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Development and Distribution of Taste Buds in *Oryzias latipes* and Their Functional Significance

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The taste buds in fish were first discovered by Schulze (1863). Storer and Usinger (1957), Jollie (1962), Nason (1967) and Nigam (1969) mentioned that taste buds are widely distributed in fishes. They reported the presence of taste buds embedded in the lining epithelia of the tongue, pharynx, palate and opercula. However, the mode of formation of the taste buds has not been recorded in detail. Thus, it was decided to study the morphological development of these taste organs in the teleost fish, *Oryzias latipes*.

Material and methods

The fry and adult of the orange red variety of the fish *Oryzias latipes* were used. Fertilized eggs were collected after natural spawning and incubated at 25°C±2°C. They were fixed in Bouin's solution and histological sections were cut at 5 μm and stained with Delafield's hematoxylin and eosin.

Results

On the lst day of hatching, localized groups of cells could be indentified among the stratified squamous cells of the surface epithelium of the gill arches, opercula and in the tail region (Fig. 1).

At the ages of 2–6 days, the intraepithelial cell groups became more distinguishable from the surrounding cells. Their central cells were rounded with pale vacuolated cytoplasm and large rounded nuclei, while the peripheral cells appeared oval with darkly stained cytoplasm. The basal part of these primordial taste buds became surrounded with elongated darkly stained cells (Fig. 2).

By the 10th day, the primordial taste organs became oval in shape and projected beyond the basement membrane into the underlying connective tissues. Their constituent cells became more numerous and further differentiated. The centrally situated pale cells were the most abundant while the peripheral cells became distinguished into oval and spindle-shaped cells. The outer wall of the primordial taste buds became surrounded with elongated darkly stained cells (Fig. 3).

On the 20th day after hatching, the taste buds increased in size and showed a definite taste pore. The peripheral spindle cells became thinner and acquired tapering ends with hair-like terminals, which might reach the taste pore. The outer elongated cells were found to form a row of cells around the taste buds which reached the inner wall of the taste pore (Fig. 4).

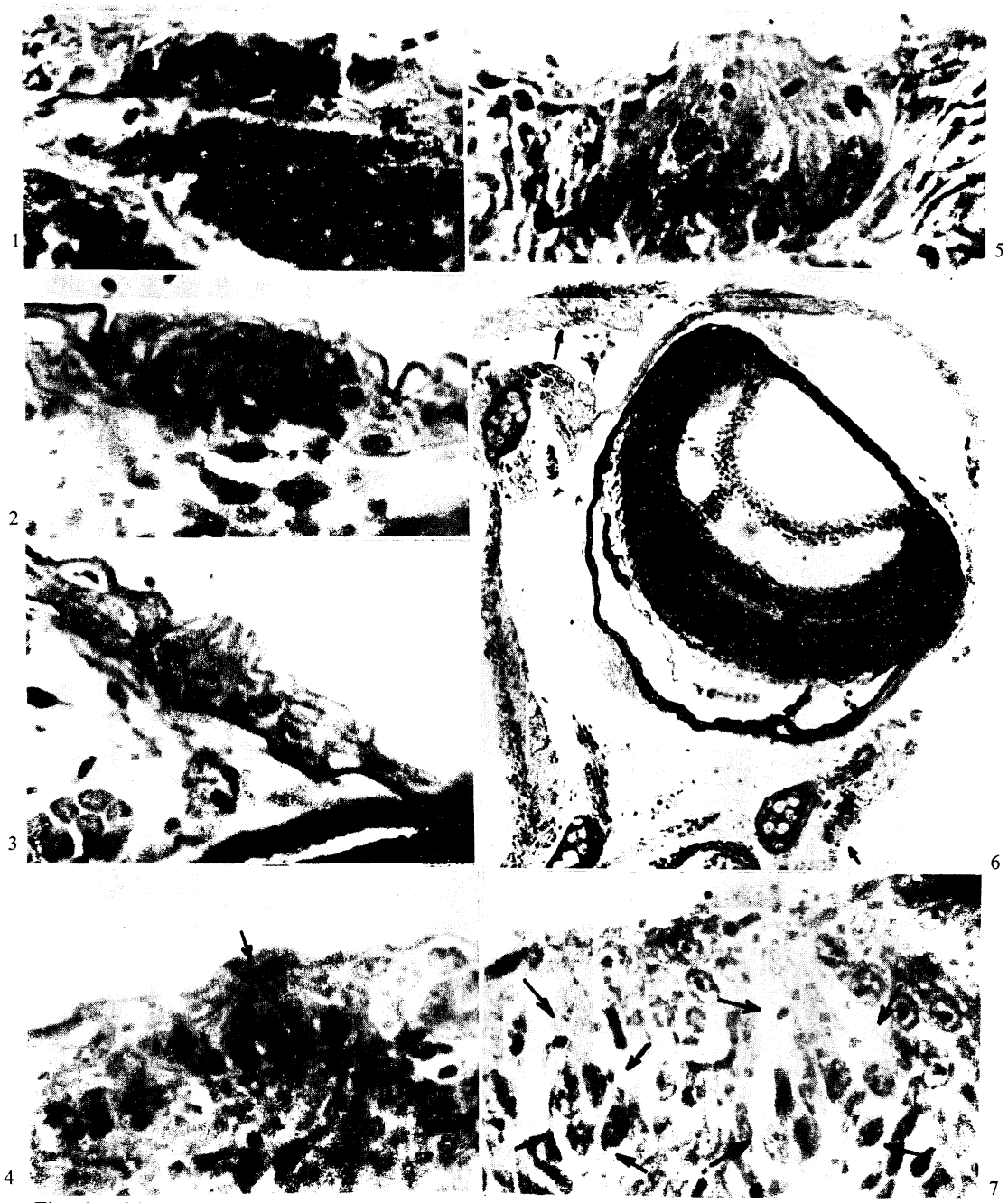
Thereafter, the taste buds were found to increase in size without further differentiation in their constituent cells till the adult size (Fig. 5).

In the roof of mouth and oesophagus, primordial taste buds could be detected for the first time at the age of 10 days after hatching. They appeared as intraepithelial cell masses hardly distinguishable from the surrounding epithelium. On the following days, they were found differentiated into the taste organs in the same way as those of body surface. However, they were found to reach the adult stage at an older age than the corresponding ones of the body surface. The adult taste buds of these regions remained smaller in size with fewer cells than those of the body surface (Fig. 5. cf. Fig. 7).

Discussion

The present study showed that taste organs of the fish *Oryzias latipes* developed very early in life. During their early developmental stages they showed several types of cells. On the day of hatching, the primordial taste buds were formed of large, pale rounded cells, however few dark cells were found at the periphery. At later stages, the dark cells increased in number and became distinguishable into spindle cells with hair-like terminales and oval rounded ones. A fourth type of cells could also be detected surrounding the taste buds from the outside and reaching the inner wall of the taste pore.

Earlier researches distinguished only two types of cells in the taste buds; taste cells with hair-like



Figs. 1 and 2. Fry of *Oryzias latipes*, 1 and 4 days after hatching, showing intraepithelial cell group among the epithelium of the body surface. Hx. and E. ×1000.

Figs 3 and 4. Fry of *Oryzias latipes*, 10 and 20 days after hatching, showing primordial taste buds on the body surface. Note the definite taste pore (arrow) in Fig. 4. Hx. and E. ×1000.

Fig. 5. A fully developed body surface taste bud of adult *Oryzias latipes*. Note the various types of taste bud cells. Hx. and E. ×1000.

Fig. 6. The head region of *Oryzias latipes* showing taste buds on the body surface (arrows). Hx. and E. ×100.

Fig. 7. A fully developed taste bud in the gut of *Oryzias latipes*. Hx. and E. ×1000.

terminales and peripherally situated supporting cells (Beidler and Smallman, 1965). Kolmer (1910); Retzius (1912) and Heidenhain (1914) suggested that the difference in morphology of the various cells of taste buds are due to differences in stages of growth in which they occur at a given time. However, De Lorenzo (1958) and Farbman (1965) described the same constituent cells observed in the taste buds of *Oryzias latipes*, in rabbit and adult rats respectively. Therefore, contrary to other body systems, taste organs in fish seemed to be well formed and looking like those of higher vertebrates.

The study also showed that taste buds in the fish *Oryzias latipes* are widely distributed among the epithelium of the head and tail regions (Fig. 6). They could be seen also in the cavities of the gill arches, opercula, roof of mouth and oesophagus. This distribution is consistent with that mentioned by Storer and Usinger (1957), Jollie (1962), Young (1962), Nason (1967) and Nigam (1969). Thus, the highly developed taste organs in fish, their early differentiation and wide distribution in the body indicates the great importance of these organs to the animal. Beside their gustatory function, they may have other functions. Patten (1953) stated that, in acquatic animals there is what he often referred to as general chemical sense, which is the forerunner of our own more specialized sense which includes, the common chemical sense, taste and smell which in these animals, is carried by taste organs. Furthermore the taste buds on the body surface are probably essential to inform the animal about the various substances in the surrounding media. This may help the animal to direct himself towards food sources. Young (1962) defined taste as a force which serves mainly to produce reaction to the food near the body such as snapping, swallowing or movement of rejection. He found that, the fish is unable to turn and snape at a piece of food at its tail after dennervation of taste buds of this region. However, taste organs in cavities of gill arches may be essential for initiating a reflex which prevents foreign materials from entering the respiratory passage, while those of the gut serve in rejecting unreliable materials taken with the food.

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メダカの味蕾の発生と分布およびその生理学的意義

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メダカのいろいろの発生段階の稚魚および成魚の味蕾を組織学的に調べ，発生と分布を記述した．その結果，発生の初期に味蕾の原基は出現することがわかった．また広く体表に分布するほか，鰓弓や鰓蓋や口腔内および咽喉にも見出された．