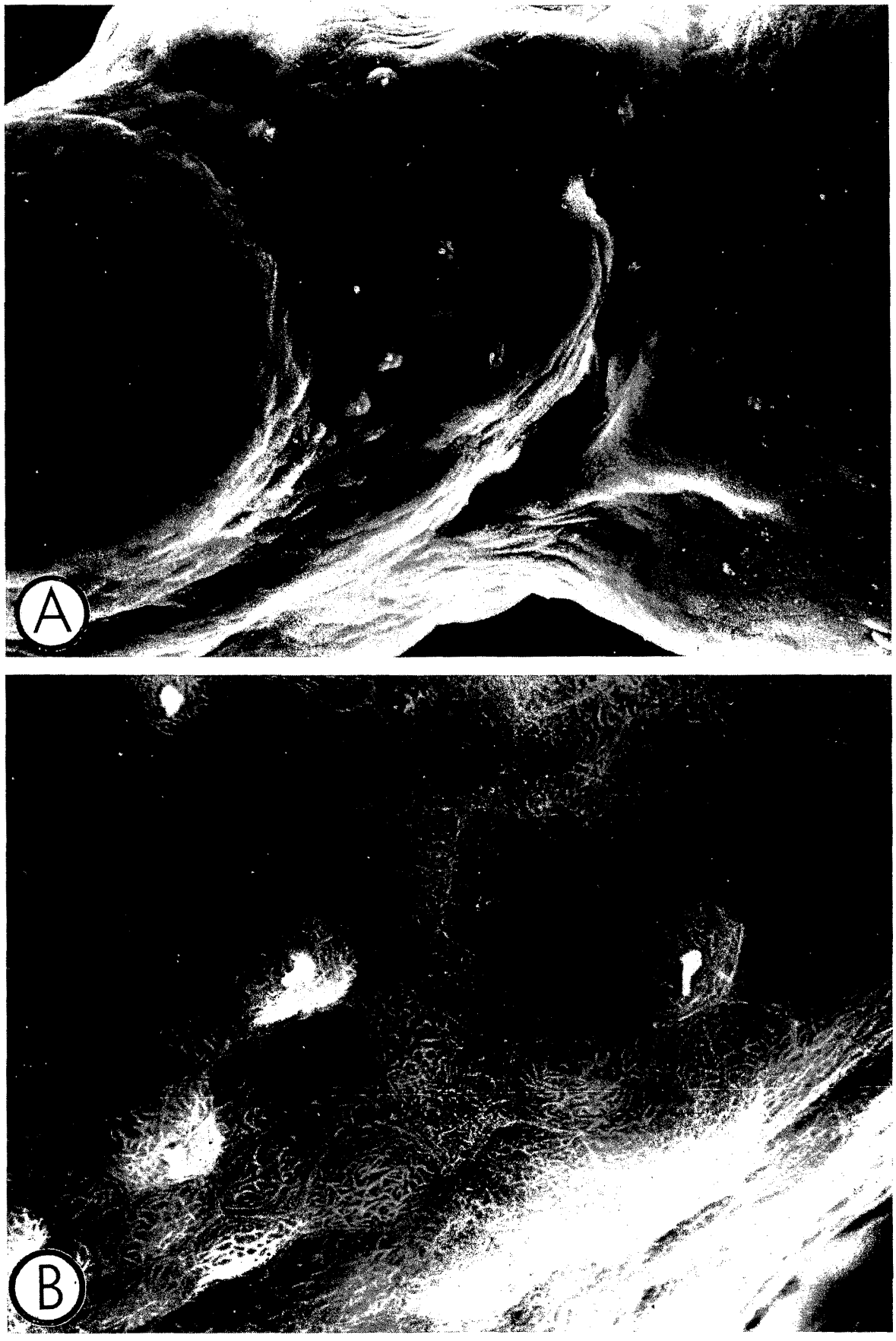


Fig. 3 Undifferentiated pit organs in the head of *O. melastigma* fry (3.7 mm in total length) just after hatching. A : Postorbital region (operculum). ×36. B : Pit organs at the enlarged region of A. ×126.

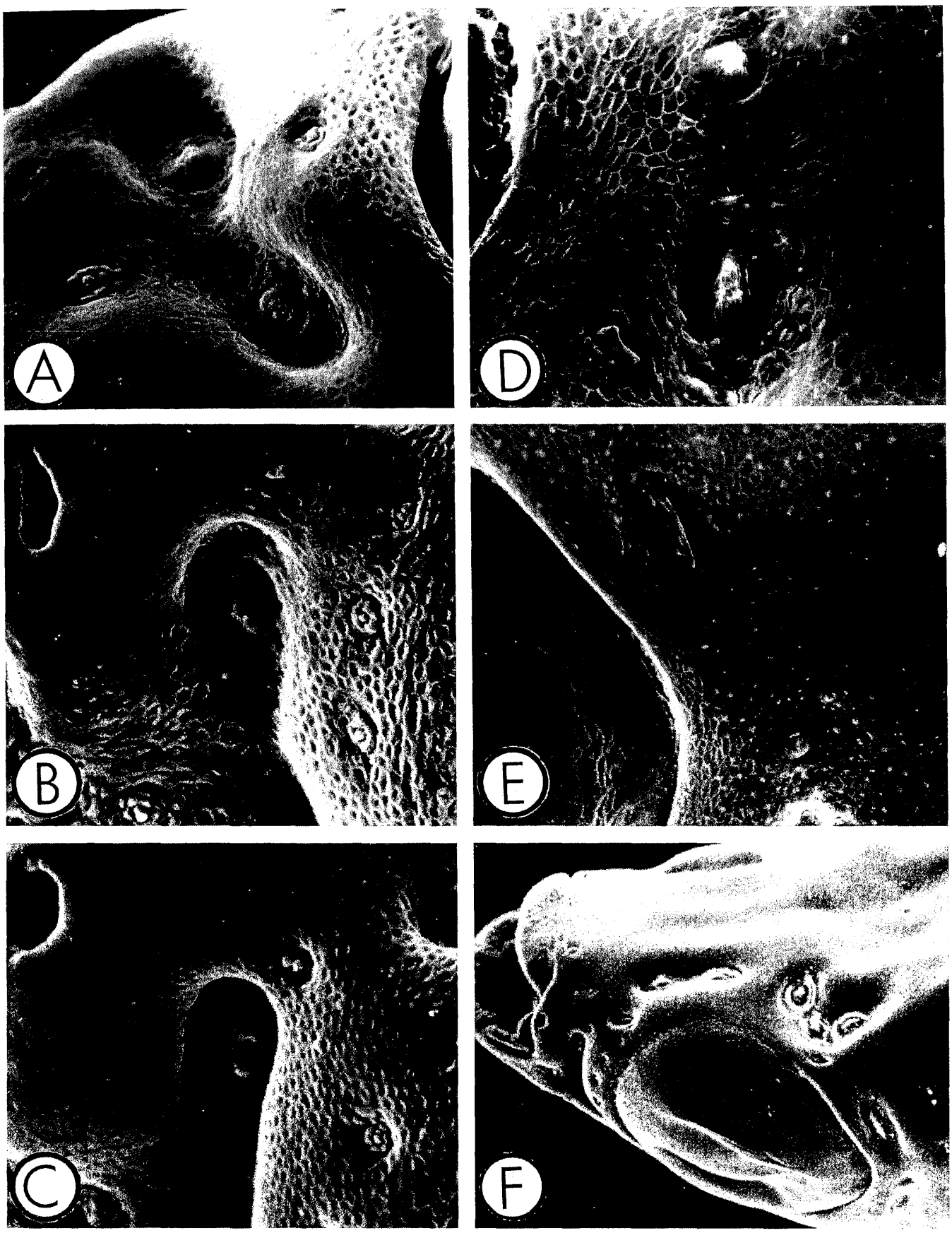
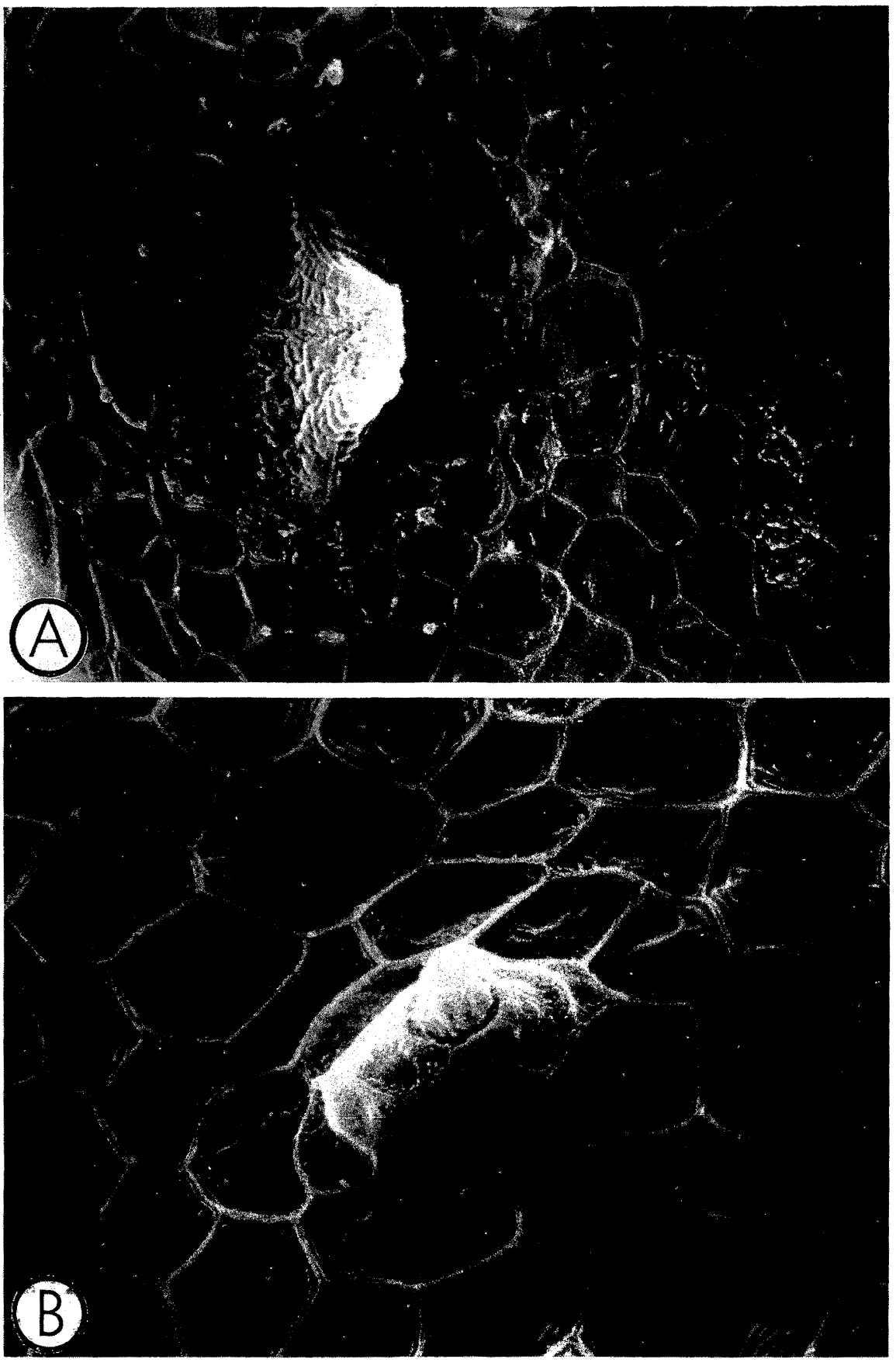


Fig. 4 Changes of outer surface of large pit organs in the head of growing *O. melastigma* fry. Antorbital (A-C) and postorbital (D-F) large pit organs of 6.7 mm (A and D, ×276), 10.5 mm (B, ×264 and E, ×230), and 13 mm (C, ×241 and F, ×40) in total length.


A
B

the pit organs corresponding to the infra-orbital line in the loach (Sato, 1950, 1955b) were distributed between the infra-orbital groove organs and the orbit. A transverse line of several pit organs followed Sato's description (1955b) of *O. latipes*.

O. latipes exhibited groove organs ditched around the orbit (Figs. 1A and 2A). The twelve naked-type large pit organs of *O. celebensis* (Figs. 1B and 2B) were similar to those of *O. latipes* : two in front of the orbit, five in the ventral and five in the posterior region of the orbit. *O. melastigma* exhibited seven naked-type and six sunken-type large pit organs with eight openings, at intervals, to the exterior (Figs. 1C and 2C). *O. javanicus* had six sunken type large pit organs as tunnel-like canals (infra-orbital canal (Fig. 1D) and an antorbital canal, Fig. 2) covered with an epidermis, and six naked-type (supra-orbital) large pit organs located in the dorsal side and behind the orbit.

Change in pit organs of growing fry of O. melastigma

In fry (3.5-4.0mm in total length) that had just hatched, undifferentiated small pit organs with small cupula were found around the orbit (Fig. 3A) and slightly projected over the epidermis, which was composed of 4-5 epidermal cells showing no typical fingerprint-like structure (Fig. 3B). The epidermal cells were different from those in the adult, as reported by Yamada (1966) for *O. latipes*. Both of these organs, scattered in the small head, were morphologically indistinguishable from the small pit organs of adult fish. In fry showing bud-like ventral fins (6.7mm in total length), elongated groove organs (Fig. 4A and D), which were differentiated at the depressed positions as in adult fish, were found. These were different from pit organs because their sensory cells were exposed. In fry (10.5-11mm in total length) with elongated ventral fins, two naked large pit organs in front of the orbit showed valley-like grooves (Fig. 4B and E). In this stage of development, large pit organs appearing as large sensory organs in grooves with comparatively large cupula were detected (Fig. 5A), besides the small pit organs. The small cupula slightly projected over the epidermis and were covered with 4-5 epidermal cells showing a fingerprint-like pattern on the outer surface (Fig. 5B). The large pit organs with large cupula were depressed in the epidermis and their surface was not protected by epidermal cells. The large pit organs in front of the orbit and ones in the ventral side were covered with an epidermis in large fry (13-14mm in total length, in Fig. 4C and F).

DISCUSSION

The present observations revealed that in the genus *Oryzias*, there are two types (the naked and sunken types) of large pit organs around the orbit. *O. latipes* and *O. celebensis* have the large pit organs belonging only to the naked type, while those of *O. javanicus* and *O. melastigma* are composed of the naked and the sunken types which sink below the surrounding epidermis. This finding is very interesting from the view point of the geographical distribution and evolution of *Oryzias* groups.

O. javanicus and *O. melastigma* which possess large pit organs as the canal organs inhabit the west and south Asia, while *O. celebensis* and *O. latipes* which have naked type pit organs are distributed in southeast and northern Asia. This suggests how these geographical variations occur within the *Oryzias* species. In this connection, the authors are interested in the type of large pit organs in *O. luzonensis* (Herre and Ablan, 1936) of Phillipines and *O. curvinotus* (Nicholes and Pope, 1927) of Hainan Island, and *O. minutillus* (Smith, 1945) of Thailand, which are in the central area of Asia.

The present observations on development of the large pit organs in *O. melastigma* showing the sunken (canal) type support the fact that the more the body length increases, the greater the extent of the sunken type of large pit organs seen in adult fish. Namely, in this species, the largest pit organs of the sunken type appear as small pit organs scattered in the head, are transformed to a line of large pit organs of the naked type and

differentiate into the sunken type. However, in *O. latipes* which possesses the naked type groove organs in the adult, such a differentiation never takes place during growth (Sato, 1952). A similar observation that some of the naked type transform into the sunken type during growth has been shown in *Amia calva* (Allis, 1889) and *Cyprinus carpio* (Sato, 1955c). If the naked type is an immature stage of the sunken type, as mentioned by Allis (1889) and Herrick (1901), it should be considered a primitive type of this genus.

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