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EGGTOOTH DEVELOPMENT AND MORPHOLOGY IN THE SIX-LINED RACERUNNER, *CNEMIDOPHORUS SEXLINEATUS* (SAURIA: TEIIDAE), USING SCANNING ELECTRON MICROSCOPY

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ABSTRACT

Eggtooth development and morphology in the six-lined racerunner, *Cnemidophorus sexlineatus,* were examined using scanning electron microscopy. The anlage of the embryonic eggtooth emerges from the anterior surface of the palate relatively late during embryonic development. The eggtooth proper erupts through an epithelial sheath and grows anteriorly to project beyond the rostral scale. The mature eggtooth is hollow, has a wall made of enamel and dentine, possesses a sharply-curved body and has a flattened, pointed tip. The eggtooth is shed within several days after the young hatch.

INTRODUCTION

The embryonic eggtooth of squamates (lizards and snakes) is a specialized, deciduous tooth found at the tip of the snout and is attached to the premaxillary bone. It is used to pierce, cut or break through the eggshell (or egg membranes) at the time of hatching or birth (Bellairs, 1970). Squamate eggteeth are similar to their regular teeth, except that they are much larger, are usually one in number (gekkonid lizards may have two) and are curved forward, projecting slightly away from the snout. Chelonians, crocodilians and birds lack a true embryonic egg tooth; however, they do possess a specialized horny, epidermal structure, the egg caruncle, which serves the same function as the eggtooth.

Fioroni (1962) provided the most comprehensive literature survey on the occurrence, structure and development of the reptilian eggtooth. Nearly all references he cited dealt with species outside the continental United States. The few exceptions included three snakes *(Crotalus atrox, Nerodia sipedon* and *Sistrurus catenatus)* as reported by Smith *et al.* (1953). Fioroni (1962) omitted a fourth snake *(Coluber constrictor)* as investigated by Weinland (1858). The only study describing eggtooth structure in the lizard genus *Cnemidophorus* was by Muller (1841). The present study addresses the chronological changes in lizard eggtooth development and structure in the six-lined racerunner, *Cnemidophorus sexlineatus,* using scanning electron microscopy (SEM). This work is the first to document embryonic eggtooth development for any North American lizard using SEM.

MATERIALS AND METHODS

Eggs of the six-lined racerunner, *Cnemidophorus sexlineatus,* were excavated (see excavation methods in Trauth [1983]) from nests buried in red clay roadside embankments along rural highways in Johnson and Madison counties, Arkansas, in July 1986. Over 100 eggs representing at least 25 egg clutches were collected. Each clutch numbered from one to five eggs, and these clutches yielded embryos in a variety of embryonic stages. In addition, hatchling lizards (32-35 mm in snout-vent length) were taken from burrow systems within the nesting habitats. Eggs and hatchlings were fixed in 10% formalin within 24 hr after collection and were later stored in 70% ethanol.

Embryos were dissected from their eggs, placed in separate vials and assigned a descriptive morphological stage following Dufaure and Hubert (1961). These stages, based upon developmental criteria rather than length of incubation time, provided a means of categorizing advancement in embryonic growth. Standard laboratory techniques were used to prepare tissues for SEM. Upper jaws of selected individuals were excised just anterior to the eyes; in more advanced specimens, the eggtooth was extracted with a pair of jeweler's forceps. All specimens were dehydrated in a graded series of ethanol and amyl acetate, dried with a Samdri critical point dryer, coated with gold/palladium in a Hummer IV sputter coater and viewed with a JEOL 100 CXII TEMSCAN electron microscope at an accelerating voltage of 40 kV.

RESULTS AND DISCUSSION

Eggtooth development and morphology in *C. sexlineatus* is shown in Fig. 1. The earliest observation of an eggtooth was in an embryo with a crown-to-rump length of 15 mm (Fig. 1A). This size roughly corresponds to Stage 36 in embryonic development (Dufaure and Hubert, 1961) and is characterized by the lack of body pigmentation and by little scale differentiation. At this stage, an anlage of the eggtooth bulges at the anterior terminus of the trabecula communis (de Beer, 1937). At Stage 37, the rapidly-growing eggtooth pushes from its medial position anteriorly toward the newly-formed rostral scale (Fig. 1B & C). The exposed body of the eggtooth now appears broad, and the lateral surfaces gradually taper to form an apex. The entire eggtooth is covered by an epithelial sheath. A terminal cap (Fig. 1B) is distinguishable from the main body of the eggtooth.

Eruption of the eggtooth proper begins in the region of the terminal cap as evidenced by a sloughing of the epithelium (Fig. 1D). This process exposes the tip of the eggtooth which may exhibit a serrated edge. As the embryo nears hatching (Stage 40), the mature eggtooth has shed most of its epithelial covering (Fig. 1E & I). Its exposed length is a little over twice its width. A rounded and relatively smooth tip was observed in most specimens; however, some specimens exhibited a lancet-like tip (Fig. 1I). In all cases, the eggtooth extends anterior to the rostral scale.

The destruction and subsequent loss of the eggtooth occurs within a few days after hatching (Fig. 1F & G). In Fig. 1F (from a hatchling 33 mm in snout-vent length), the eggtooth appears to have been sheared in half. Debris or possibly eggtooth material has accumulated around the remaining stump. Horizontal fracture lines are evident along the base of the stump. The rest of the eggtooth is discarded, perhaps, as hatchlings begin foraging for insects. The ventral edge of the rostral scale (Fig. 1G) will eventually assume a normal shape leaving no trace of the eggtooth.

The morphology of the extracted eggtooth is shown in Fig. 1H & I). The body is oval in cross section and has a hollow central cavity which extends into the flattened tip. The eggtooth wall is relatively thin and consists of two layers approximately equal in thickness. These layers are made of enamel (outer) and dentine (inner). Internally, the lining of the cavity is quite porous; a mat-like network of minute fibers lies on this surface. All mature eggteeth exhibit a curved body. The convex or exposed surface may flare along the lateral edges prior to the tip. Most of the concave surface (normally hidden from view, but evident in H & I) is covered by a thin layer of squamous epithelium.

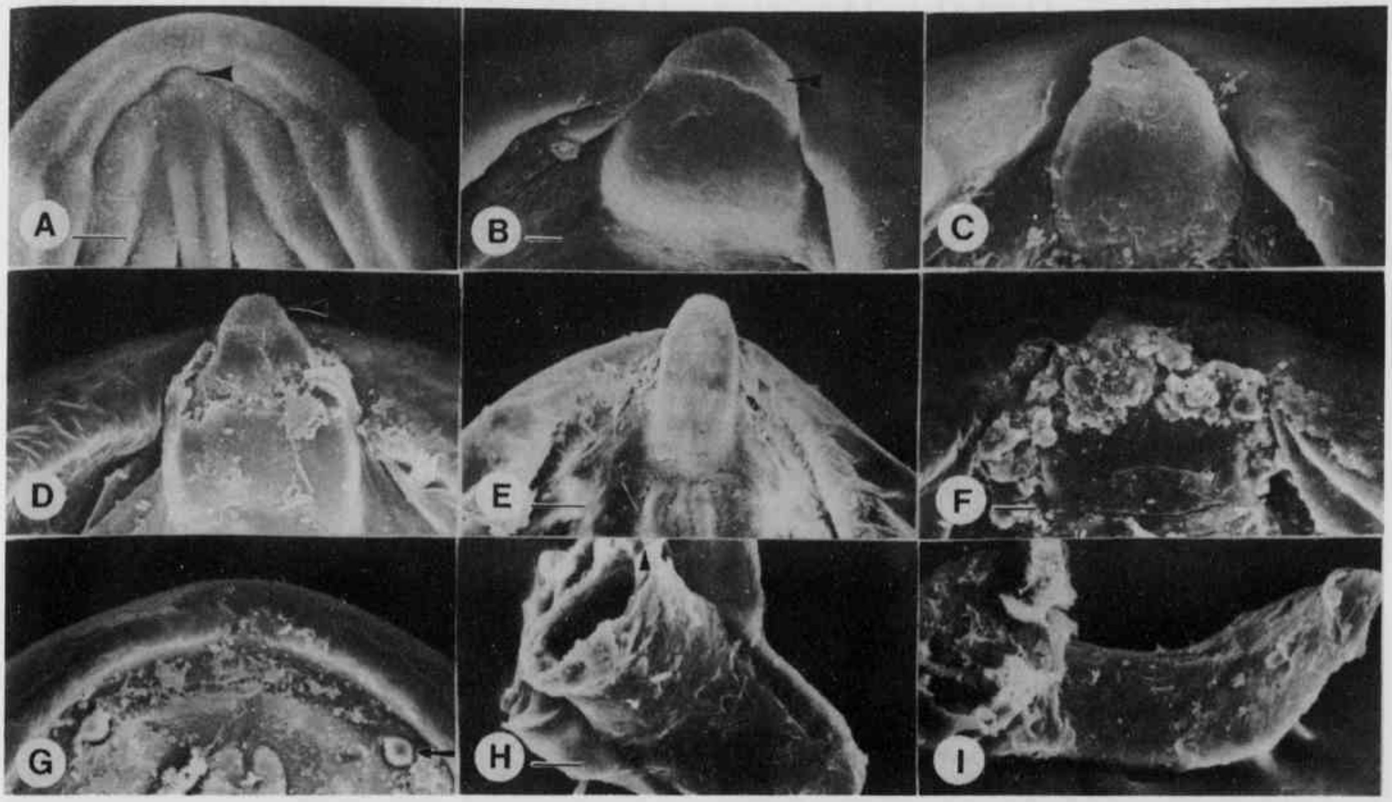

Figure 1. Scanning electron micrographs of eggtooth development and morphology in *Cnemidophorus sexlineatus*. A. Anterior region of the palate of an embryo (crown-to-rump length = 15 mm). Pointer denotes the initial appearance of the primordial eggtooth. Line = 100 μm. B. Magnification of eggtooth bud as it grows ventrally and pushes anteriorly. An epidermal cap (pointer) is separated from the body of the eggtooth by a transverse groove. Line = 50 μm for B - D. C. Eggtooth bud showing loosened epithelial cells in the region of the epidermal cap. D. Eruption of the eggtooth proper through the epithelial sheath. A serrated edge (pointer) is present at the tip of the eggtooth at this stage. E. Mature eggtooth of an embryo nearing hatching. Line = 100 μm for E & G. F. Destruction of the eggtooth following hatching. G. Morphology of the anterior palate of a hatchling following complete sloughing of the eggtooth. Notice the absence of any premaxillary teeth in the region of the lost eggtooth. Arrow points to the anteriormost left premaxillary tooth. H. Extracted mature eggtooth showing the hollow nature of the tooth. Pointer refers to the separation of the two layers of the eggtooth wall. Line = 50 μm for H & I. I. Right lateral view of mature eggtooth revealing the marked curvature of the body.

Early developmental structure of the eggtooth in *C. sexlineatus* is similar to the condition found in a European lacertid lizard *(Lacerta muralis)* as illustrated by Fioroni (1962). In both species the eggtooth eventually curves sharply forward and tapers to a point (as in Fig. 1I). These common features are not surprising as these lizards are closely related (Camp, 1923). Although some adult lizards may possess enlarged, medially-positioned premaxillary teeth (amphisbaenids and some agamids), which may or may not be a vestige of eggteeth (Santonja and Bons, 1972; Smith *et al.*, 1953), *C. sexlineatus* completely sheds the eggtooth following hatching. No premaxillary teeth ever replace or fill the gap occupied by the eggtooth.

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