

MORPHOLOGY AND PATHOMORPHOLOGY

FORMATION OF THE ACCESSORY APPARATUS OF CHEMICAL SENSATION IN THE RAT TONGUE DURING DEVELOPMENT: A SCANNING ELECTRON MICRO- SCOPIC INVESTIGATION

Z. V. Lyubimova and A. I. Esakov

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The formation of the accessory apparatus for chemical sensation in the rat tongue during ontogeny was studied by scanning electron microscopy. Different chemically sensitive structures in the tongue were found to mature at different times, possibly in connection with changes in the dietary pattern at different stages of postnatal development.

KEY WORDS: *chemoreception (taste reception); oral cavity; tongue; ontogeny of sensory systems.*

One approach to the experimental study of the formation of sensory functions is to investigate the morphogenesis of the accessory apparatus of the sensory organ and its ultrastructural features that are responsible for primary contact of the receptor with the stimulus. A suitable object for investigations of this type is the sensory surface of the tongue, which is richly supplied with chemoreceptors and mechanoreceptors of various structural types. The study of the structures responsible for the chemoreceptor function of the tongue in ontogeny can contribute significantly to the understanding of the formation of the functional system of the animal's food behavior. The investigation described below was undertaken to study the formation of the fungiform, foliate, and circumvallate papillae of the rat tongue at different stages of postnatal development.

EXPERIMENTAL METHOD

The dorsal surface of the tongue was studied by means of a "Stereoscan" scanning electron microscope in rats of the following ages: 2.5 weeks of gestation and 2 days and 1, 2, and 3 weeks after birth. The tongue was removed near the root, washed for 15-20 min in tap and distilled water, fixed for 12 h in 10% formalin, and dried for several days over anhydrous CaCl_2 at 12°C. The dried tongue was cut into several parts, after which the parts containing fungiform, foliate, and circumvallate papillae were studied.

EXPERIMENTAL RESULTS AND DISCUSSION

At birth and in the early postnatal period (7-12 days after birth) the chemoreceptor structures of the rat tongue show signs of functional immaturity. The fungiform papillae, located on the anterior free part of the tongue, have a smooth surface without taste pores and they are smaller than the papillae of adult animals (Fig. 1A, B).

The dynamics of appearance of the taste pore plays an essential role in the ensuring of access of the chemical stimuli and their contact with the receptors of the taste bud. Fungiform papillae, located on the free surface of the tongue in young rats, have no taste pores until the age of 2 weeks (Fig. 1C). Only on the 14th- to 16th day of the postnatal period do pores begin to appear (Fig. 1D), mainly in papillae located on the dorsum of the tongue, and later in those nearer to its edges. By the end of the third week the fungiform papillae as a rule have open pores, but papillae with no pores can still be found on the anterior free surface of the tongue.

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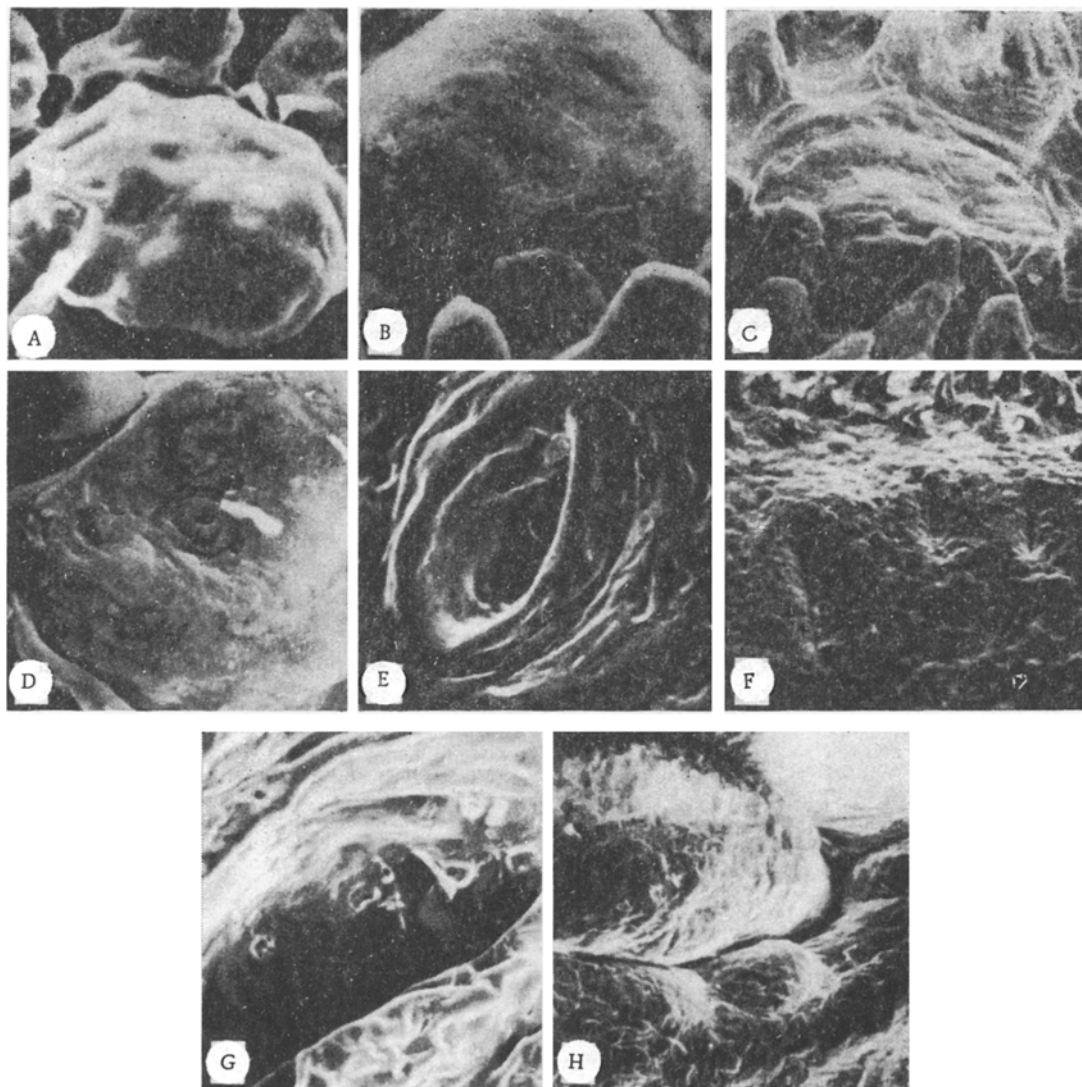


Fig. 1. Taste papillae of rat tongue in early ontogeny. A) Fungiform papilla on anterior edge of tongue of 2.5-week rat fetus, 1200 \times ; B) fungiform papilla on edge of tongue of rat aged 2 days, 1200 \times ; C) fungiform papilla on anterior part of tongue of rat aged 8 days, without pore; filiform papillae visible around, 500 \times ; D) pore of fungiform papilla on anterior edge of tongue of rat aged 14 days, 2000 \times ; E) cup-shaped slit of foliate papilla in tongue of rat aged 2 weeks, 500 \times ; F) slits of foliate papillae of adult rat, 100 \times ; G) internal aspect of ridge with pores of taste buds of circumvallate papilla from tongue of rat aged 1 week, 500 \times ; H) circumvallate papilla from tongue of rat aged 3 weeks, showing longitudinal depression in papilla, 200 \times .

The foliate papillae of the rat tongue in the early postnatal period have shallow slits, which increase in size rapidly until the age of 2 weeks, when the papillae become cup-shaped (Fig. 1E), a feature which disappears in the adult state (Fig. 1F).

Distinctive changes also take place after birth in the solitary circumvallate papilla of the rat which, unlike the papilla of the adult rat's tongue, has a shallower depression between the ridge and the middle part of the papilla. Taste pores appear on both inner surfaces of the circumvallate papilla at the age of 1 week after birth (Fig. 1G). They can also be found at that time on the inner surfaces of the depression, indicating that at this period the position of the taste buds of the circumvallate papilla is more dorsal than in adult animals.

The dynamics of formation of the taste pores is evidence of functional preparation of the taste apparatus for the transition from a strictly milk diet to an independent type of nutrition. Since in animals born blind the process of feeding is entirely dependent on

contact with the mother and not with the external environment, the accessory apparatus for chemical sensation in the tongue is evidently not yet ready to perform its chemoreceptor function. This is shown by the absence of taste pores at the age of 1 week in all types of taste papillae in the tongue. Maturation of the different types of chemoreceptor structures of the tongue shows a marked asynchronous pattern. To begin with, pores appear in the buds of the circumvallate papillae, a fact which is evidently connected with the biologically important guarding role of the sensory apparatus of this part of the tongue, which lies in the path of liquid food from the nipple to the pharynx and is innervated by the glossopharyngeal nerve, the fibers of which are highly sensitive to bitter, the taste of substances to be avoided [4]. Pores then appear in the fungiform papillae, initially in papillae in the middle part of the dorsal surface of the tongue, nearer to the point which comes into contact with the mother's nipple, whereas pores in the fungiform papillae of the anterior part of the tongue appear much latter, toward the end of the third week after birth. Meanwhile the slit in the foliate papillae becomes maximally widened, anticipating the development of taste analysis essential for the transition to the independent type of nutrition.

The dynamics of maturation of the accessory apparatus responsible for contact with the external stimulus preceding the primary process of reception, as described above, correlates sufficiently closely with data on the morphological maturation of the taste buds. For example, electron microscopy before the 12th day of the postnatal period reveals no mature taste buds in either the fungiform [1, 2] or the foliate [5] papillae of the rat tongue. The times of appearance of morphologically mature taste buds correspond to the time of formation of the taste pore apparatus, providing access for the chemical stimulus to the receptor cells. It should be specially emphasized that this is also the time of activation of the function of salivation, with its important role not only for wetting the food mass with saliva, but also for creating adequate conditions surrounding the taste receptors [2]. The various components of the system for normal taste analysis during the transition to an independent type of nutrition takes place in this way.

To conclude, although the method of scanning electron microscopy cannot give a full picture of maturation of the receptor apparatus of the taste bud, it nevertheless provides sufficiently reliable evidence to show the time of appearance of pores in the taste buds. By comparing these findings with the results of morphological investigations, the approximate times of physiological maturation of the chemoreceptor apparatus can be estimated. However, before a final decision regarding the functional maturity of the chemoreceptor formations can be reached, special physiological investigations will be required.

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