

GENERAL NOTES

DENTAL ONTOGENY AND ADAPTATION IN *DIPHYLLA ECAUDATA*

The deciduous or lacteal dentition of the hairy-legged vampire bat, *Diphylla ecaudata*, has not been described, and like that of other vampire bats is incompletely known. Miller (1896) described and illustrated a partial milk dentition for *Desmodus rotundus*, but we have been unable to locate more recent descriptions of the milk dentition of any of the three genera of vampires. Several authors, including Allen (1896), Miller (1907), and de la Torre (1956), have contributed to our understanding of the form and function of the permanent dentition of these highly specialized sanguivores. The deciduous teeth of bats also are highly specialized structures, important to the young for clinging firmly to the nipples of the mother, but they do not resemble the permanent teeth. Based on study of six juvenile specimens of *D. ecaudata*, we were able to describe the basic dental ontogeny of the species and to comment on some aspects of dental adaptation.

Our two smallest and supposed youngest specimens have the deciduous dentitions described below. Notations of dentitions refer to a single side unless otherwise indicated. That of MVZ 130,963 (total length, 48 millimeters, mm; forearm length, 29.5 mm; greatest length of skull, 16.9 mm) has in the upper jaw two incisors, the canine, and one premolar, and in the lower jaw one incisor, the canine, and one premolar. The upper jaw of UMMZ 99,102 (forearm length, 29.7 mm; greatest length of skull, 17.9 mm) has two incisors, the canine, and no premolars, but two alveoli indicate loss of premolars subsequent to death. The lower jaw of the latter contains two incisors, the canine, and one premolar. The third specimen in our series, MMNH 12,075 (total length, 62 mm; forearm length, 34.5 mm; greatest length of skull, 18.4 mm; weight, 11.0 grams, g), has the following deciduous teeth: upper—two incisors, the canine, and two premolars; lower—one incisor, the canine, and one premolar. A fourth specimen (MMNH 12,316) retains both deciduous upper incisors whereas the fifth (MMNH 12,317) has only the second upper incisor. Measurements of these two specimens, respectively, are: total length, 60, 62 mm; length of forearm, 42.5, 44.9 mm; greatest length of skull, 19.5, 19.4 mm; weight, 14.8, 17.3 g. A sixth specimen (MMNH 12,315) in juvenile pelage is only slightly larger (total length, 69 mm; length of forearm, 49.5 mm; greatest length of skull, 21.1 mm; weight, 21.1 g), despite the fact that it has lost all deciduous teeth and has its full complement of permanent teeth.

The deciduous teeth appear to be situated tenuously on the labial edge of the upper and lower jaws. Their loss occurs simultaneously with the emergence of the permanent teeth, which erupt along the median axis of the jaws lingual to the deciduous teeth (Fig. 1). The apparent sequence for eruption of the permanent dentition is as follows: both lower and the first upper incisors; lower canine and first lower molar; upper canine, upper and lower first premolars, and first upper molar; second lower premolar and second lower molar; second upper incisor and second upper molar. The sequence for loss of the deciduous dentition appears to be as follows: second lower premolar (known for the deciduous set of related species but not seen in *Diphylla*); first lower incisor; second lower incisor; first upper and lower premolars; second upper premolar and lower canine; upper canine; first upper incisor; second upper incisor.

Both pair of deciduous upper incisors slant forward, then recurve sharply forming well-developed hooks. The two in each premaxilla are relatively close together, but at the alveoli they are separated widely from the other pair by the large, emerging permanent incisors. The first deciduous incisors are located at the posterior margins of the sharp-pointed permanent incisors. Their hooked tips are thereby in close proximity and functional even after surpassed in length by the permanent pair. *Diphylla* has two pair

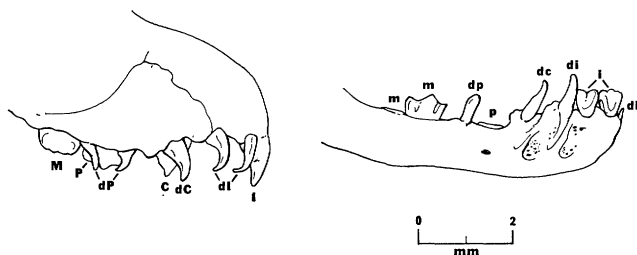


FIG. 1.—Line drawings of upper (MMNH 12,075) and lower (UMMZ 99,102) jaws of *Diphylla ecaudata* showing one stage of replacement of the deciduous by the permanent dentitions. Both specimens were drawn from an anterolabial perspective.

of permanent upper incisors; those of the second are small and emerge posterior to the second deciduous incisors.

Only one specimen (UMMZ 99102) retains the first lower deciduous incisors. These teeth are small, pointed, and situated at the anterior margin of the rami where they are separated only by the width of the mandibular symphysis. The deciduous second lower incisors, located along the labioposterior surface of the second incisor of the permanent set, are well-developed spicules comparable in size to the adjacent canines and show only the slightest indication of being hooked.

The permanent lower incisors are large and reach adult size early in life. Their rapid development probably is at least in part an adaptation that provides protection for the permanent upper incisors after they have emerged from the gingivae and before they receive much protection from the mandibular pits. Miller (1907) and Burt and Stirton (1961) noted the well-developed pits in the lower mandibles of adult vampire bats wherein the large pair of permanent incisors rest. These pits together with the characteristic underbite of vampires appear to be specializations that help protect the all-important upper incisors. Greenhall (1972) has suggested that the upper incisors of *Desmodus* are sharpened as they enter the pits. The incipient pits are barely visible in our youngest specimen, but deep and well developed in larger juveniles. In the largest juvenile of our sample they are indistinguishable from those of adults.

The morphology of the lower incisors of *Diphylla* contrasts markedly with that of *Desmodus*. In *Diphylla*, these teeth are broad, serrated, and lack a diastema. The lower incisors of *Desmodus* are sharp and bicuspidate; the anterior pair are separated by a distinct diastema. These morphological differences probably evolved concomitantly with the specialized feeding habits of the bats. Mammals are the primary source of blood for *Desmodus*, whereas *Diphylla* feeds primarily on birds (Vaughan, 1972). The lower canines and incisors play an important role when an incision is made (Storch, 1968; Schmidt and Manske, 1973). Skin of mammals generally is both thicker and of a firmer texture than that of birds. Thus, mammalian skin may be held most effectively by teeth having a few large and possibly penetrating cusps, whereas that of birds may best be held by teeth with a greater number of cusps making contact with the skin over a relatively greater surface area.

The deciduous canines slant forward and have terminal hooks. The uppers are slightly larger and more strongly developed than the lowers. Miller (1896) considered these teeth to be nonfunctional in *Desmodus* despite the fact they are similarly well developed in that species. We have not examined deciduous canines in specimens having intact gingivae, but nevertheless consider them to be functional in *Diphylla*.

Both deciduous upper premolars are small and directed anterolingually. The terminal hook is only slightly developed on the first and is absent from the second, which appears

not to function in attachment. The first is adjacent to the incoming premolar (P4) and the second emerges labial to the gap between P4 and M1. The single deciduous lower premolar present in our material is a simple, straight spicule situated beside the emerging permanent second premolar.

The lacteal teeth of most bats that have been examined number either 20 or 22, depending on the presence of either two or three lower incisors (Vaughan, 1970). Miller (1896) observed two lower deciduous premolars in *Desmodus*, but found only a single premolar in the upper jaw. He postulated the dental formula for the deciduous dentition to be $2/2, 1/1, 1/2 (2) = 18$, but later (1907) gave 20 as the probable number of deciduous teeth for that vampire. We found only a single lower premolar in *Diphylla*, but based on the presence of two in other phyllostomatids, including *Desmodus*, we postulate the existence of a second. Thus the formula for the deciduous dentition of *Diphylla ecaudata* appears to be $2/2, 1/1, 2/2 (2) = 20$. However, it must be noted that Phillips (1971) recently reported three upper deciduous premolars in *Glossophaga soricina* and *Choeronycteris mexicana*. He found a total of only 22 deciduous teeth, however, as both bats have two rather than three lower incisors. Phillips (1971) further postulated the same formula for *Leptonycteris*, noting that in *Glossophaga* the upper third premolar is the first deciduous premolar to be shed. Perhaps study of a more complete series of younger animals will reveal the presence of three upper (and possibly lower) premolars in most or all phyllostomatids, including the desmodontines.

Appreciation is expressed to John B. Bowles of Central College of Pella, Iowa, and Stephen L. Williams of Texas Tech University for assistance in collecting specimens in Yucatán. Field work was supported in part by funds made available to Birney from The Society of The Sigma Xi and from the College of Biological Sciences and the Graduate School, University of Minnesota. We acknowledge with special thanks the loan of specimens from the Museum of Vertebrate Zoology (MVZ), University of California at Berkeley, made available by James L. Patton, and from the Museum of Zoology (UMMZ), University of Michigan, made available by Emmet T. Hooper, who generously gave us permission to remove the skull from a specimen preserved in spirits. Carleton J. Phillips critically reviewed the manuscript, several drafts of which were typed by Carol Gobar.

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CLIFF CHIPMUNK VOCALIZATIONS AND THEIR RELEVANCE TO THE TAXONOMY OF COASTAL SONORAN CHIPMUNKS

Loomis and Stephens (1965) have described a chipmunk captured just north of Guaymas on the coast of Sonora, Mexico, as a cliff chipmunk, *Eutamias dorsalis dorsalis*. There are several reasons for reconsidering their assignment. First, we have found these coastal chipmunks only in very hot, dry, rocky situations—Lower Sonoran Zone desert mountains with no regular access to free water, riparian vegetation, or montane woodland. *E. dorsalis* has not been found before in such a habitat. Second, the nearest previous record of *E. dorsalis* is about 300 kilometers from the coast even though much of the habitat lying between seems suitable, especially for chipmunks able to survive in the Lower Sonoran Zone. Either these intervening habitats have not been adequately explored (but see Burt, 1938) or the coastal chipmunks are isolated. Third, directly across the Gulf in central Baja California is the isolated population of *E. merriami meridionalis* (see Hall and Kelson, 1959). These chipmunks are reported to occupy habitats similar to those on the Sonoran coast (Nelson, 1922; J. Callahan, personal communication). It is possible that the coastal Sonoran chipmunks have closer affinities to the Baja population than to *E. dorsalis* on the Mexican mainland. Fourth, *E. dorsalis* and *E. merriami* are sibling species, very difficult to distinguish by standard criteria. In addition to geographical and external morphological considerations, Loomis and Stephens (personal communication) used the morphology of the baculum in making their identification (based on White, 1953). However, with data presently available, this method is unreliable. Fifth, skull measurements made by R. Davis and R. Schwab (unpublished) show the coastal Sonoran chipmunks are in certain respects more similar to *E. merriami* from northern Baja California than to *E. dorsalis* from southern Arizona (the nearest populations for which sufficient numbers of specimens are available). In short, the taxonomic status of the coastal Sonoran chipmunks is in doubt. We have attempted to clarify this situation by using differences in the vocal behavior of *E. dorsalis* and *E. merriami* as additional taxonomic criteria.

We recorded chipmunk calls with a Uher 4000 Report-L tape recorder set at 7½ inches per second, a Uher M-514 microphone, and a 24-inch parabolic reflector. One or more sonagrams were made from each recording with the Kay Sona-Graph 6061 B set for wide band analysis. Frequency and time interval measurements were made from each sonagram to the nearest 0.5 kiloHertz (kHz) and 1 millisecond (msec), respectively. When harmonics were present, we measured only the dominant frequency (the dominant is not necessarily the fundamental). When there were two or more equally dominant harmonics (as in some terminal pulses), we measured the lowest one. Calling rates were computed by counting the number of calls in one or more 15 second segments chosen randomly from each recording.

All 22 recordings of *E. dorsalis* from southern Arizona were made in the Santa Catalina Mountains, Pima County, in August and September. Nine of these were made in pine forest of Rose Canyon at an elevation of 2100 meters (m), 12 were made in pine-oak