tropical sand lizard (Liolaemus lutzae) of southeastern Brazil. J. Herpetol. 26:17–23.


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Esophageal Papillae in Pelomedusid Turtles


Esophageal papillae were first noted in Dermochelys and Chelonia by Cuvier (1835) and are known to occur in all species of sea turtles (Parsons and Cameron, 1977; Bjornal, 1985). These papillae in sea turtles are conical, cornified, and project posteriorly. Sections of “esophageal spines” of Dermochelys reach 5.1 cm in length and have a surface layer of “heavily keratinized squamous epithelium, covering a core of loose myxomatous tissue” (Dunlap, 1955). The posterior orientation of the papillae suggests that they might function in food ingestion or limiting the regurgitation of food from the stomach due to changes in pressure while diving (Bleakney, 1965).

Parsons and Cameron (1977) presented a review of the internal relief of the digestive tract in Testudines, including eight families and 26 genera spanning both suborders. Fourteen of these genera they examined themselves, including Podocnemis expansa, without finding esophageal papillae in any species besides sea turtles. Winokur (1988), however, reported on the buccopharyngeal mucosa of 80 species of turtles in 12 families and found esophageal papillae resembling those of sea turtles in Carettochelys, Podocnemis expansa, and P. sextuberculata. These papillae were not keratinized, differing from those of sea turtles.

While examining turtles in the collection of the Museu de Zoologia de Sao Paulo, RCV noticed a complete circular rosette of large conical papillae partially occluding the esophagus of the pelomedusid turtle Peltocephalus dumerilii (Fig. 1). This suggested possible association with the peculiar feeding behavior, neustophobia, employed by Podocnemis unifilis (Belkin and Gans, 1968) and other species of Podocnemis (Rhodin et al., 1981). Possibly these structures are functionally important as filters to retain food particles while water is expelled during this feeding mechanism.

To determine the occurrence of esophageal papillae in neotropical side-necks, we dissected the esophagus of five species of Pelomedusidæ: Peltocephalus dumerilii, Podocnemis expansa, P. unifilis, P. tryphoncephala, and P. sextuberculata, and four species of Chelidæ: Phrynops raniceps, P. geoffroanus, Platemyx platycephala, and Chelus fimbriata. Preserved specimens were examined in the collection of the Museu de Zoologia de Sao Paulo, Brazil (MZUSP). Fresh specimens of the five species of Pelomedusidæ were also collected and examined in the Rio Trombetas and Rio Tapajós, Para, Brazil. Fresh specimens of Phrynops raniceps, P. geoffroanus, Platemyx platycephala, and Chelus fimbriata were
We removed the esophageal regions from an adult female of each *Podocnemis erythrocephala* (Instituto Nacional de Pesquisas do Amazonas-Herpetologia 1212) and *P. sextuberculata* (INPA-H 1405). We fixed these tissues in 10% neutral buffered formalin and prepared them histologically. We rinsed the tissue in distilled water, dehydrated in a graded series of ethanol, cleared in toluene, and embedded in paraffin. We cut transverse sections 10 mm thick on a rotary microtome and affixed to albuminized slides. Alternate slides were stained with hematoxylin-eosin (for general cytology), and alcian blue 8GX at pH 2.5 (AB, for primarily carboxylated glycosaminoglycans) followed by the periodic acid-Schiff's method without diastase (PAS, glycogen and other neutral carbohydrates and sialic acids). Procedures followed Kieman (1990).

Papillae were present in the esophageal regions as a rosette at one level (not spread throughout the esophagus as in *Dermatemys*) in all five species of Pelomedusidae but were absent in the Chelidae. Papillae were detected even in juveniles but are more pronounced in adults. The papillae were largest in the specimen of *Peltocephalus* examined, reaching a length of 12 mm each (Fig. 1).

Histologically, the esophageal mucosa consists of stratified, squamous epithelium (Fig. 2A). The epithelium is uncornified and was aglandular, although the apical borders have a slight positive reaction to both AB and PAS. The papillae are conical projections of the epithelium and underlying lamina propria, ex-
Fig. 2. Esophagus of *Podocnemis*. (A) Esophageal papilla of *P. erythrocephala*, stained with hematoxylin-eosin (HE). (B) Same as (A), but showing supporting tissue stained with alcian blue 8GX at pH 2.5 (AB). (C) Esophageal papilla of *P. sextuberculata*, stained AB+. (D) Superficial layers of the esophagus in *P. sextuberculata* in an interpapillary area, stained with HE. AB = supporting tissue staining AB+; BV = blood vessels; EP = mucosal epithelium; LP = lamina propria; LU = lumen; ME = muscularis externa; MM = muscularis mucosa; SM = submucosa; ST = supporting tissue stained with HE.
tending perpendicular from the esophageal wall. The lamina propria of the papillae consists of a mass of irregular collagen fibers in an AB+ matrix probably composed of a macromolecular mesh of proteoglycans and hyaluronic acid (Kierman, 1990; Fig. 2B, C). Associated with the lamina propria adjacent to the papillae are numerous blood vessels (Fig. 2D). Esophageal glands are absent. The muscularis mucosa consists primarily of longitudinal fibers (Fig. 2B, D). The submucosa is a thin highly vascular, but a glandular layer (Fig. 2D). Discrete layers are not apparent in the muscularis externa, and this region seems composed of a mixture of longitudinal and circular sheets of muscle fibers (Fig. 2D), no sphincter like structures were found. Skeletal muscle fibers, characteristic of the esophagus in many vertebrates, are lacking. The collagenous support of the papillae make them quite rigid projections into the esophagus. We are uncertain how the esophageal muscularis affect function of the papillae. The lack of a distinct circular muscle layer suggests that the lumen of the esophagus does not expand and contract sphincter-like, with papillae either filling or peripherally lining a variably sized lumen. In other words, they must always just be there. The few specimens available for histological examination and their condition precluded more extensive histological tests. We had no a priori reason to suspect that the papillar support consisted of connective tissue fibers in an AB+ matrix. In the future tests should examine the type of collagen fibers and other connective tissue fibers in the papillar supporting tissue.

The difference in the feeding behavior and type of food consumed by the pelomedusids and chelids examined (Fachin et al, 1995) suggest that the papillae function as a filter to retain ingested particulate matter, such as algae, small seeds, small invertebrates and periphyton, within the digestive tract when the turtles expel water during neustophagia. The chelids lack these papillae and feed primarily on whole animals: Chelus, fish; Phrynops raniceps, mollusks; Phrynops Geoffroanus, insects; and Platemyx platycephala, tadpoles. Esophageal papillae might not be useful in feeding on such bulky food items. It is unclear why the pelomedusid Peltocephalus dumerilinans should have such large papillae in that most of the food items found in the stomach contents of adults are large seeds, (RCV, unpublished data; Perez-Eman and Paolillo, 1997) but perhaps they are more functional in the feeding habits of juveniles which are not yet known. Future studies should video record these papillae while the turtles are feeding in an attempt to discover their exact function and to determine if the papillae are stationary or motile.

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LITERATURE CITED


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APPENDIX 1

Specimens examined, all from Brazil
Pelomedusidae: Peltocephalus dumerilinans MZUSP 2899, female, 500 mm CL, Rio Autas-Acu, AM; MZUSP 3117, sex ?, 175 mm CL, Rio Negro, AM. Podocnemis unifilis: MZUSP 2553, male, 235 mm CL, Rio Negro, AM. Podocnemis expansa MZUSP 2423, juv, 103 mm CL, Rio Branco, RO. Podocnemis sextuberculata: MZUSP 2470, female, 136 mm CL, Rio Januari, AM; INPA H 1405, female, 255 mm CL, Rio Tapajos, PA. Podocnemis erythrecephala MZUSP 2908, female, 242 mm CL, Rio Tupana, AM; INPA H 1212, female, 244 mm CL, Rio Tapajos, PA. Chelidae: Phrynops Geoffroanus: MZUSP 2667, female, 250 mm CL, Jales, SP.