

# Distribution of Taste Buds in the Oropharyngeal Cavity of Fry and Fingerling Amago Salmon, *Oncorhynchus rhodurus*

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It has long been known that fishes in general have specialized taste organs in the epidermis of the mouth, lips and pharynx, and over the surface of the head and trunk (Iwai, 1964; Atema, 1971; Kiyohara et al., 1980; Ezeasor, 1982; Hamed et al., 1984). However, the growth of taste buds in fishes has not

been recorded in detail. In this paper, the change in distribution pattern, size and number of taste buds in the oropharyngeal cavity were studied in relation to body growth in the Amago salmon, *Oncorhynchus rhodurus*.

## Materials and Methods

Twenty seven hatchery-reared *Oncorhynchus rhodurus*, including 3 day old (13-15 mm in total length [TL]), 5 day old (13-15 mm TL), 7 day old (14-15 mm TL), 30 day old (16-18 mm TL), 60 day old (19-20 mm TL), 150 day old (65-66 mm TL), and 360 day old (130-140 mm TL) specimens and 3 individuals (18.0, 19.5, 65.0 mm TL) collected from the Nagara River in 1990, were used for the study. The head of each specimen was removed and fixed with Bouin's solution, and subsequently decalcified,

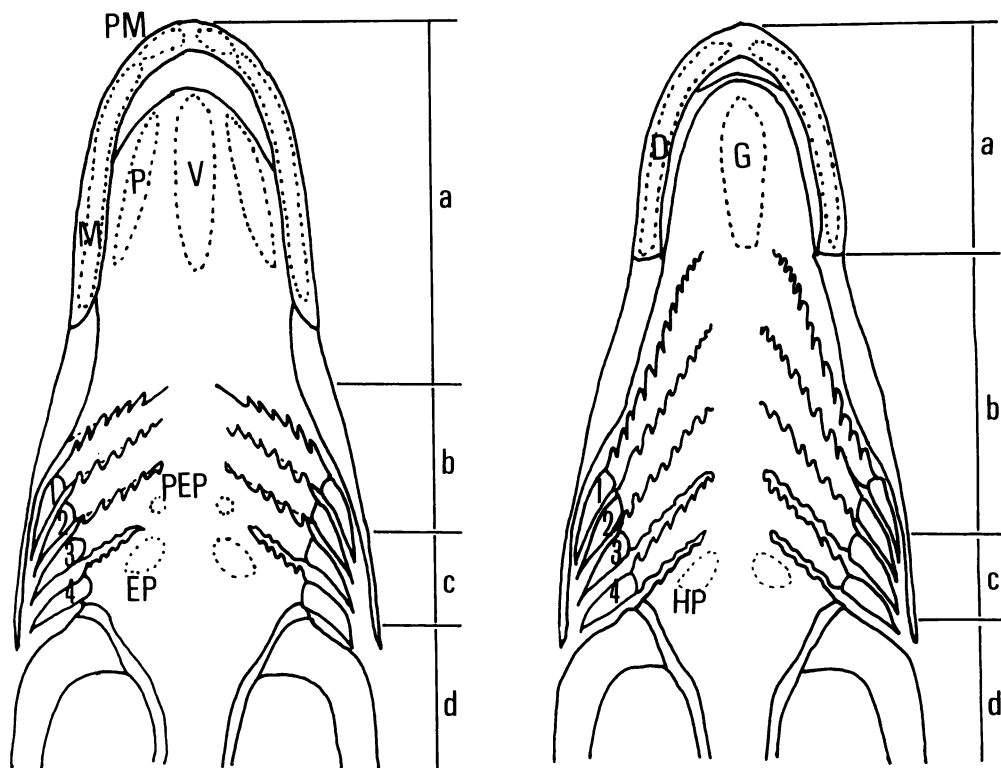
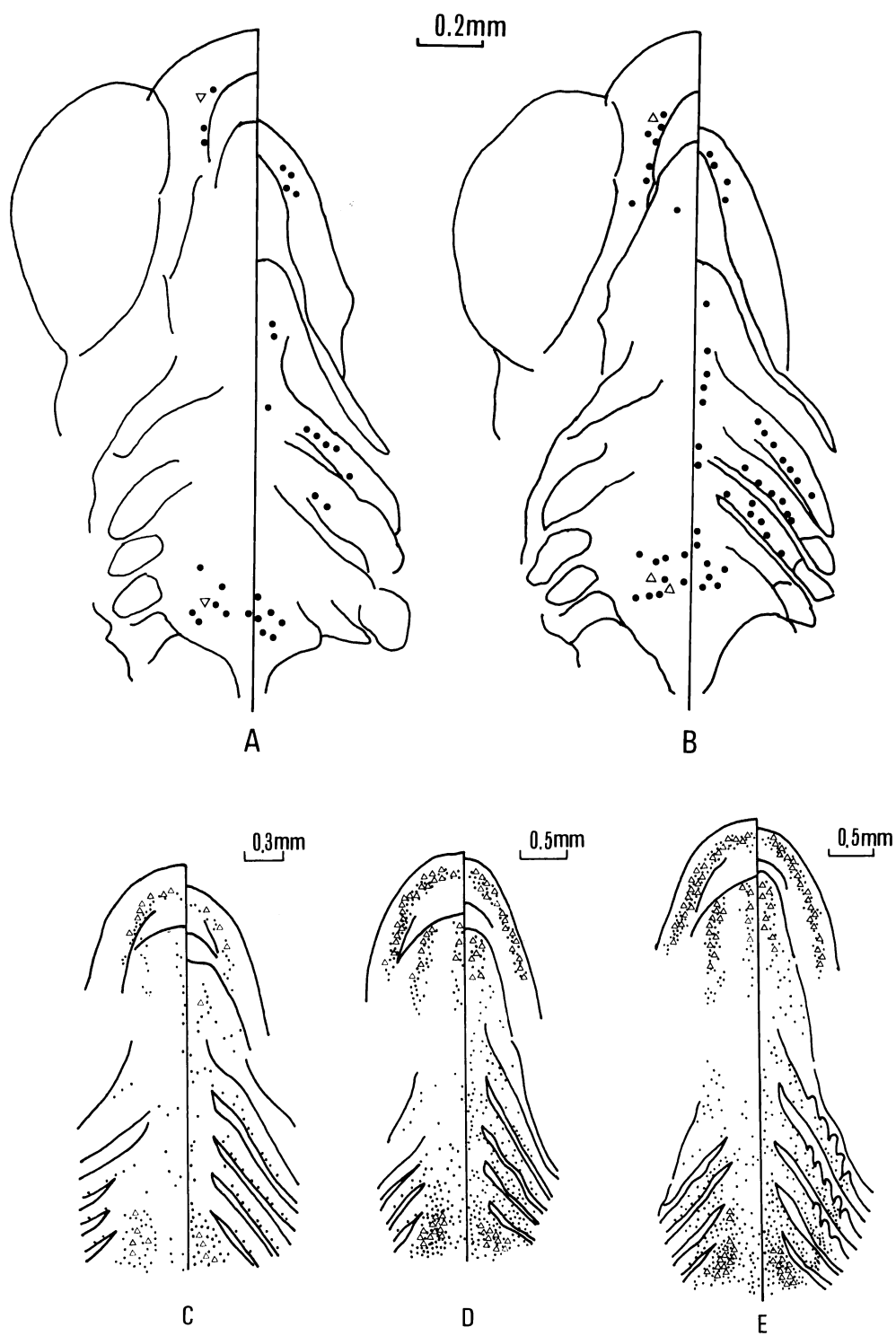


Fig. 1. Schematic figure showing the oropharyngeal cavity of the Amago salmon, *Oncorhynchus rhodurus*. Left—ventral side; right—dorsal side; a—oral region; b—branchial region; c—pharyngeal region; d—esophageal region; PM—premaxillary; M—maxillary; V—vomer; P—palatine; PEP—proepipharyngeal; EP—epipharyngeal; D—dentary; G—glossohyal; HP—hypopharyngeal; 1-4=number of each gill arch.

# Taste Buds of Amago Salmon



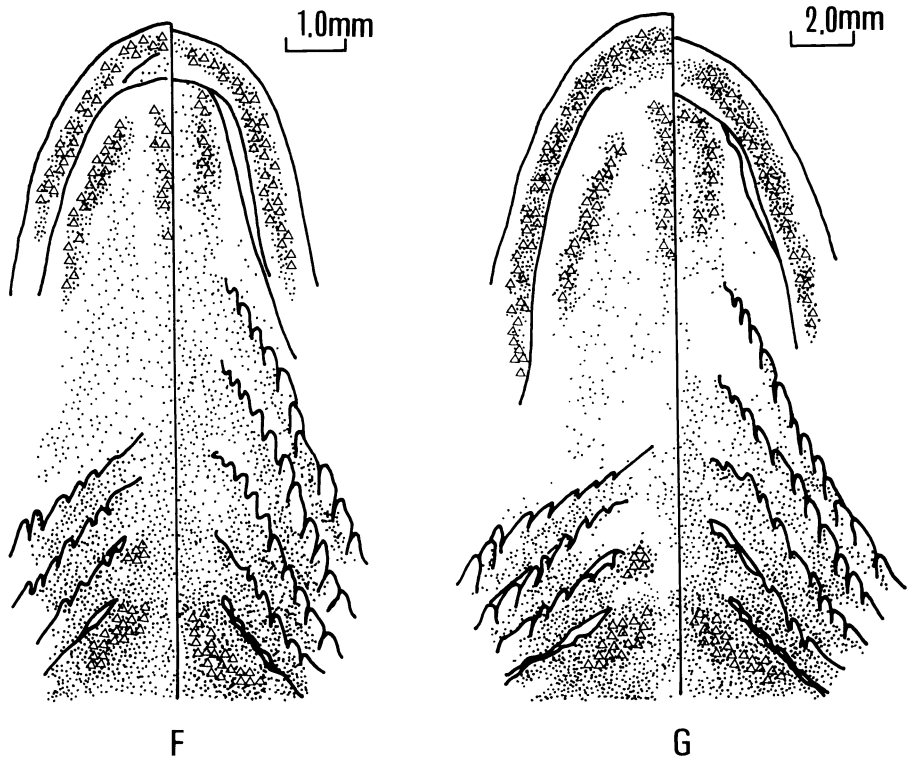


Fig. 2. Distribution of the taste buds (small dots) and canine like tooth or toothgerms (triangle) in the oropharyngeal cavity of *Oncorhynchus rhodurus*. A) 3 day old; B) 5 day old; C) 7 day old; D) 30 day old; E) 60 day old; F) 150 day old; G) 360 day old. Each left half is the ventral side and each right half is the dorsal side of the oropharyngeal cavity.

dehydrated and embedded in paraffin. Prior to examination, the heads were sectioned ( $10\mu\text{m}$ ) and stained with Mayer's hematoxylin and eosin.

### Results and Discussion

On the third day after hatching (3 day old), localized cell groups could be identified among the stratified squamous cells of the surface epithelium of the oropharyngeal cavity. By the age of 7 days, these intra epithelial cell groups had become even more distinct from the surrounding cells, on the tongue, lips, pharynx, gill arches, palate and other parts of the mouth (Figs. 1, 2). The cell groups were invariably associated with the location of toothgerms in these regions. The total number of taste buds (cell groups) counted was about 60, 108 and 440 in the oropharyngeal cavity of 3, 5 and 7 day old fish, respectively. The number of taste buds in the ob-

served regions increased gradually up to 60 days of age, and thereafter increased markedly over the next 300 days. During this period the fish's body grew remarkably. The total number of taste buds was estimated to be 997 in the 30 days old specimen, 1,345 at 60 days, 9,333 at 150 days, and 15,319 after 360 days (Table 1). In the fish of 18.0, 19.5 and 65.0 mm TL, collected from the Nagara River, the number of taste buds in the oropharyngeal cavity was 1,007, 1,376 and 9,443, respectively (Table 2). The distribution pattern, number and density of taste buds in the cavity of the fingerling from the Nagara river were similar to those in hatchery-reared fish. The taste buds of these specimens, like those of higher vertebrates, were oval or barrelshaped clusters of elongated cells.

The distribution of taste buds over the ventral and dorsal mucous membrane covering the oropharyngeal cavity is shown schematically in Figure 2. The average density of taste buds in the oropharyngeal

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**Table 1.** Counts of the taste buds in the oropharyngeal cavity of hatchery-reared *Oncorhynchus rhodurus* (n=5)

Position		Age in days					
		30		60		150	
		number	per mm <sup>2</sup>	number	per mm <sup>2</sup>	number	per mm <sup>2</sup>
Dorsal side							
Maxillary*	Mean ± SD	75.2 ± 6.8	109.4 ± 3.7	90.8 ± 2.0	107.0 ± 2.9	344.4 ± 6.5	107.0 ± 4.8
	Range	68–84	106–114	88–93	103–110	336–352	102–114
Vomer*	Mean ± SD	26.8 ± 3.3	83.0 ± 2.4	39.0 ± 2.4	78.2 ± 3.9	144.8 ± 3.3	76.0 ± 3.1
	Range	23–30	80–86	36–42	73–83	140–148	72–80
Palatine*	Mean ± SD	52.4 ± 3.1	87.6 ± 3.7	68.2 ± 3.9	88.6 ± 6.2	358.0 ± 7.7	84.0 ± 3.4
	Range	49–51	82–92	63–73	81–97	348–368	80–88
Gill arch**	Mean ± SD	194.0 ± 4.8	96.0 ± 4.4	260.8 ± 10.2	95.0 ± 3.4	2054.0 ± 107.8	89.0 ± 7.5
	Range	190–198	91–101	250–276	90–98	1988–2201	81–97
Other parts**	Mean ± SD	19.2 ± 3.7	15.2 ± 2.5	52.0 ± 3.8	19.0 ± 2.4	476.8 ± 17.7	22.4 ± 3.6
	Range	15–24	12–18	48–56	16–22	460–501	18–26
Upper pharyngeal***	Mean ± SD	96.8 ± 5.9	149.0 ± 9.7	102.4 ± 5.5	141.8 ± 5.3	860.0 ± 39.5	127.4 ± 8.4
	Range	90–104	140–159	96–110	135–147	814–900	119–137
Ventral side							
Dentary*	Mean ± SD	68.0 ± 4.1	84.0 ± 3.8	106.0 ± 5.4	102.2 ± 4.2	463.2 ± 9.3	97.2 ± 4.2
	Range	63–73	80–88	100–112	97–107	451–473	92–101
Glossohyal*	Mean ± SD	45.8 ± 4.1	71.0 ± 6.0	57.8 ± 6.4	72.6 ± 3.8	288.0 ± 18.6	75.0 ± 3.8
	Range	41–51	63–77	50–65	68–76	260–304	70–79
Gill arch**	Mean ± SD	331.6 ± 15.3	117.8 ± 5.6	479.6 ± 17.9	116.8 ± 7.4	3446.0 ± 208.8	94.4 ± 3.4
	Range	316–350	111–125	458–500	108–125	3150–3690	90–97
Lower pharyngeal***	Mean ± SD	87.2 ± 4.7	150.6 ± 10.5	91.2 ± 6.8	134.6 ± 4.1	873.8 ± 24.1	138.6 ± 4.1
	Range	82–93	139–161	83–100	130–141	845–900	134–144
Total	Mean ± SD	996.6 ± 27.2	83.0 ± 5.0	1344.8 ± 39.9	82.2 ± 6.0	9332.6 ± 225.8	79.0 ± 4.1
	Range	983–1025	78–90	1303–1397	75–90	9096–9533	75–85

\*Oral region; \*\*branchial region; \*\*\*pharyngeal region. For details, see Figure 1.

**Table 2.** Counts of the taste buds in the oropharyngeal cavity of *Oncorhynchus rhodurus* collected from the Nagara River in 1990

Position	Total length (mm)					
	18.0		19.5		67.0	
	number	per mm <sup>2</sup>	number	per mm <sup>2</sup>	number	per mm <sup>2</sup>
Dorsal side						
Maxillary*	75	101	86	104	338	104
Vomer*	25	85	40	80	150	70
Palatine*	50	86	72	86	362	80
Gill arch**	201	100	265	96	2050	70
Other parts**	21	18	55	19	485	20
Upper pharyngeal***	100	151	104	145	865	125
Ventral side						
Dentary*	71	85	110	105	465	92
Glossohyal*	51	72	60	75	299	71
Gill arch**	342	120	485	121	3544	92
Lower pharyngeal***	92	155	93	138	885	140
Total	1007	85	1376	86	9443	73

\*Oral region; \*\*branchial region; \*\*\*pharyngeal region. For details, see Figure 1.

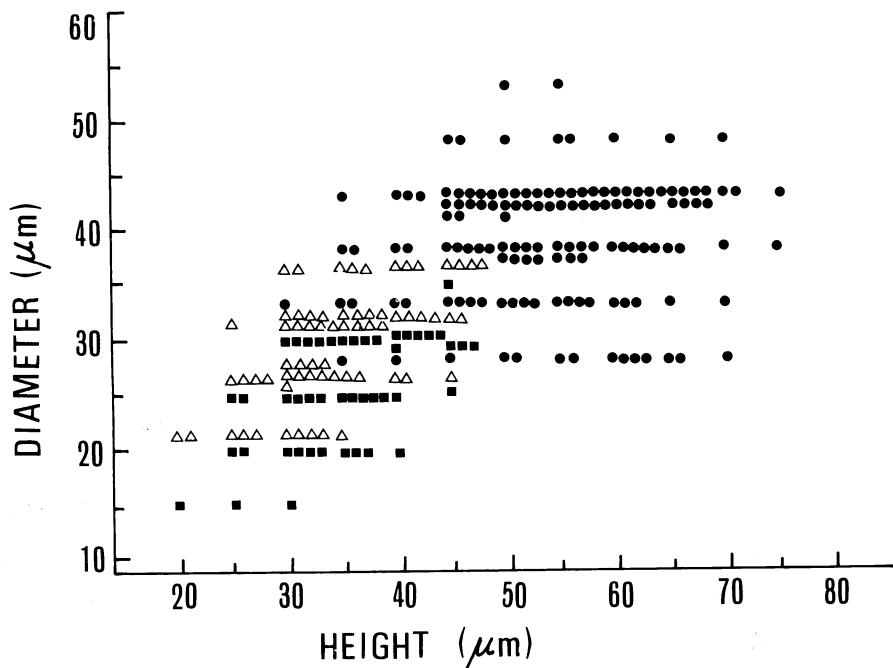


Fig. 3. Measurements (height and maximum diameter of cross-section) of the taste buds buried in the densest area on the gill arches. 30 day old (■); 60 day old (△); 150 day old (●).

cavity was  $20/\text{mm}^2$ ,  $32/\text{mm}^2$  and  $114/\text{mm}^2$  in 3, 5 and 7 day old fish, respectively. From 30 to 150 day old, the density remained at about  $85/\text{mm}^2$ , but by 360 day old it had become reduced to nearly half. A high density of taste buds, in excess of  $130/\text{mm}^2$ , were observed in the pharyngeal region. Taste buds were also densely distributed on the upper and lower jaws and gill arches. Few taste buds were found on the roof of the branchial cavity. The densities of taste buds in the branchial and pharyngeal regions of 30 day old fish were higher than in those of 150 days of age. When the fish reached about 20 mm TL (60 day old), yolk absorption had almost been completed. It has been reported that the taste buds are more conspicuously arranged in the branchial region of fresh water fishes than in marine fishes (Iwai, 1964). Because in one year old *O. rhodurus*, smolt transformation the fishes moving to the sea-run form takes place in the river from the end of October, into the sea during winter (Kato, 1973), it is believed that the distribution and density of taste buds reflect the habitat of the species.

The taste buds increased in size, especially in height, with overall fish growth (Fig. 3). The long axis of the taste buds extended from the base to the

surface of the epithelium. Thus, the length of the buds was closely correlated to the thickness of the epithelial layer. The epithelial layer of the oropharyngeal cavity was usually thicker in old fish than in young fish. The taste buds were located in the apices of elevated dermal papillae (Fig. 4), each papilla containing a single bud. The papillae were invariably aligned with the teeth in the oropharyngeal cavity, being arranged in rows on the ridge between the conical teeth on the maxillary, dentary, vomer, palatine, glossohyal and pharyngeal bones (Fig. 4). In *O. rhodurus*, the formation of conical teeth on these bones, has been observed in 20–24 mm in standard length fish (24–64 day old) (Komada, 1981).

The differences in distribution pattern, densities and size of taste buds in the oropharyngeal cavity between the 60 day old and 360 day old fish may be associated with differences in the feeding habits of the different size classes. Sixty day old fish feed on small benthic organisms and zooplankton, whereas 360 day old fish feed on land insects and larval fishes. Ezeasor (1982) postulated that a predatory carnivore such as the rainbow trout would restrain and pierce its prey with its canine-like tooth, evaluate the prey by means of nearby taste buds and finally either

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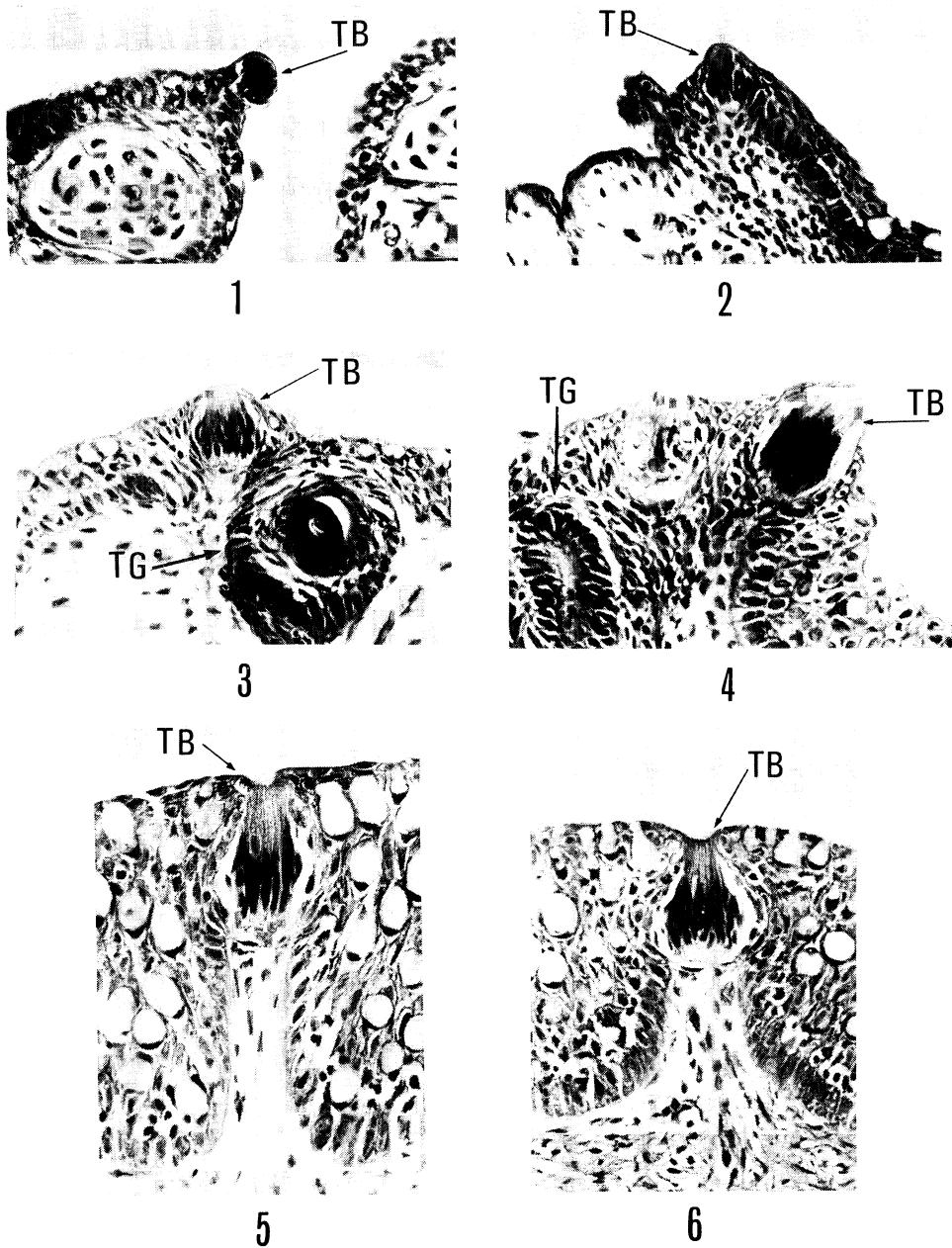


Fig. 4. Photographs of the taste buds (TB) and toothgerms (TG) in the oropharyngeal cavity. 1) Gill arch at 7 day old; 2) glossohyal at 7 day old; 3) glossohyal at 30 day old; 4) maxillary at 60 day old; 5) and 6) gill arches at 360 day old.

reject or ingest it. In *O. rhodurus*, the majority of taste buds were located close to the teeth in the oral, branchial and pharyngeal regions, indicating that

these regions are involved in grasping, filtering and swallowing food. Salmon presumably use the taste buds in these regions to discriminate between palata-

ble and unpalatable objects.

### Acknowledgments

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### アマゴ仔・稚魚における味蕾の分布および数の変化

駒田格知

人工孵化アマゴ仔・稚魚における味蕾の分布、数、密度および大きさを調べた。さらに、長良川にて採捕したアマゴについても同様の調査を行って比較した。

孵化後3日目(3日齢)のアマゴの口腔—咽頭部の粘膜上皮中に味蕾の初期と思われる細胞の集団が認められた。味蕾数はその後、日齢の進行に伴って著しく増加した。しかし、味蕾の密度は7日齢をピークにして、60日齢頃までは高密度に維持されたが、その後は急激に減少し、360日齢では60日齢時の約半分であった。味蕾の分布は、歯の配列状況に深く関係していた。味蕾の径や長さは日齢の進行に伴って増大したが、これは粘膜上皮の肥厚に伴うものと考えられた。長良川にて採捕されたアマゴの味蕾の分布・数および密度は同じ体長の人工孵化仔・稚魚とはほぼ同じであった。

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