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Epithelium of Lips and Associated Structures of the Indian Major Carp, *Catla catla*

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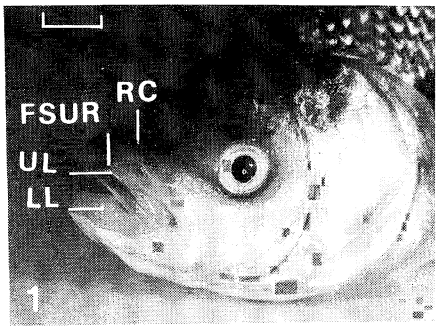
Abstract Structural organization of the epithelium of the lips and associated structures of the Indian major carp, *Catla catla*, is described. The upper lip is thin and is associated on its dorsal side with a membranous fold of skin and the rostral cap. In contrast, the lower lip is thick and very conspicuous. It is associated on its ventral side with a fold of skin between it and the ventral head skin. The lower lip is divided into a non-projectile portion, a projectile portion and an intermediate groove region. The projectile portion remains folded covering a part of the ventral head skin when the mouth is closed. Their role in relation to the formation of the characteristic feeding tube is discussed. The epithelium of the lips and associated structures is stratified in nature and is composed of the epithelial cells, mucous cells, club cells, lymphocytes and the taste buds. The mucous cells are small, few or even absent and do not appear to secrete profusely at the surfaces of the upper and the lower lips. This suggests that the lips in *Catla catla*, which feeds on micro-organisms, do not need extra lubrication for protection against abrasion during feeding. In the epithelium at the folds of skin, the voluminous mucous cells secrete profusely and provide extra lubrication to their surface. This reduces the resistance to surface drag during stretching and enables the jaws to protrude with increasing efficiency and swiftness. The club cells are developed additionally to complement the mucous cells in the rostral cap and the upper lip epithelium. Their primary function appears protective in some way, which needs further confirmation. The taste buds, though few in the lower lip, are located in a good number in the upper lip on the characteristic epithelial papillae-like projections, and are projected at the surface. These have been associated with the acute gustatory sense of the fish. The taste buds are absent on the folds of skin where they may not be of much significance.

The lips and the structures intimately associated with them are characteristically modified in different groups of fishes in relation to either their diet or the method of feeding.

The lip covering the upper jaw is, in general, separated from the snout by an extendable fold of skin lying in a groove when the mouth is closed. The skin overlying this groove usually forms a more or less pronounced fold or flap which, referred to by Minzenmay (1933) as the Rostralkappe (=rostral cap; Roberts, 1982), has frequently been confused with the upper lip. The upper and lower jaws generally bear relatively simple lips. Besides the lips, the jaws also quite commonly have well-developed horny sheaths which lie medially to the upper and lower lips and separate them from the bony support of the jaws (Minzenmay, 1933; Girgis, 1952; Mester, 1971; Verighina, 1971; Roberts, 1982).

Literature about the organizational pattern of the lips and associated structures in fishes is sporadic and scanty. Vanajakshi (1938), Pasha (1964a–c), Chitray (1965), Moitra and Bhowmik (1967), Lal (1968), Sinha (1975), Sinha and Moitra (1975, 1976, 1978) and Kapoor et al. (1975), while studying the alimentary canal, briefly described the morphology and structural organization of the lips in different fish species. Suzuki (1956) described the histological organization of the lips of *Pseudogobio esocinus*. Branson and Hake (1972) reported that the lips in *Piaractus nigripinnis* are adapted for accessory respiratory function. Miller and Evans (1965) studied the relationship between the external morphology of the brain and that of the lips with emphasis on the distribution of the taste buds. Kiyohara et al. (1980) gave an account of the distribution of the taste buds on the lips of a minnow, *Pseudorasbora parva*. Ono (1980) made scanning electron microscopic and transmission electron microscopic observations on the epidermal projections associated with the taste buds on the lips in some loricariid catfishes. Horny projections from the single cells of the lips and associated structures have also been reported in a



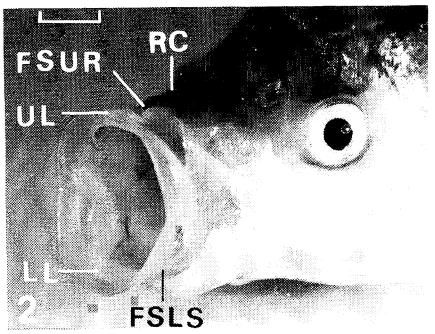


Fig. 1. Photograph of the head region of *Catla catla* with its mouth slightly open. Note: the upper lip (UL) is thin and associated with the rostral cap (RC) and the fold of skin between the UL and the RC (FSUR). The lower lip (LL) is very conspicuous and its major portion is folded covering a part of the ventral surface of the head. Scale line, 10 mm.

Fig. 2. Photograph of the head region of *Catla catla* with its mouth open showing the formation of the characteristic feeding tube. The upper lip (UL) is associated with the rostral cap (RC) and the fold of skin between the UL and the RC (FSUR) and the lower lip (LL) is associated with the fold of skin between LL and ventral head skin (FSLS). Scale line, 10 mm.

wide variety of fishes (for literature, see Roberts, 1982).

Roberts (1982) examined a wide variety of fishes using a scanning electron microscope and reported that differences in the morphology of the lips and associated structures included the 1) degree of development and specialization of the rostral cap, 2) degree of development and specialization of the lips, 3) presence or absence of horny sheaths on the jaws in addition to, or in place of, the normal lips, and 4) form and distribution of unicellular horny projections or unculi on the rostral cap, lips and horny jaw sheaths.

The aim of the present investigation is to study the structural organization of the epithelium of the lips and associated structures in the Indian major carp, *Catla catla* (Hamilton), a surface plankton and detritus feeder belonging to the family Cyprinidae and order Cypriniformes (Misra, 1962; Greenwood et al., 1966; Welcomme, 1988).

Materials and methods

Live specimens of *Catla catla* (approx. 160–180 mm in length) were collected from the local ponds at Varanasi, India. They were maintained in the laboratory conditions and were fed with a mixture of rice bran, linseed cake and dry prawn powder on alternate days.

The upper and lower lips along with their associated structures were excised and were fixed in 10% neutral formalin and Aqueous Bouin's fluid. Paraffin sections were cut at 6 μm and were stained with Ehrlich's haematoxylin eosin (HE) (Ehrlich, 1886), Verhoeff's haematoxylin eosin (VHE) (Lillie, 1954), Papanicolaou's stain (PS) (Gurr, 1958) and Feulgen reaction for nuclear DNA (Feulgen and Rossenbeck, 1924).

Observations

In *Catla catla*, both the upper and the lower jaws are protrusible. The degree of protrusibility shown by the upper jaw is, however, relatively much higher.

The lip covering the upper jaw is, in general, thin and is directed slightly upwards. It is associated on its dorsal side with a membranous fold of skin and the rostral cap (Figs. 1–3). The fold of skin lies in a deep groove between the upper lip and the rostral cap, and has a remarkable capacity of extendibility.

In contrast, the lower lip is very thick and much more conspicuous. It may be divided into a non-projectile portion (NPL), a projectile portion (PL) and an intermediate region represented by a characteristic groove (Fig. 4). The projectile portion constitutes the major part of the lower lip and remains folded characteristically, covering a part of the ventral surface of the head when the mouth of the fish is closed (Fig. 1). The inner surface of the PL thus comes to lie on the outer surface of the body.

The lower lip is associated on its ventral side with a thin fold of skin lying in a deep groove between the lower lip and the ventral head skin (Fig. 4). The

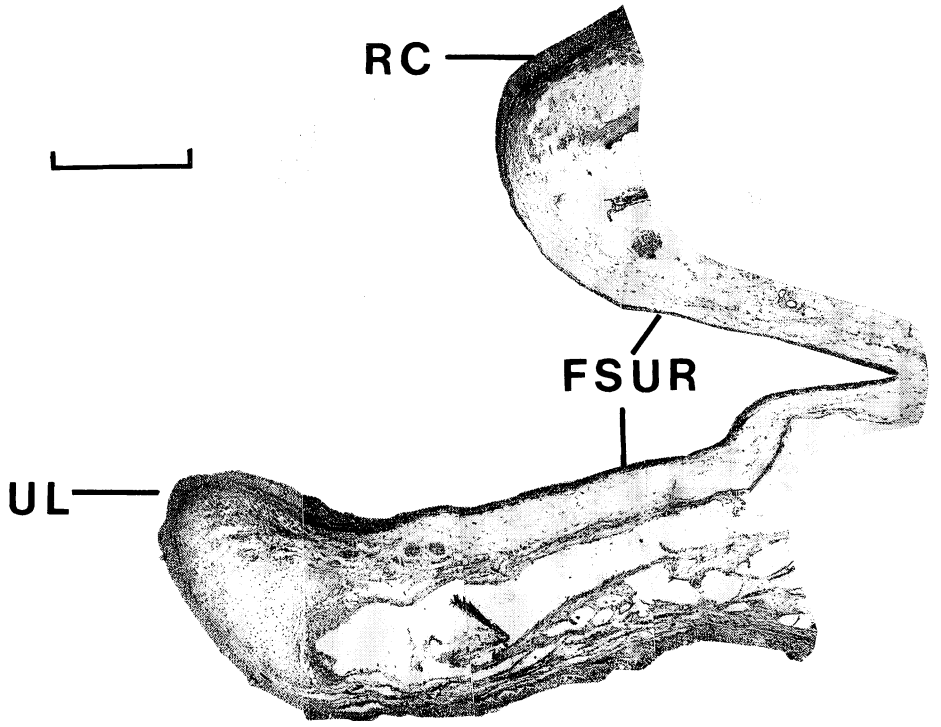


Fig. 3. Photomontage of the cross sections showing the disposition of the upper lip (UL) and associated structures—the rostral cap (RC) and the fold of skin between the UL and the RC (FSUR) in *Catla catla*. Note: the epithelia at these locations are differentiated from each other in their general organization (HE stain). Scale line, 150 mm.

upper lip epithelium on the ventral side and the lower lip epithelium on the dorsal side continue with the buccal epithelium.

When the fish opens its mouth, the upper and lower jaws are protruded forward resulting in the formation of a feeding tube-like structure (Fig. 2). While the dorsal half of the feeding tube is formed by the upper lip together with the stretching out of the fold of skin between the upper lip and the rostral cap (FSUR), its ventral half is formed due to the unfolding of the PL together with the stretching out of the fold of skin between the lower lip and the ventral head skin (FSLS).

The epithelium of the lips and associated structures in *Catla catla* is separated from the underlying tissues by a thin non-cellular basement membrane, and is stratified in nature. In general, it may be divided into three principal layers, the superficial layer, the middle layer and the basal layer. The main structural component of the epithelium consists of the epithelial cells. The intercellular space between them is, in general, less distinct. Interspersed between the epithelial cells are located a variable number of gland cells—the mucous cells and the club cells. In addition lymphocytes and a variable number of taste buds are also located.

The epithelium shows significant differences in its thickness at the lips and the associated structures, which is summarized in Table 1.

Epithelial cells. In the upper lip and the rostral cap epithelium the superficial layer epithelial cells appear polygonal, often vertically compressed or somewhat rectangular in outline with rounded nuclei. These cells at the apical end of the upper lip are often provided with pyknotic nuclei and are observed exfoliating in flakes. The middle layer epithelial cells are, in general, arranged in 4–6 layers and appear roughly polygonal with rounded nuclei. They acquire vertically compressed shape as they are displaced towards the surface. In the layer immediately above the basal layer, however, these cells often appear vertically elongated with elongated

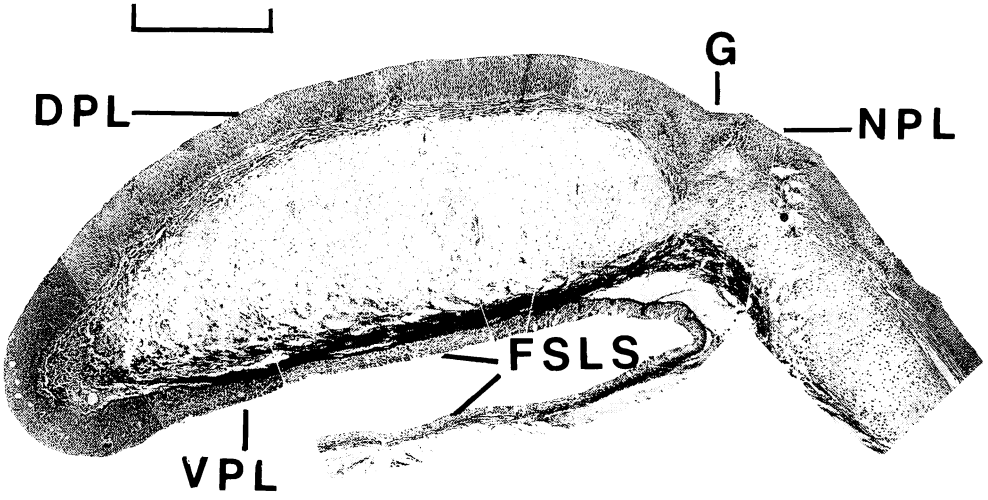


Fig. 4. Photomontage of the cross sections showing the disposition of the lower lip (LL) and the associated structures—the fold of skin between LL and the ventral head skin (FSLS) in *Catla catla*. Note: the epithelia of the lower lip at the non-projectile portion (NPL), the groove (G), the dorsal side of the projectile portion (DPL) and the ventral side of the projectile portion (VPL) and of the FSLS are differentiated from each other in their general organization (HE stain). Scale line, 150 μm.

nuclei. The basal layer epithelial cells are tall and columnar (15.0±1.77 μm in height and 2.11±0.62 μm in width), closely approximated and are provided with elongated nuclei (Figs. 5–7).

In the epithelium of FSUR, the epithelial cells in the superficial layer appear very much flattened or squamous in shape, having flattened nuclei (Fig. 8). In the middle layer they appear vertically compressed with flattened nuclei and are arranged in 1–2 layers. The basal layer epithelial cells appear cuboidal or vertically compressed with rounded or flattened nuclei.

Table 1. Average thickness of the epithelium of the lips and associated structures in *Catla catla* (approx. 160 mm in length). *10.98±1.52 at the locations where voluminous mucous cells are discernible.

Lips and associated structures	Average thickness of the epithelium in μm (±SD)
Upper lip	52.94±4.32
Fold of skin between the upper lip and the rostral cap	8.65±2.19*
Rostral cap	43.29±5.12
Lower lip	
Projectile portion	
Dorsal side	131.20±8.02
Ventral side	24.50±2.14
Non-projectile portion	78.92±6.14
Fold of skin between the lower lip and the ventral head skin	18.01±5.16

In the lower lip epithelium at the NPL and at the ventral surface of the PL, the superficial layer epithelial cells appear dilated with flattened free margins and with rounded nuclei (Figs. 9, 10). At the dorsal surface of the PL, the superficial layer epithelial cells often appear rounded with small, compact, rounded or vertically compressed pyknotic nuclei. Fine cellular fragments are invariably observed attached to the free surface of these cells in this region (Fig. 11). At the apical region of the PL and at the intermediate groove region between PL and NPL, these cells, in general, appear much flattened, often exfoliating on the surface in flakes (Fig. 12). In the middle layer the epithelial cells are, in general, arranged in several layers. They appear polygonal with rounded nuclei at the NPL (Fig. 9), vertically compressed with flattened nuclei at the ventral surface of PL (Fig. 10) and vertically elongated with elongated nuclei at the dorsal surface of the PL (Fig. 11). Towards the surface, however, they gradually acquire polygonal shape with rounded nuclei. The basal layer epithelial cells are tall columnar having elongated nuclei at the NPL (height

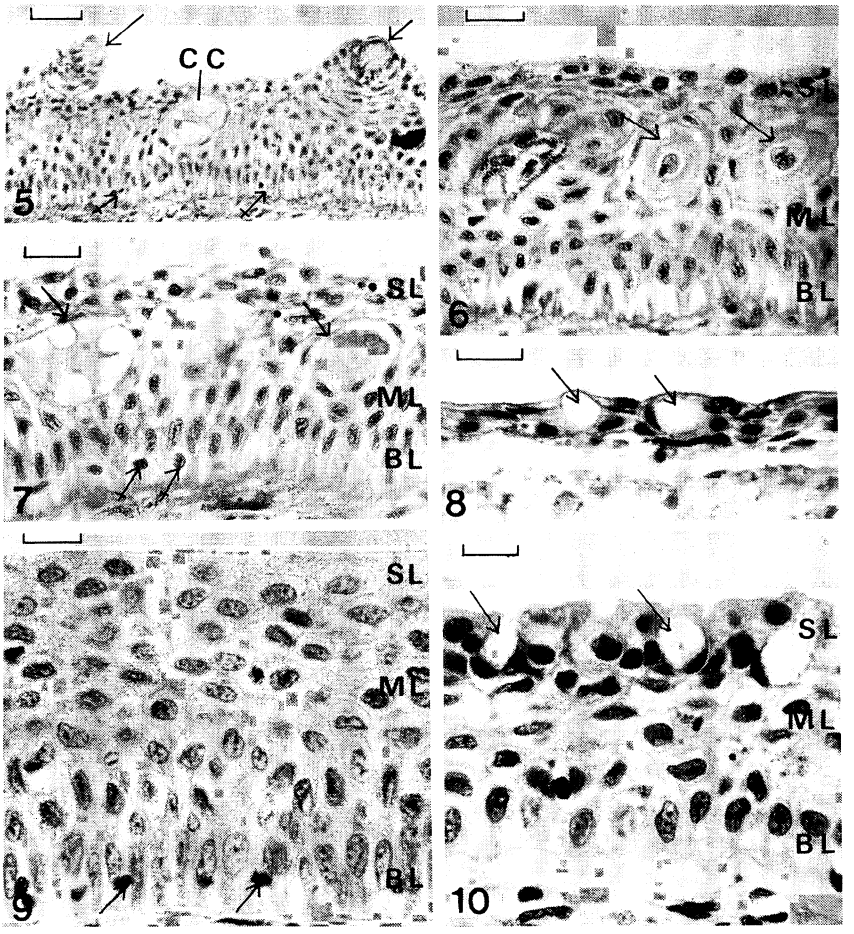


Fig. 5. Cross section of the upper lip epithelium showing epithelial papillae with the taste buds (arrows) projected at the surface. Note: a club cell (CC) in the epithelium and a few lymphocytes (barred arrows) are located in between the columnar basal layer epithelial cells (HE stain). Scale line, 10 μm.

Fig. 6. Cross section of the upper lip epithelium showing epithelial cells, flattened in the superficial layer (SL), polygonal in the middle layer (ML) and tall columnar in the basal layer (BL). Note the club cells (arrows) in the middle layer (HE stain). Scale line, 5 μm.

Fig. 7. Cross section of the rostral cap epithelium. Note the club cells (arrows) in the middle layer (ML) and lymphocytes (barred arrows) among the tall columnar basal layer (BL) epithelial cells (HE stain). Scale line, 5 μm.

Fig. 8. Cross section of the epithelium of the fold of skin between the upper lip and the rostral cap. Note: the epithelium is very thin and the mucous cells (arrows) are relatively voluminous in dimensions (HE stain). Scale line, 5 μm.

Fig. 9. Cross section of the epithelium of the non-projectile portion of the lower lip. Note: the epithelium is devoid of gland cells; the epithelial cells are dilated with flat free margins in the superficial layer (SL), polygonal in the middle layer (ML) and tall columnar in the basal layer (BL). The lymphocytes (arrows) are located in between the basal layer epithelial cells (HE stain). Scale line, 4 μm.

Fig. 10. Cross section of the epithelium on the ventral side of the projectile portion of lower lip. Note the mucous cells (arrows) in the superficial layer (SL); the epithelial cells appear dilated in the superficial layer, vertically compressed in the middle layer (ML) and low columnar in the basal layer (BL) of the epithelium (HE stain). Scale line, 4 μm.

18.0±1.81 μm and width 2.11±0.73 μm) (Fig. 9), at the dorsal surface of the PL (height 23.55±1.89 μm and width 2.37±0.88 μm) (Fig. 11) and at the groove region (height 24.50±1.80 μm and width 2.14±1.99 μm) and low columnar with rounded nuclei (height 6.82±1.27 μm and width 2.44±0.72 μm) at the ventral surface of the PL (Fig. 10).

In the FSLS, the epithelium appears folded, having ridges supported by prominent papillae-like projections from the underlying tissues (Fig. 13). The free margins of the superficial layer epithelial cells appear elevated, separated by shallow depressions, giving a corrugated appearance to the surface of the epithelium (Fig. 13). The middle and the basal layer epithelial cells are similar in disposition to those of the epithelium on the ventral side of the PL.

In general, the cytoplasm in the epithelial cells in the epithelium at different regions of the upper and lower lips and associated structures, is homogeneous and stains light blue with HE and PS, and light pink with VHE. The nuclei are healthy-appearing with distinct chromatin material and nucleoli, and are centrally placed in the epithelial cells at the superficial and the middle layers. They are apically placed in the tall columnar cells of the basal layer and are centrally placed where they are cuboidal or flattened. In general, the nuclei stain moderately blue with HE and PS, blue black in VHE and purple with Feulgen reaction for DNA. The pyknotic nuclei often observed in the superficial layer epithelial cells at the apical region of the upper lip, at the groove region and at the dorsal surface of the PL are, however, stained deep blue in HE and PS, black in VHE and magenta with Feulgen reaction for DNA.

Mucous cells. The mucous cells in the epithelium of the lips and associated structures in *Catla catla*, in general, appear rounded or typically goblet-shaped, each characterized by a rounded basal body and a narrow neck filled up with secretory contents that push the nucleus and the cytoplasm to the periphery (Figs. 10–13). These cells open on the surface by small pores through which they void their secretions on the surface of the epithelium. The peripheral cytoplasm forms a thin rim and is homogeneous and stains moderately blue in HE and PS preparations. The nuclei are flat, crescentic and basal in position (Figs. 10–13). They are stained dark blue in HE and PS, bluish black in VHE and stain deep magenta with Feulgen reaction for DNA. The secretory contents of the mucous cells appear weakly basophilic in HE and PS, and remain unstained in VHE.

In the upper lip epithelium, the mucous cells appear rounded and very small in dimensions (diameter 8.55±1.65 μm). They are few, and may be located in between the epithelial cells of the superficial layer and in the underlying 1–2 layers.

In the FSUR, the mucous cells invariably traverse the whole thickness of the epithelium, appear rounded and voluminous in dimensions (diameter 11.40±2.43 μm) in relation to the thickness of the epithelium and secrete profusely at the surface (Fig. 8).

In the lower lip epithelium, the mucous cells are, in general, absent at the NPL. At the groove region, the mucous cells are rounded, very small in dimensions and are not easily located in routine histological stains. At the dorsal surface of PL, the mucous cells are few in number and appear rounded and relatively much larger in dimensions (diameter 16.35±3.55 μm). They are located mainly in the outer middle layer of the epithelium and are not frequently observed opening on the surface (Figs. 11, 12). At the ventral surface of PL, the mucous cells are goblet-shaped and are smaller in dimensions (height 10.15±2.12 μm and width 7.50±1.73 μm). They are located in an appreciable number and lie close to each other between the epithelial cells in the superficial layer and the underlying 1–2 layers (Fig. 10).

In the FSLS, the mucous cells appear rounded and are voluminous in dimensions (13.36±1.88 μm), secreting profusely at the surface (Fig. 13).

Club cells. The club cells which are located in the epithelium on the dorsal surface of the upper lip are few in number (Figs. 5, 6). Those located in the rostral cap epithelium are relatively more in number (Fig. 7). The club cells appear rounded and voluminous in dimensions (diameter 16.83±2.71 μm). Like those in the epidermis covering the general body surface of the fish (Singh and Mittal, 1990), each of them has a single, rounded, centrally-placed healthy-appearing nucleus, which stains moderately blue in HE and PS, bluish black in VHE and weakly with Feulgen reaction for DNA. Sometimes the nuclei appear shrunken or pyknotic and darkly stained. The contents of these cells exhibit variable degrees of shrinkage and vacuolization with various fixatives. They appear homogeneous and pink with HE, PS, and VHE. A narrow perinuclear zone, however, remains unstained.

The club cells could not be located in the epithelium at the anterior end and at the ventral surface of

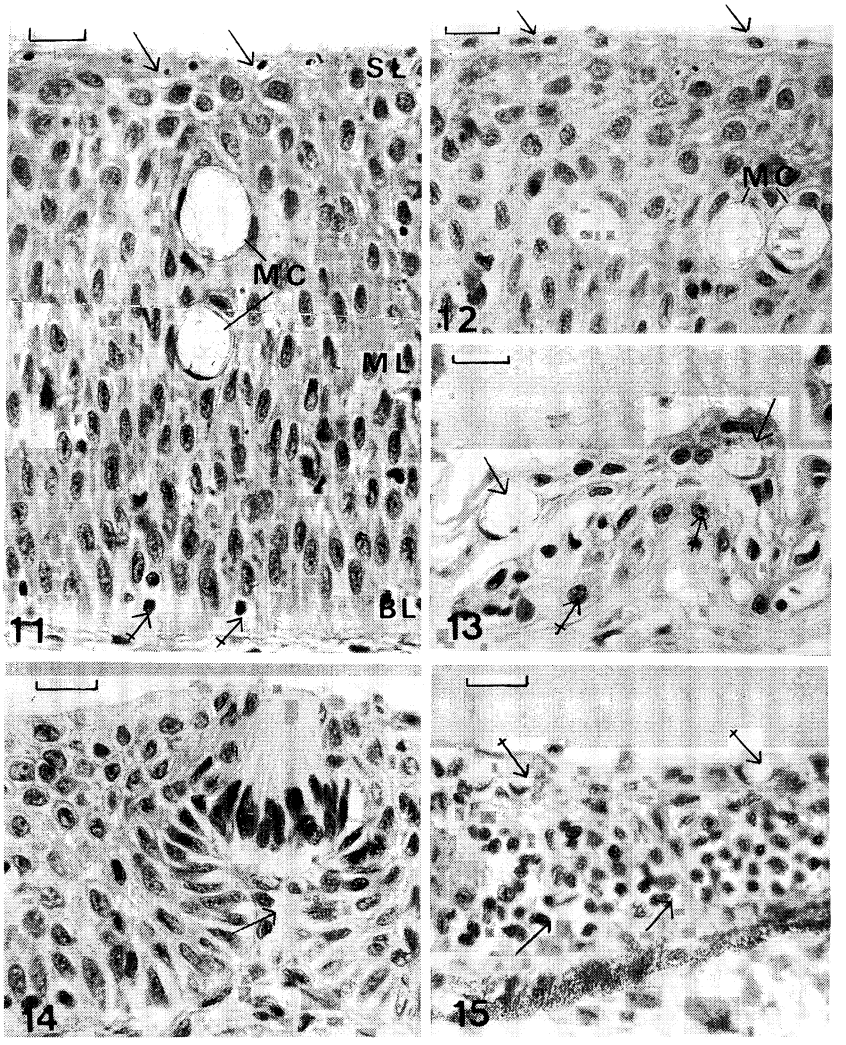


Fig. 11. Photomontage of the cross sections of the epithelium at the dorsal side of the projectile portion of the lower lip, showing epithelial cells, rounded with darkly stained pyknotic nuclei (arrows) in the superficial layer (SL), vertically elongated in the middle layer (ML) and tall columnar in the basal layer (BL). Note the rounded mucous cells (MC) in the middle layer and the lymphocytes (barred arrows) in the basal layer (HE stain). Scale line, 5 μm.

Fig. 12. Cross section of the epithelium at the apical region of the projectile portion of lower lip, showing much flattened superficial layer epithelial cells (arrows) with pyknotic nuclei. Note the mucous cells (MC) in the epithelium (HE stain). Scale line, 5 μm.

Fig. 13. Cross section of the epithelium of the fold of skin between the lower lip and the ventral head skin. The epithelium is thrown into folds and is supported by papillae-like projections from the underlying tissues. Note: the epithelial surface is corrugated. The mucous cells (arrows) are relatively voluminous and the basal layer epithelial cells (barred arrows) are low columnar (HE stain). Scale line, 5 μm.

Fig. 14. Cross section of the upper lip epithelium showing a typical taste bud supported by a papillae (arrow) from the subepithelial tissues (HE stain). Scale line, 5 μm.

Fig. 15. Cross section of the epithelium at the region, where the upper lip epithelium continues with that of the fold of skin between it and the rostral cap showing a large number of lymphocytes (arrows). Note the small mucous cells (barred arrows) in the superficial layer of the epithelium (HE stain). Scale line, 5 μm.

the upper lip, at the FSUR, at the different regions of the lower lip and at the FSLS.

Taste buds. In the epithelium of the upper lip, small pear-shaped typical taste buds (Fig. 14), invariably projected significantly on the surface and each supported by a papilla from the sub-epithelial tissues (Fig. 14) are located in a large number. Often, the epithelium is also thrown into characteristic papillae-like projections of variable heights to enable them to protrude out to a great extent from the general surface of the epithelium (Fig. 5). In contrast, in the lower lip epithelium at the NPL and at the dorsal surface of the PL and in the rostral cap epithelium, the taste buds are not easily located. Further, at these regions, they are not projected out from the general surface of the epithelium.

The taste buds are entirely absent in the epithelium at the ventral surface of the PL, at the FSUR and at the FSLS.

Lymphocytes. Typical lymphocytes, enclosed within characteristic lymphatic spaces in between the basal layer epithelial cells as in fish epidermis (Singh and Mittal, 1990), are located in the epithelium at different regions of the lips and associated structures. In general, they appear few in number. However, at the groove region between the PL and the NPL, they appear relatively more in number, and may even penetrate the middle layer. In the region where the upper lip epithelium continues with that of the FSUR, a large number of lymphocytes are often observed, enclosed within dilated lymphatic spaces, penetrating the middle layer and even up to the superficial layer of the epithelium (Fig. 15).

Discussion

In *Catla catla*, the epithelium of the lips and the structures associated with them show considerable structural modifications. These may be considered as adaptations in relation to its peculiar food procuring device, feeding habit, feeding zone and the nature of its food.

The primary function of the epithelium is protection. In *Catla catla* the epithelium at the dorsal side and at the apical end of PL is very thick as compared to that of NPL, UL and RC. This may be regarded as an adaptation in view of the need for an efficient protection against the increased stress to which they are susceptible due to characteristic folding and unfolding of the PL during feeding.

The epithelium of the ventral side of the PL is thin, probably because the epithelium on this side invariably lies very close against the ventral head skin during the folded condition of the PL and thus appears well protected.

The epithelium is very thin at the FSUR and FSLS. The presence of a thick epithelium in these regions is not necessitated as the folds of skin remain well protected in the grooves between the upper lip and the rostral cap, and the lower lip and the ventral head skin. Further, a thin epithelium will result in an increased stretchability, elasticity and large sheets may be easily folded and accommodated in narrow spaces or the grooves that will in turn facilitate the extensibility of the jaws to a great extent.

The presence of a groove in the epithelium covering the narrow transitional zone between the NPL and PL in *Catla catla* may be regarded as an adaptation to reduce the chances of wear and tear from the great mechanical stress to which the epithelium in this region is often subjected during the characteristic feeding mechanism of the fish. When it closes its mouth, the PL folds at an acute angle exerting great stretching stress to the epithelium at the groove region. Simultaneously, the epithelium in the groove region is stretched and the groove appears shallow, thus preventing the damage to the epithelium due to such mechanical stress. When the fish opens its mouth, the PL unfolds and becomes straight, relieving the epithelium at the groove region from the stress due to stretching. The groove thus appears deep at this stage.

The mucous cells are, in general, the most common unicellular glands in the epithelium of the lips and associated structures in fish. Though the secretions of the mucous cells at these structures, like those in the epidermis on the general body surface of fish, may have such diverse functions as have been summarized by Mittal and Banerjee (1980) and Imaki and Chavin (1984), one of their major roles is protection against physical abrasion (Liem, 1967; Downing and Novales, 1971; Mittal and Munshi, 1971; Mittal et al., 1980). The mucous cells are few and very small in dimensions in the upper lip and in the groove region of the lower lip, are not often located opening on the surface at the dorsal side of PL and even absent in NPL, suggesting that mucus does not appear to be secreted profusely at the surface of the epithelium of the upper lip and the lower lip. This may be due to the reason that the epithelium of the lips in this fish is not often prone to abrasion during feeding and thus does not need extra

lubrication. The food of this fish consists of plankton, the micro-organisms, which are simply taken in along with the water engulfed by the fish without causing alarm to the lip epithelium.

The mucous cells in the epithelium of the folds of skin between the upper lip and the rostral cap, and between the lower lip and the ventral head skin are voluminous in dimensions and secrete profusely at the surface. In addition to their primary role to protect and to keep the surface of the epithelium clean by preventing the deposition of foreign matters in the groove, profuse mucous secretions in these regions may play a significant role in providing extra lubrication to the surface of the folds of skin. This reduces the resistance to surface drag during their stretching, enabling the jaws to protrude at the time of feeding with increasing efficiency and swiftness. Rosen and Cornford (1971) suggested the lubricating effect of the mucus secreted on the body surface, in reducing water friction around the body of the fish and enabling movement at a greater speed with less expenditure of energy.

The club cells in *Catla catla* are uninucleated as in the epidermis in most carps (Singh and Mittal, 1990). Information regarding the functional significance of the club cells is available mainly from the studies on the epidermis covering the general body surface of fish. It appears that the club cells are developed additionally to complement the mucous cells in the efficient functioning of the epithelium in the protection against various hazards. Whitear and Mittal (1983) described the fine structure of the club cells in the skin of ostariophysan fish and suggested that the primary function of the club cells was protective in some way which is not yet experimentally established and that the recognition of specific pheromones (Pfeiffer, 1974, 1982) in ostariophysan fish was a secondary phenomenon. Randall et al. (1981) and Suzuki (1985) reported the occurrence of active hemolysin and hemagglutinin in eel skin mucus and suggested that their source might be club cells. Recently, immunocytochemical studies of Suzuki and Kaneko (1986) confirmed that the hemagglutinin is derived from the club cells in eel skin.

The gustatory system in fish is represented by taste buds which, in general, in addition to the lips and associated structures, are widely distributed in the skin covering the outer surface of the body and in the bucco-pharynx. Though the taste buds show considerable variation in their distribution as well as in the degree of their development on the lips in fish, their presence in the epithelium of the lips may be considered to indicate that the fish is able to sense the nature of food before swallowing.

Like most plankton feeders, *Catla catla* has a peculiar mode of feeding. It gulps large quantities of water which is filtered through their gill rakers in such a way that the particulate food items which give sustenance to the fish may be retained. This may lead to presume, as suggested by Kapoor (1958), that in such fishes an acute sense of taste is not needed, and consequently it is expected that the taste buds on the lips may be either absent or few in number and rudimentary. In *Catla catla*, well-developed taste buds are few in the lower lip epithelium. In the upper lip epithelium, however, they are located in a large number often supported by a characteristic epithelial papillae-like projection and thus projected outwards from the general surface of the epithelium. Such a unique arrangement of the taste buds on the upper lip in a surface plankton feeder may be associated with the acute gustatory sense. The projected taste buds are the first to come in contact with surface water and enable the fish to sense the nature of food available in a particular feeding zone before it opens its mouth to form a temporary feeding tube to gulp in large quantities of water along with available food particles. The elevated taste buds may have an additional mechanoreceptive function as suggested by Reutter et al. (1974) and Reutter and Breipohl (1975). The elevated taste buds may be deflected by food or other types of particles. The resulting mechanical impules could be transmitted from the sensory cells to the brain centres. Reports on the distribution of the taste buds on the lips of *Catla catla* by previous workers are conflicting. Mookerjee and Ganguly (1952) reported the absence of taste buds while, Moitra and Bhowmik (1967) reported numerous taste buds in young and comparatively fewer in adult *Catla catla*. They have, however, made no distinction between the upper and the lower lips and made no reference to the elevated taste buds on the upper lip.

On the FSUR and FSLS in *Catla catla* the taste buds are absent. Here the taste buds are not necessitated or may not be of much significant value probably because the folds of skin lie in deep grooves and do not remain in direct contact with the surrounding medium except when they are temporarily stretched out for short periods during jaw protrusion for feeding.

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インド産コイ科魚類の一種 *Catla catla* の唇上皮とその付随構造

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インド産コイ科魚類の一種 *Catla catla* の上唇は，薄くて背面で皮膚の膜質褶と吻冠とに連結し，下唇は厚くて，腹面の下唇と腹側頭皮との間に皮膚褶がある．下唇は非突出部，突出部および中間の溝部から成り，突出部は口を閉じた際に腹側頭皮の一部を覆ったまま，内方へ折り込まれている．そこで，両唇の役割を特異な摂食管形成との関連から論じてみた．唇および付随構造は重層上皮で粘液細胞に乏しいが，これは微小生物摂食の際にすりむけることを防ぐ必要が無いことを意味する．一方，褶上皮には多数の粘液細胞があり，効率よく顎を伸ばす際に表面の抵抗を減少させるのに役立つ．棍棒細胞は吻冠と上唇上皮の粘液細胞を補強し，味蕾は上唇の乳頭状突起の上に多数存在し，鋭敏な味覚に携わっているが，味覚にかかわりをもたぬ下唇の褶にはない．