

Ultrastructure of the lingual epithelium of adult scincine lizard *Chalcides ocellatus*

Ekbal T Wassif

Zoology Department, Faculty of Science, Assiut University, Egypt.

ABSTRACT

In the present investigation, the histological and histochemical characteristics, as well as the ultrastructure of the lingual epithelium of the adult lizard *Chalcides ocellatus*, were investigated by light microscopy (LM) and scanning electron microscopy (SEM). Histological examination revealed taste buds and sensory papillae on the tongue tip and on the foretongue. The papillae were covered by stratified squamous epithelium and the core of the papillae is penetrated by connective tissues, pigment cells and striated muscle fibers. The acinar lingual glands appeared between the lateral sides of the papillae with increased number posteriorly. These glands stained purple with AB-PAS dorsally, and pink, with some purple cells, ventrally. SEM observations revealed three different types of lingual papillae, which were widely distributed over most dorsal surface of the tongue. The epithelial cells covering the surface of each papilla include smooth surface epithelial cells at the distal part of the papillae (free border) and cells with microridges interspersed with micropores at the intermediate portion of the papillae. Cells with densely distributed tall microvilli bearing extracellular mucus were noticed at the proximal portion of the papillae (near the base). Most of the surface of the bifurcated part of the tongue was relatively smooth with pitted and wrinkled surfaces (characteristic marks of the keratinized epithelium). Also the correlations between the structure and function were discussed in details.

KEYWORDS: taste buds, papillae, scanning electron microscope, acid mucopolysaccharides.

INTRODUCTION

The tongues of reptiles are structures that are variable in their gross and microscopic structure, as well as their functions. Underwood (1971) proposed that feeding and sensory functions of the tongue are commonly limited within lizards. While McDowell (1972) mentioned that the tongue function is specialized for chemosensory behaviors. In lizards, tongue flicking serves to collect chemical particles from the surrounding environment to be transferred to the vomeronasal organs (Graves & Halpern 1989).

Tongue morphology was found to be very important in systematic studies of squamates (Schwenk 1986). Moreover, many descriptive studies, using light microscopy, had been done on the structure of the tongue surface of reptiles (McDowell 1972; Smith 1984; Schwenk 1986; Mohammed 1991a & b; 1992; Attia *et al.* 1998; Mohammed *et al.* 1998; Wassif & El-Hawary 1998). These studies showed great variety in lingual morphology and histology, especially variation in size and shape of the dorsal papillae. Apparently, the differences between the tongue surfaces of various reptiles depend on dissimilarities in diet, feeding habits and handling of the food in the mouth (Pianka 1986; Mohammed 1987 & 1992).

By using scanning electron microscopy marked variations in the architectures of the dorsal surface of the tongue were found, (Winokur 1988; Iwasaki 1990; 1992; Delheusy *et al.* 1994; Iwasaki *et al.* 1996; Wassif & El-Hawary 1998; Lemell *et al.* 2000). Kullaa-Mikkonen (1986) mentioned that mechanical stresses modify the surface structure of the superficial cells.

The aim of the present work is to study the morphology, histology and histochemistry of the tongue of the adult lizard *Chalcides ocellatus*, by the aid of light and scanning electron microscopy, to reveal the form and function of the tongue with comment on its significance.

MATERIALS AND METHODS

Tongues from seven male and four female adult lizards, *Chalcides ocellatus* were collected from Abu-Rawash (thirty kilometers North-West of Cairo).

For scanning electron microscopy preparations, the tongues were fixed in Karnovsky solution (4% paraformaldehyde and 5% glutaraldehyde, pH 7.4). After rinsing in 0.1M cacodylate buffer, the samples were postfixed in a phosphate-buffered solution of 1% osmium tetroxide at 37° C for 2hr. Samples were treated with 8 N hydrochloric acid at 60° C for 30 min in order to remove the mucus from the surface of the tissue (Iwasaki *et al.* 1987). Washing, then dehydration in ethanol and critical point drying in carbon dioxide followed. A thin layer of gold ion was applied to coat the samples. The specimens were examined by JEOL scanning electron microscope (JSM-5400 LV).

Further samples of tongues were fixed either in acetic alcohol formalin fixatives or in Bouin's fluid. Then the fixed samples were dehydrated then embedded in paraffin by conventional techniques and serially sectioned at 6 μ m. Bouin's-fixed samples were stained by haematoxylin and eosin and Milligan's trichrome stain (this stain differentiates muscle and connective tissue). In addition, acid and neutral mucopolysaccharides were visualized together by the Alcian blue at pH 2.6 and periodic acid Schiff's reagent method (AB/PAS) (Humason 1979). Acetic alcohol formalin samples were stained by toluidine blue stain to differentiate between sulfated sialomucins (permanent metachromasia) and nonsulfated sialomucins (unpermanent metachromasia) (Nasr 1997). General proteins were revealed by mercury bromophenol blue (Mazia *et al.* 1953).

RESULTS

Light microscopic observations: The tongue of the *Chalcides ocellatus* can be divided into 4 regions. The anterior part is the tongue tip, which consists of un-papillosed bifurcated apex (fig.1), lateral and ventral sides, and a papillosed segment, which lies dorsally at the middle portion of the tongue tip (fig.2). The un-papillosed tongue tip is covered by a keratinized stratified squamous epithelium. The keratin layer at the dorsal surface is thinner than that at the ventral surface (horny pads) (fig. 1). A large core consists of loose connective tissue rich in pigment cells that form the center of the bifurcated tongue tip (fig.1). Lymphatic ducts are seen in the bifurcated tongue tip and in the fore-tongue (fig. 2). The middle segment of the tongue tip is papillosed and covered by short cylindrical-like papillae. Such papillae are covered by thin stratified squamous epithelium with a thick layer of keratin (fig. 2A). Sensory papillae are seen at this region (fig. 3). Also some papillae are seen bearing taste buds at this portion of the tongue (fig. 4). The anterior portion of the tongue appeared black owing to the presence of numerous pigment cells in the superficial layers of the connective tissue, which penetrated deeply to the lingual muscles at this part (figs. 1-3 and 5).

The second portion of the tongue is the fore-tongue. This part extends to the attachment of the tongue with the buccal floor. The anterior portion of the fore-tongue is non-glandular and has short papillae. The covering of these papillae is similar to that described previously. Muscle bundles and pigment cells can be seen invading the core of the papillae (fig.5). Caudally the papillae are elongated and attain a scale-like structure. The acinar lingual glands gradually appeared between the lateral sides of the papillae (fig 6). The number of these glands increased posteriorly and is lined by mucous secreting cells. The cytoplasm of these cells is faintly stained with eosin and contained basally located flattened nuclei. However, the apical portions of these glands found between the papillae are lined by stratified squamous epithelium at the fore and mid-tongue (figs.6&7). A thin sheet of collagenous fiber lies beneath the lingual epithelium (fig. 7).

The posterior-lateral portions of the hind-tongue carry fan-shaped papillae at the dorsal and ventral surfaces and scale-like and fungi-form likes papillae near the pharynx.

Some papillae are branched. The glands at the hind-tongue open directly between the papillae. These papillae are very rich in lingual simple and branched acinar glands (fig. 8).

Fig. 1: Vertical section of a tongue tip showing the keratinized stratified squamous epithelium (arrow head) and pigment cells (P).

Fig. 2: Vertical section of a tongue tip showing the nonpapillosed lateral and ventral sides, lymph ducts (L) and the papillosed middle segment (arrow). (H&E X 40).

Fig. 2A: Vertical section of the papillosed tongue tip showing keratinized squamous epithelium (arrows) covering the papillae and muscle bundles (M) invading the core of the papillae. Pigment cells (P) can be seen at the connective tissue between the muscle bundles (M). (Milligan's stain X 200).

Fig. 3: The papillosed tongue tip showing the sensory papillae (arrows). (H&E X 400).

Fig. 4: Section showing the taste bud. (H&E X1000).

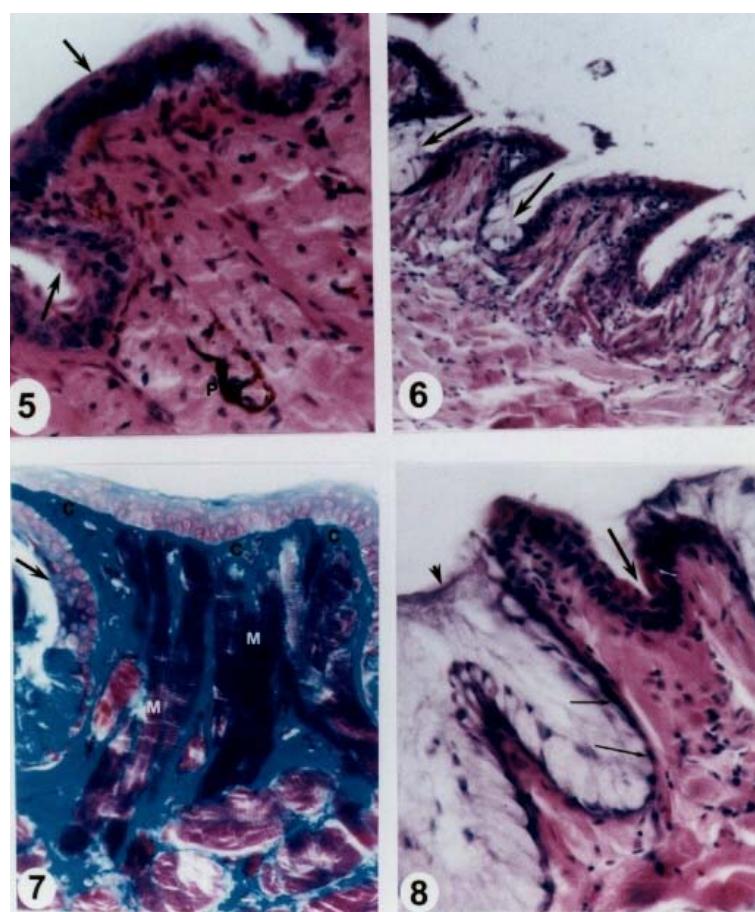
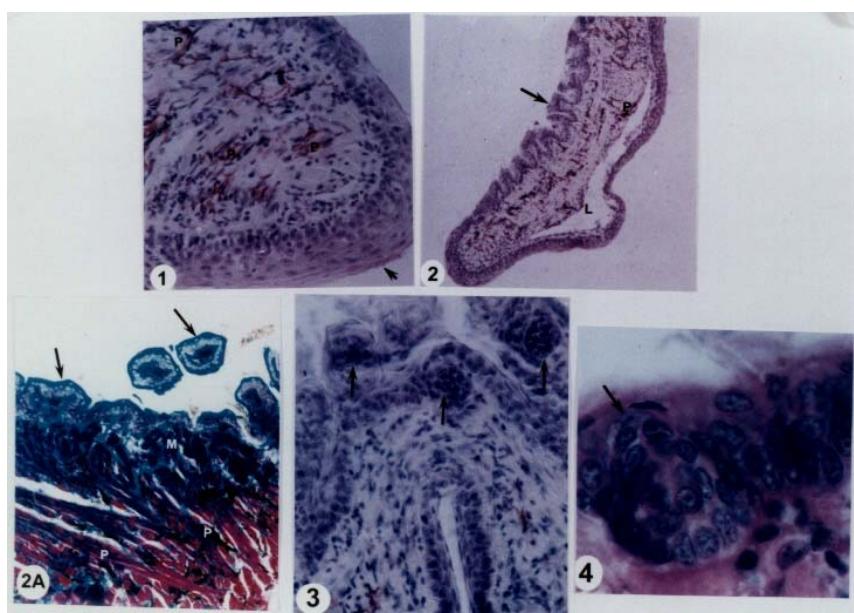


Fig. 5: The most anterior portion of the foretongue showing the stratified squamous epithelium cover the summit of the papillae as well as its lateral sides (arrows). (H&E 400).

Fig. 6: The foretongue posterior to the previous section showing the appearance of the lingual glands (arrows). (H&E X 200).

Fig. 7: Section of the midtongue showing the collagenous connective tissue (c) invaded by the striated muscle bundles (M) at the core of the papillae. Note the neck of the lingual gland consists of non-secretory stratified squamous epithelium (arrow). Also showing mucous cells with basally located flattened nuclei at the base of the gland. (Milligan's stain X400).

Fig. 8: Section of the hindtongue, showing the thin stratified squamous epithelium covering the summit of the papillae (thick arrow). Note the lingual gland opens directly at the surface of the tongue (arrow-head). Also showing faintly stained mucous cells with basally located flattened nuclei (thin arrows). (H &E X 400).

Histochemical observations: The mucous cells were negatively stained with bromophenol blue. Staining with Milligan's technique indicated the presence of acid mucopolysaccharides in these cells (fig. 7). Staining with AB-PAS revealed that lingual epithelium was negatively stained. The mucous acini at the dorsal surface were stained purple with AB-PAS indicating the presence of both neutral and acid mucosubstances (fig.9). The ventral glands were composed of cells which contained pink substances indicative of neutral periodate reactive

mucosubstances. However, some cells in the acinar glands also contained purple substance (AB-PAS positive), indicating the secretion of a small amount of both neutral and acid mucosubstances (fig. 10). A thin layer of AB-PAS stained material was seen over the surface of the papillae of the tongue (fig. 9). The presence of non-sulfated and sulfated sialomucin was verified by the use of toluidine blue in the dorsal and ventral glands (figs. 11 & 12).

SEM observations: By using SEM at low magnification, the tongue of *Chalcides ocellatus* appeared triangular in shape with a slightly bifurcated apex. The pharynx opens near the end of the posterior region of the tongue (fig.13). Dorsally the tongue is divided into the tip, the fore-tongue, the mid-tongue and the hind-tongue (fig.13). The tongue tip is subdivided into a U-shaped portion (the bifurcated part), two lateral portions on each side of the furcated part and a median large portion (fig.13). The bifurcated part and the two lateral portions of the tongue tips are keratinized but not papillosed. The middle portion of the tongue tip is papillosed (figs.13). These papillae increased in size and attained a scale-like appearance towards the posterior end of the tongue. The papillae are overlapped and their posterior portions are more or less serrated and posteriorly oriented. The hind part of the tongue is limited by the opening of the pharynx and consists of two lateral limbs. These limbs bear ridge-like papillae laterally and scale like ones near the pharynx (fig.13). Ventrally the tongue is attached to the buccal floor by most of its entire length. The ventral surface of the tongue carries two horny pads at the tongue tip and ridge-like papillae at the lateral sides of the tongue (fig.14).

Using higher magnification (SEM), the surface of the U-shaped portion of the tongue tips is wrinkled and bears a network of micro-ridges, interspersed with micro-pores. The most anterior parts of the tongue tip were also wrinkled with parallel and branched microfolds. A few pits were seen at this portion. The boundaries between cells are not clear at this area (fig.15). At the lateral sides of the tongue tip, near the papillosed portion, the surface of the epithelial cells has microvilli with fine granules and anastomosed micro-ridges interspersed with numerous micropores (fig.16). The boundaries between cells are more or less clear (fig.16). Polygonal depressions can be seen between the cells from which a tuft of microvilli with fine granules was projected (fig. 16). These structures may resemble the pores of the taste buds.

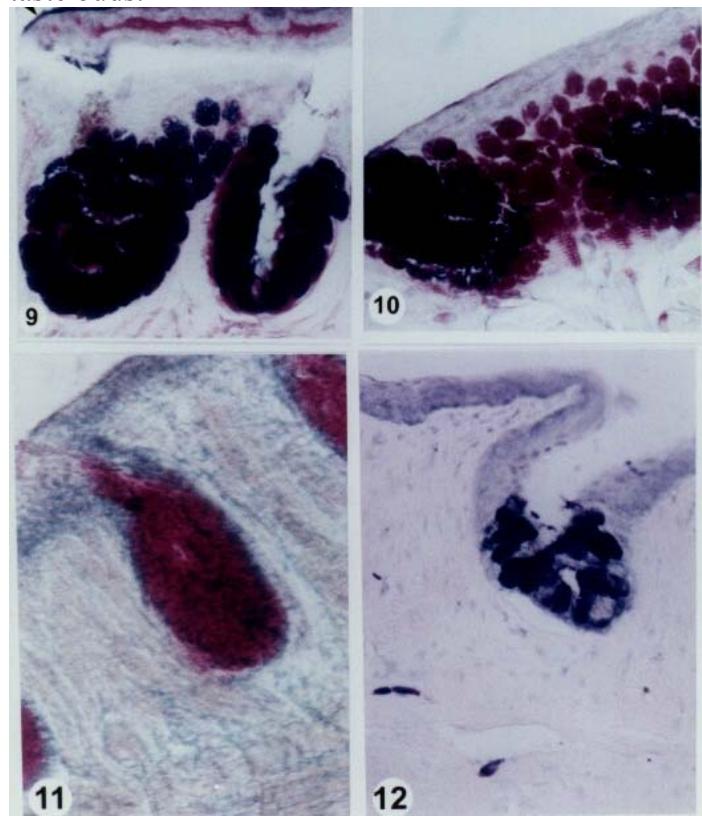


Fig. 9: The lingual glands at the dorsal surface showing the darkly stained (purple) mucous secreting cells by AB-PAS. Also showing the mucus at the surface (arrow head). (X 400).

Fig. 10: The lingual glands at the ventral surface showing pink stained mucous secreting cells and others darkly stained purple by AB-PAS. (X 400).

Fig. 11: Metachromasia (Pink) of the mucous cells of the lingual glands of the tongue before dehydration indicating the presence of acid mucous substance. Toluidine blue stain. (X 400).

Fig. 12: Metachromasia (purple) of the mucous cells of the lingual glands of the tongue after dehydration indicating the presence of sulfated acid mucous substance. Toluidine blue stain. (X 400).

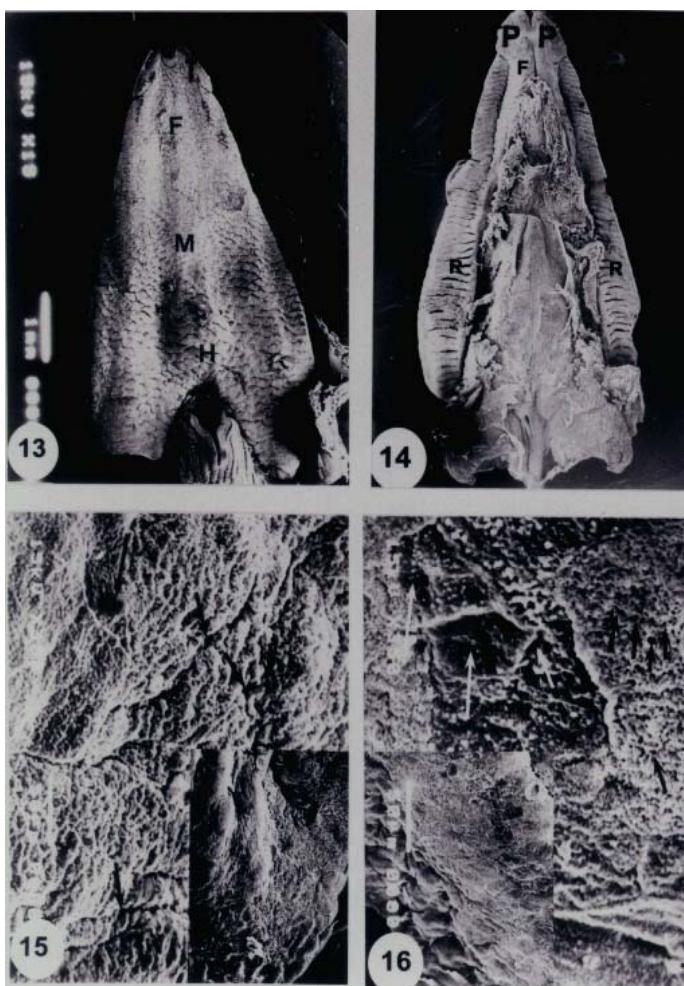


Fig. 13: Scanning electron micrograph (SEM) of the dorsal surface of the tongue of the lizard *Chalcides ocellatus*, showing the nonpapillosed tongue tip (T) and the papillosed fore-tongue (F), mid-tongue (M) and hind-tongue (H). (X 15).

Fig. 14: SEM of the ventral surface of the tongue showing the two horny pads (P), free portion of the foretongue (F), the ridge-like papillae (R) at both sides. (X15).

Fig. 15: SEM of the dorsal surface of the lateral side of the tongue tip (X 500). Higher magnification of the epithelial cells showing their wrinkled surface with many pits (arrows) (X.3500).

Fig. 16: SEM of the dorsal surface of the tongue tip near the papillosed portion showing polygonal depressions with pores of the taste buds (white arrows) having microvilli bearing fine granules. The adjacent cells have anastomosed micro-ridges interspersed with micropores (black arrows). (X 3500).

The fore-tongue and the middle segment of the tongue tip are covered by polygonal shape cobblestone-like papillae separated by clefts. Most cells covering these papillae have more or less smooth surfaces (fig.17), apart from some cells bearing microvilli with fine granules. The cells in this part of the papillae possess a slightly wrinkled surface and are located close to each other, with clear limits between each other (fig. 17). At the center of some papillae, a triangular shaped depression was observed (from which a tuft of closely packed processes was projected). This structure is surrounded by microvilli bearing micro granules. All these structures are surrounded by flat and polygonal cells with prominent borders (fig. 17), which resemble the taste bud.

Posteriorly, the cobblestone-like papillae increase in size and attain scale-like appearance. The scale-like papillae or the ridge-like ones can be divided into distal, intermediate, and proximal portions in relation to the base of the papillae. The epithelial cells lying on the distal part of the papillae (at their free border) are typically large, flat and polygonal with prominent borders and more or less smoothed surface (fig.18). In the intermediate portion of the papillae, the cells are flat, polygonal and the surface has a network of microridges interspersed with micropores (fig.19). The borders between cells are elevated and the limits between cells are clear (fig.19). Near the base of the papillae, the surface architectures of the cells are similar to that of the previous portion except for the presence of larger micropores, thus giving a reticular aspect to the cell surface. The boundaries between cells are more or less clear (fig. 19A).

Cobblestone-like cells cover the papillae at the most posterior portion of the hind tongue. These cells are smaller than that of the aforementioned ones. The boundaries between cells are not clearly defined but appeared as clefts between cells, since they present dilated

apices and their surfaces are richly covered by tall microvilli bearing extracellular mucus (fig.20). The openings of some glands were seen between cells (fig. 20).

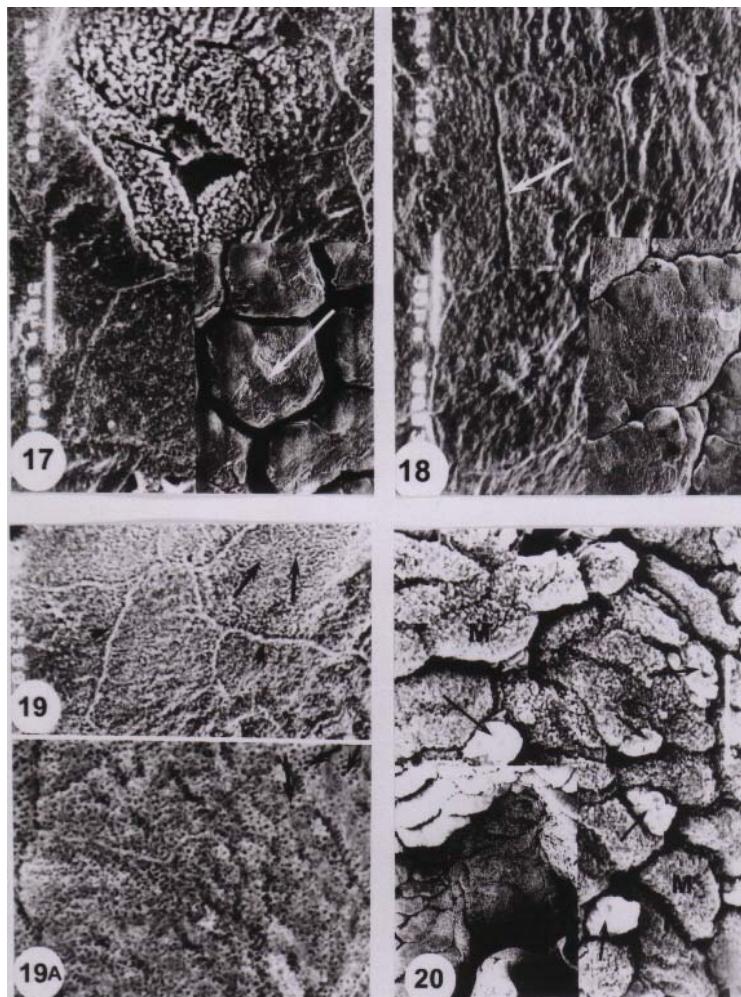


Fig. 17: SEM of the dorsal surface of the anterior fore-tongue showing cobblestone-like papillae bearing a triangular pore of the taste bud (white arrow). (X 500). Higher magnification of the same papillae showing a tuft of micro-processes projects from the pore of the taste bud (black arrow). (X 3500).

Fig. 18: SEM of the dorsal surface of the serrated scale like papillae (X 500). Higher magnification of the papillae at its free border (asterisk) showing the smoothed surface of the cells and the prominent borders between cells (white arrow). (X 3500).

Fig. 19: SEM of the dorsal surface of the serrated scale like papillae at the intermediate portion of the papillae showing the surface architecture of the epithelial cells with the presence of small micropores (arrows) and the elevated borders between cells (arrow heads). (X 3500).

Fig. 19A: SEM of the dorsal surface of the serrated scale-like papillae near the base showing many large micropores (arrows). The limits between cells are not clear. (X 3500)

Fig. 20: SEM of the dorsal surface of the papillae of the posterior portion of the hindtongue (X 500). Higher magnification of the papillae showing cobblestone-like cells of different sizes. They have dilated apices and their surfaces are richly covered by microvilli bearing extracellular mucus (M). Notice the opening of the mucous glands (arrows). (X 3500).

DISCUSSION

The morphology of the tongue in *Chalcides ocellatus* is characterized by a smooth and slightly bifurcated distal portion and by the presence of well-developed papillae on the remaining surface of the tongue. This is similar to that described by Wassif & El-Hawary (1998) in the tongue of the golden lizard, *Eumeces schneideri*. In most lizards, the dorsal surface is covered with papillae or keratinized scales and has a broad, roughened fractional surface for food transport (Smith 1984; Mohammed 1992).

Scanning electron microscopy examination was revealed that the dorsum of the reptilian tongues is covered by various types of papillae that differ in shape, size, number, nomenclature and distribution among different groups (Schwenk 1986; Iwasaki 1990; 1992 ; Toubeau *et al.* 1994; Iwasaki *et al.* 1996; Wassif & El-Hawary 1998; Lemell *et al.* 2000). These differences depend on dissimilarities in diet, feeding habits and handling of the food in the mouth (Iwasaki & Miyata 1985; Pianka 1986; Mohammed 1987, 1992). It has been reported that in most lizards the papillae are covered by stratified squamous epithelium that differed only in thickness and degree of keratinization (Schwenk 1986; Mohammed 1991a & b; 1992; Wassif & El-Hawary 1998). This observation is in agreement with the present investigation.

The posterior limbs of the hind tongue are absent in crocodilians but are present in some terrestrial turtles (Bramble & Wake 1985). Well-developed posterior limbs are found in Sphenodon (Schwenk 1986) and in Gekkonidae (Mohammed 1991b). In the present report it is obvious that the posterior lateral limbs of the hind tongue is similar to the lateral wings in *Eumeces schneideri* (Wassif & El- Hawary 1998) and to the lingual radix in *Gekko japonicus* (Iwasaki 1990) and paired posterolateral projections (McDowell 1972). Smith (1984) speculated that the posterior limbs of squamate tongues serve to push food into the esophagus during swallowing. The loss of lingual posterior limbs in reptiles is apparently correlated with the absence of lingual food transport and in squamates may also be associated with a greater degree of tongue protrusion (Schwenk 1986).

The results also showed that bifurcated tongue tip is covered by non-papillosed epithelium at the dorsal and ventral surfaces. This is similar to that observed in the golden lizard *Eumeces schneideri* (Wassif & El- Hawary 1998); *Anguis fragilis* (Toubeau *et al.* 1994) *Gekko Japonicus* (Iwasaki 1990); *Anolis carolinensis* (Rabinowitz & Tandler 1986) and *Takydromus tachydromoides* (Iwasaki & Miyata 1985). However, in *Sphenodon punctatus*, the anterior region of the blunted tongue is covered with long filamentous papillae (Schwenk 1986).

The present LM observations revealed that, the ventral and dorsal surfaces of the tongue tip were covered by keratinized squamous epithelium. This is similar to the results of Toubeau *et al.* (1994) and Wassif & El-Hawary (1998) in *Anguis fragilis* and *Eumeces schneideri* respectively.

Lingual pigmentation was observed in the anterior portion of the tongue, such pigmentation was also revealed in the tongue of the lizard *Anguis fragilis* (Toubeau *et al.* 1994) and the turtle, *Malayemys subtrijuga* (Winokur 1988). However, in *Eumeces schneideri* there is no evidence of lingual pigmentation (Wassif & El-Hawary 1998).

SEM examination revealed that the cells at the dorsal surface of the tongue tip are wrinkled, pitted and have many anastomosed microridges and microfolds. Kullaa-Mikkonen (1986) observed that the fully keratinized epithelial cells have a pitted appearance. Rabinowitz & Tandler (1986) mentioned that the cell surface in parakeratinized-stratified squamous epithelium is distinguished by the presence of prominent microfolds of the free surface. Fahrenbach & Knutson (1975) suggested that the microridges and microfolds of the cornified area protect the surface of the tongue from an abrasive contact with the anterior teeth or the substrate during tongue flicking or substrate licking. Toubeau *et al.* (1994) mentioned that the presence of microstructures increases the surface area of the tongue tips of *Anguis fragilis* and may be useful for the pickup and transfer of chemicals into the buccal cavity during tongue flicking.

The anterior bifurcation of the tongue of *C. ocellatus* is also present in all squamates except Dibamidae (Greer 1985). A deep bifurcation was reported in snakes and varanids (Oelofsen & Van Den Heever 1979; Attia *et al.* 1998). The tongue is slightly bifurcated in Gekkonidae (Mohammed 1991b), but absent in turtles (Iwasaki 1992), crocodilians (Ferguson 1981), Sphenodon (Schwenk 1986) and in agamid lizard (Mohammed 1991a). In varanids and snakes the bifurcated tongue tip is associated with transmitting of chemicals from the environment to the vomeronasal (Jacobson) organ (Oelofsen & Van Den Heever 1979) or prey odor discrimination by lizards (Cooper 1998). Thus, the tongue may be considered as an accessory organ functioning in conjunction with the vomerolfaction (VNO) to provide information regarding sex identification and reproductive status (Schwenk 1986) and is used as a prehensile organ during prey capture (Gorniak *et al.* 1982). Mohammed *et al.* (1998) confirmed that gekkonids use the tongue primarily for food transport and it is specialized for chemoreception.

Taste buds were rarely found on the tongue tip and on the summits of the papillae of the fore-tongue of the present lizard. Taste buds are also very rare in *Eumeces schneideri*

(Wassif & El-Hawary 1998). Taste buds occur in the oral and lingual epithelia of crocodilians (Ferguson 1981), turtles (Winokur 1988) and squamates (Schwenk 1985).

Delheusy *et al.* (1994) mentioned that the role of these taste buds on the anterior papillae might be testing the palatability of the prey when contacts with the tongue occur during capture. In *Acanthodactylus boskianus* gustation may be used during mate selection (Mohammed 1992). The presence of taste buds on the tongue tip and on the fore-tongue might play the same role in *C. ocellatus*.

Nishida *et al.* (2000) found that the snake sensory papilla represents one of the most specialized, compound sensory systems among vertebrates, which may play an important role in receiving chemical and mechanical information on prey. Similarly, the presence of sensory papillae on the tongue tip might play the same role in *C. ocellatus*.

By using scanning electron microscopy, Schwenk (1985) and Rabinowitz & Tandler (1986) recognized taste pores as small depressions at the papillae apex. A similar description was reported in the present investigation with a tuft of processes project from these depressions. Short processes of the clear sensory cells that protrude slightly through small pores of the taste buds were reported by Schwenk (1986).

Schwenk (1985) suggests that the distribution of taste buds on the squamate tongue may be related to the availability of suitable epithelium. Kubota & Kubota (1963) stated that taste buds are developed only in the epithelial portion that is lined with rich interpapillary nerve plexus and continue only in anatomical connection with abundant nerve fibers. Roper (1989) mentioned that taste buds are collections of 100 specialized chemoreceptor cells embedded in the lingual epithelium and about 90% of the cells in the taste buds are receptor cells.

The present SEM investigation, revealed three types of cells covering the papillae. Anastomosed microridges interspersed with micropores are visible on the surface of almost all epithelial cells at the interpapillary portion of the papillae. Toward the base of the papillae these microridges are replaced gradually by long microvilli immersed in mucus. This observation is similar to that described by Wassif & El-Hawary (1998) in *Eumeces schneideri*. Iwasaki *et al.* (1987) mentioned that the differences in the pattern of microridges on the interpapillary surface might be related to the degree of keratinization of the interpapillary epithelium. Fawcet (1981) proposed that microridges and microfolds serve to hold in place a layer of mucus, which acts as a lubricant. Microridges might also play a role in binding and spreading of mucus on the epithelium (Sperry & Wassersug 1976). Iwasaki (1992) suggested that microvilli on the surface of the oral epithelial cells be thought to have almost the same function as microridges. It is assumed that both microvilli and microridges may function as a supporting structure for food uptake, mastication and swallowing.

Use of the light microscope, showed that a collagenous connective tissue sheet lies just beneath the epithelium and the center of each papilla is invaded with skeletal muscle fibers. Similar observations were noticed in *Eumeces schneideri* (Wassif & El-Hawary 1998). Rabinowitz & Tandler (1986) reported the attachment of the collagenous fibers by endomysial fibrils to the surface epithelium at the tips of the papillae. The contraction of the muscle will cause either shortening or bending of the papillae. Winokur (1988) suggested that these muscles also attached to the base of the mucous glands to squeeze mucus to the surface of the tongue.

The present study showed that the lingual glands lie between the bases of the papillae and are abundant in the posterior region of the tongue. The gland cells are faintly stained with eosin and negatively stained with bromophenol blue and have flattened nuclei located in the basal portion of the cells. Thus, appeared to be mucus-secreting cells. Similar glands are found in *Eumeces schneideri* (Wassif & El-Hawary 1998), *Acanthodactylus boskianus* (Mohammed 1992) and in iguanid lizards *Oplurus cuvieri* (Delheusy *et al.* 1994). These numerous mucous glands are observed in Sphenodon and terrestrial tortoises (Schwenk 1986; Winokur 1988). The secretion of large amounts of mucus acts as a lubricant that facilitates

food movements, transport and swallowing (Winokur 1988; Mohammed *et al.* 1998). These mucous cells are strongly positive AB-PAS. Since the buccal cavity is the first protective barrier, it is believed that its acid mucosubstances might act as an antibacterial protection as in the nasal cavity of the mouse (Larochelle & Martineau-Doize 1991). Despite the submersion of the lizard under the sand, the animal spends considerable time with its anterior portion of the tongue exposed to the air and associated microorganisms. The acid mucus may discourage the growth of microorganisms that are usually found in abundance on most external surface of these lizards.

In conclusion, the present study revealed that the dorsal surface of the tongue of *Chalcides ocellatus* is covered with papillae and so has a broad, roughened fractional surface for food transport. There are two posterior limbs that serve to push food into the esophagus during swallowing. Microridges and microplicae found on the cell surfaces of the tongue tip serve to hold in place a layer of mucus, which acts as a lubricant. The presence of microstructures increases the surface area of the tongue tip and may be useful for the pickup and transfer of chemicals into the buccal cavity. The presence of taste buds and sensory papillae on the anterior portion of the tongue may test the palatability of the prey when contacts with the tongue occur during capture and may play an important role in receiving chemical and mechanical information on prey. Both microvilli and microridges, found on the cell surfaces of the papillae, may function as a supporting structure for food uptake, mastication and swallowing. The secretion of large amounts of mucus acts as a lubricant that facilitates food movements, transport and swallowing. In *C. ocellatus* the tongue is an important organ for secretion fluids into the oral cavity and this moist tongue is also useful for catching food. As the buccal cavity is the first protective barrier, the investigator proposed that acid mucosubstance might be acts as an antibacterial protection.

REFERENCES

- Attia MNT, Mohammed BHM & Mohallal ME (1998) Structure and function of the lingual mucosa of Agamid lizard and Varanids. *J Egyp. Ger. Soc. Zool.*, 26(B): 113-133.
- Bramble DM & Wake DB (1985) The feeding mechanisms of lower tetrapods. In: Hildebrand M, Bramble DM, Liem KF & Wake DB (Eds): Functional Vertebrate Morphology, Cambridge: Harvard Univ. Press, pp. 230-261.
- Cooper WE Jr (1998) Prey chemical discrimination indicated by tongue-flicking in the eublepharid gecko *Coleonyx variegates*. *J. Exp. Zool.* 281: 21-25.
- Delheusy V, Toubeau G & Bels VL (1994) Tongue structure and function in *Oplurus cuvieri* (Reptilia: Iguanidae). *Anat. Rec.* 238: 263-276.
- Fahrenbach WH & Knutson DD (1975) Surface adaptations of the vertebrate epidermis to friction. *J. Invest. Dermato* 65: 39-44.
- Fawcet DW (1981) The Cell. Saunders WB Company (2nd Ed.), Philadelphia, pp 84-87.
- Ferguson MWJ (1981) The structure and development of the palate in *Alligator mississippiensis*. *Arch. Oral Biol.* 26: 427- 443.
- Gorniak GC, Rosenberg HI & Gans C (1982) Mastication in the tuatara, *Sphenodon punctatus* (Reptilia: Rhynchocephalia: Structure and activity of the motor system. *J Morphol* 171: 321-353.
- Graves BM & Halpern M (1989) Chemical access to the vomeronasal organs of the lizard *Chalcides ocellatus*. *J. Exp. Zool.* 249: 150-157.
- Greer AE (1985) The relationships of the genera *Anelytropsis* and *Dibamis*. *J. Herp.* 19: 116-156.
- Humason GL (1979) Animal Tissue Techniques. Freeman WH and Co (4th Edition), San Francisco,
- Iwasaki S (1990) Fine structure of the dorsal lingual epithelium of the lizard, *Gekko japonicus* (Lacertilia, Gekkonidae). *Am. J. Anat.* 187: 12-20.
- Iwasaki S (1992) Fine structure of the dorsal epithelium of the tongue of the freshwater turtle, *Geoclemys reevesii* (Chelonia, Emydinae). *J. Morphol.* 211(2): 125-135.
- Iwasaki S & Miyata K (1985) Scanning electron microscopy of the lingual dorsal surface of the Japanese lizard, *Takydromus tachydromoides*. *Okajimas folia anat. Jpn.*, 62:15-26.
- Iwasaki S, Miyata K & Kobayashi K (1987) Comparative studies of the dorsal surface of the tongue in three mammalian species by scanning electron microscopy. *Acta anat.* 128: 140- 146.

Wassif: Lingual epithelium of *Chalcides ocellatus*

- Iwasaki S, Wanichanon C & Asami T (1996) Histological and ultrastructural study of the lingual epithelium of the juvenile Pacific ridley turtle, *Lepidochelys olivacea* (Chelonia, Cheloniidae). *Anat. Anz.* 178(3): 243-250.
- Kubota K & Kubota J (1963) New types of taste bud formation in human gustatory papillae. *Acta Biol., (Acta Universitatis Szegediensis)* 9: 195-206.
- Kullaa-Mikkonen A (1986) A scanning electron microscopic study of surface of human oral mucosa. *Scand. J. dent. Res.* 94: 50-56.
- Larochelle R & Martineau-Doize (1991) Distribution and histochemical characterization of goblet cells in the nasal cavity of piglets. *Am. J. Anat.* 191: 103-111.
- Lemell P, Beisser CJ & Weisgram J (2000) Morphology and function of the feeding apparatus of *Pelusios castaneus* (Chelonia; Pleurodira). *J. Morphol.* 244 (2): 127-135.
- Mazia D, Brewer PA & Alfert M (1953) The cytological staining and measurement of protein with mercuric bromophenol blue. *J Biol Bull* 104: 57-67.
- McDowell SB (1972) The evolution of tongue of snakes and its bearing on snake origins. In: T. Dobzhansky T. Hecht M & Street W (eds): Evolutionary Biology. Vol. 6: pp 191-273 Appleton Century Crofts, New York.
- Mohammed MBH (1987) Notes on the diets of some lizards in the state of Qatar. *Herpetological J.* 1: 157- 158.
- Mohammed MBH (1991a) Structure of the tongue in agamid reptiles: *Phrynocephalus arabicus* and *Uromastyx microlepis*. *J. Egypt. Ger. Soc. Zool.* 6(B): 265-288.
- Mohammed MBH (1991b) The structure of the tongue in certain Geckos (Gekkonidae: Reptilia). *J Egypt. Ger. Soc. Zool.* 6 (B): 289-314.
- Mohammed MBH (1992) Structure and function of the tongue and hyoid apparatus in *Acanthodactylus boskianus* (Lacertidae; Reptilia). *J. Egypt. Ger. Soc. Zool.* 7(B): 65-89.
- Mohammed BHM, Mohallal MH & Attia MNT (1998) The functional significance of lingual epithelium in some Geckos: histological and histochemical analysis. *J Egyp Ger. Soc. Zool.* 26(B): 75-90.
- Nasr AN (1997) Histochemistry. A theoretical and a practical approach. Assiut University press.
- Nishida Y, Yoshie S & Fujita T (2000) Oral sensory papillae, chemo- mecano-receptors, in the snake, *Elaphe quadrivirgata*. A light and electron microscopic study. *Arch. Histol. Cytol.* 63 (1): 55-70.
- Oelofsen BW & Van Den Heever JA (1979) Role of the tongue during olfaction in varanids and snakes. *S. Afr. J. Sci.* 75: 365- 366.
- Pianka ER (1986) Ecology and natural history of desert lizards. Princeton. NJ. Princeton Univ. Press.
- Rabinowitz T & Tandler B (1986) Papillary morphology of the tongue of the American Chameleon ; *Anolis carolinensis*. *Anat. Rec.* 216: (4): 483- 489.
- Roper SD (1989) The cell biology of the vertebrate taste receptors. *Ann. Rev. Neuroscr.* 12: 329-352.
- Schwenk K(1985) Occurrence, distribution and functional significance of taste buds in lizards. *Copeia* 1985 91-101.
- Schwenk K (1986) Morphology of the tongue in the Tuarata. *Sphenodon punctatus* (Reptilia: Lepidosauria), with comment on function and phylogeny. *J. Morphol.* 188: 129-159.
- Smith KK (1984) The use of the tongue and hyoid apparatus during feeding in lizards (*Ctenaura similis* and *Tupinambis nigropunctatus*). *J. Zool. (Lond.)* 202: 115-143.
- Sperry DG & Wassersug RJ (1976) A proposed function for microridges on epithelial cells. *Anat Rec.* 185: 253-258.
- Toubeau G, Cotman C & Bels V (1994) Morphological and kinematic study of the tongue and buccal cavity in the lizard. *Anguis fragilis* (Reptilia: Anguidae). *Anat. Rec.* 240: 423-433.
- Underwood G (1971) A modern appreciation of Camp's classification of the lizards. Introduction to reprint by Society for the study of Amphibians and Reptiles. Cited from Mohammed (1992).
- Wassif IT & El- Hawary MS (1998) Scanning Electron Microscopy of the Dorsal Lingual Epithelium of the Golden Lizard; *Eumeces schneideri* Reptilia: Scincidae). *J Egypt Ger Soc Zool.* 26 (c): 11-30.
- Winokur RM (1988) The buccopharyngeal mucosa of the turtles (Testudines). *J. Morphol.* 196: 33-52.

()

()

()