

# Fine Structure of the Dental Enamel in the Order Chiroptera from Colombia, South America

Alberto CADENA G.  
*Instituto de Ciencias Naturales,*  
*Universidad Nacional, Colombia*  
 and Yasuo NOGAMI  
*Primate Research Institute,*  
*Kyoto University, Japan*

## ABSTRACT

The dental enamel of bats was tentatively examined, mainly based on the living materials from Colombia, South America. The materials show primitive state of "nonserial" pattern, so far as examined. They are, however, changed exceedingly in thickness, likely fit for eating habits.

## INTRODUCTION

Primate Research Institute, Kyoto University, has sent several expeditions to South America since the fiscal year of 1976. Especially in Colombia, the geological and paleontological surveys were carried in close cooperation with National Institute of Geology and Mining, as well as with National University of Colombia, and resulted in obtaining many teeth of primates, bats, rodents and others from the middle Miocene Honda Formation. These fossils have been intensively studied and successively published in international journals.

The teeth of living bats have been morphologically examined, in immediate connection with those of fossil bats. The dental enamel and its fine structure have been tested, in order to deduce phylogenic, taxonomical and ecological aspects of the fossils obtained. The results will be tentatively discussed in this report.

## MATERIALS AND METHODS

The dental enamel of the living bats obtained in Colombia was tentatively examined. Nomenclature and classification follow KOOPMAN (1984). The Family Phyllostomidae are represented by five subfamilies in Colombia. Each subfamily was stood by a typical species, so far as possible: the Subfamily Phyllostominae by *Phyllostomus hastatus*, Glossophaginae by *Glossophaga soricina*, Carollinae by *Carollia perspicillata*, Stenoderminae by *Artibeus lituratus* as well as by *Sturnira lilium*, Desmodontinae by *Desmodus rotundus*. Other families were also based on a typical species: the Family Emballonuridae on *Saccopteryx bilineata*, Noctilionidae on *Noctilio albiventris*, Mormoopidae on *Mormoops megalophylla*, Natalidae on *Natalus tumidirostris*, Thyropteridae on *Thyroptera tricolor*, Vespertilionidae on *Eptesicus fuscus*, Molossidae on *Molossus molossus*. For comparison, *Pteropus vampyrus* was selected from the Family Pteropodidae belonging to the Suborder Megachiroptera.

All teeth of *Artibeus lituratus* were examined, and a lower first incisor, lower second incisor and lower canine of *Pteropus vampyrus* were tested for comparison, but concerning other species an upper canine was limited. Almost all teeth were labio-lingually cut through the tip and pulp cavity, as accurately in orientation as possible, and only a few mesio-distally through the paracone and metacone. The cut surface of tooth was carefully polished by fine alumina and diamond paste, slightly etched by diluted hydrochloric acid, coated with gold for scanning electronic microscopy.

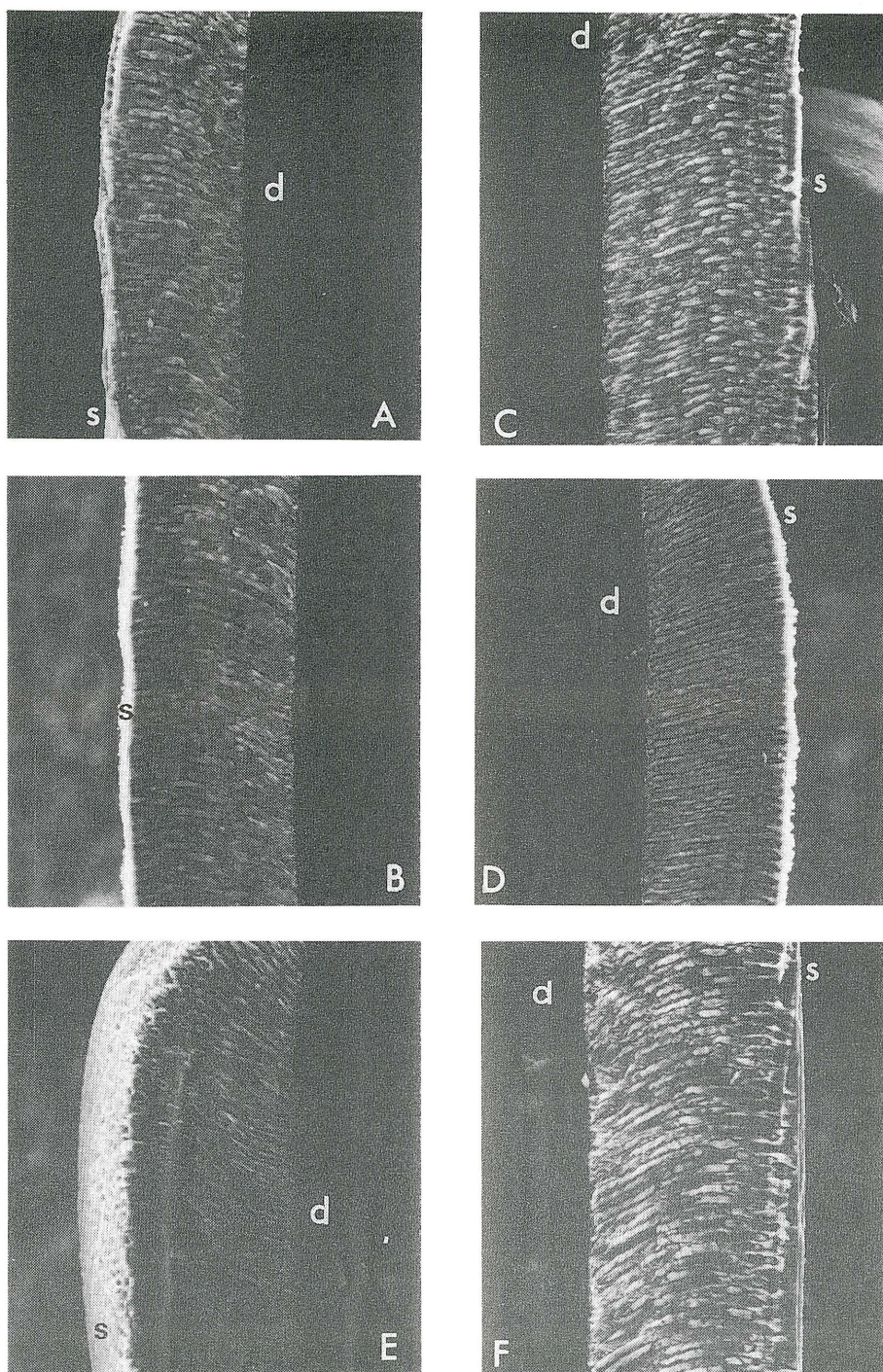
The materials obtained and examined in this work are listed in Table 1.

**Table 1.** List of materials obtained and examined

| Species                       | Reg. No. | Teeth                                        | Figure      | Enamel       | Classification   |
|-------------------------------|----------|----------------------------------------------|-------------|--------------|------------------|
|                               |          |                                              |             |              | Microchiroptera  |
|                               |          |                                              |             |              | Phyllostomidae   |
| <i>Phyllostomus hastatus</i>  | ICN 6970 | $\overline{C}$                               | Fig. 2 A    | rather thick | Phyllostominae   |
| <i>Glossophaga soricina</i>   | ICN 5944 | $\overline{C}$                               | Fig. 3 D    | very thin    | Glossophaginae   |
| <i>Carollia perspicillata</i> | ICN 7676 | $\overline{C}$                               | Fig. 2 E    | moderate     | Carollinae       |
| <i>Artibeus lituratus</i>     | ICN 2205 | $\overline{C}$                               |             | rather thick | Stenoderminae    |
| <i>Artibeus lituratus</i>     | ICN 0042 | all teeth                                    | Fig. 1      | rather thick | Stenoderminae    |
| <i>Sturnira lilium</i>        | ICN 5317 | $\overline{C}$                               | Fig. 2 D    | moderate     | Stenoderminae    |
| <i>Desmodus rotundus</i>      | ICN 6683 | $\overline{C}$                               | Fig. 2 B, C | rudimentary  | Desmodontinae    |
| <i>Saccopteryx billineata</i> | ICN 5872 | $\overline{C}$                               | Fig. 3 B    | rather thick | Emballonuridae   |
| <i>Noctilio albiventris</i>   | ICN 6936 | $\overline{C}$                               | Fig. 3 A    | rather thick | Noctilionidae    |
| <i>Mormoops megalophylla</i>  | ICN 2293 | $\overline{C}$                               | Fig. 3 C    | very thin    | Mormoopidae      |
| <i>Natalus tumidirostris</i>  | ICN 8650 | $\overline{C}$                               |             | rather thick | Natalidae        |
| <i>Natalus tumidirostris</i>  | ICN 9065 | $\overline{C}$                               |             | rather thick | Natalidae        |
| <i>Thyroptera tricolor</i>    | ICN 7724 | $\overline{C}$                               | Fig. 3 E    | very thin    | Thyropteridae    |
| <i>Eptesicus fuscus</i>       | ICN 4505 | $\overline{C}$                               | Fig. 4 A    | rather thick | Vespertilionidae |
| <i>Molossus molossus</i>      | ICN 8535 | $\overline{C}$                               | Fig. 4 B    | moderate     | Molossidae       |
| <i>Pteropus vampyrus</i>      | PRI 0945 | I <sub>1</sub> I <sub>2</sub> $\overline{C}$ | Fig. 4 C-E  | rather thick | Pteropodidae     |
|                               |          |                                              |             |              | Magachiroptera   |

I: incisor; C: canine; under line: lower; over line: upper; ICN: instituto de Ciencias Naturales, Universidad Nacional, Colombia; PRI: Primate Research Institute, Kyoto University

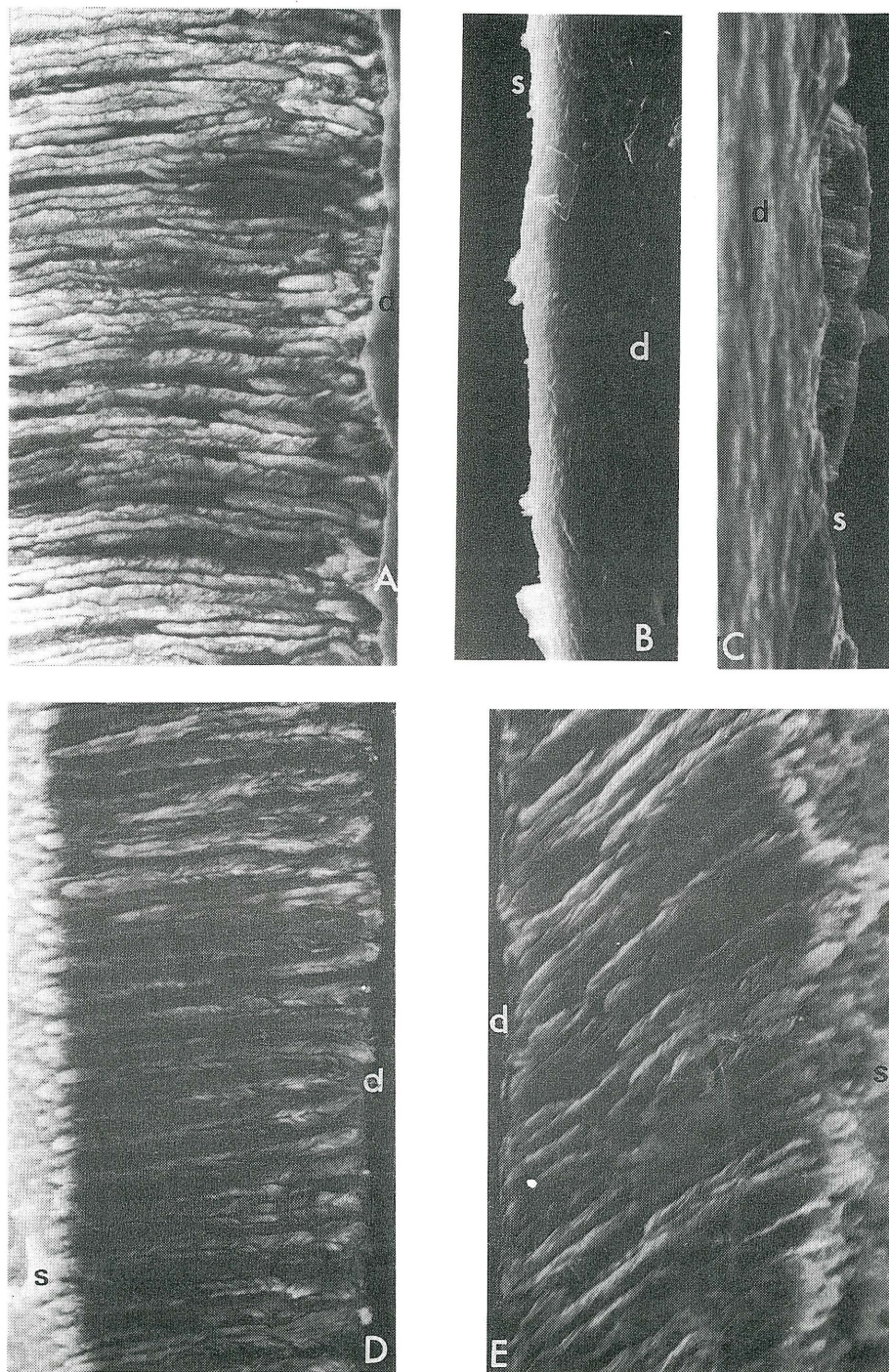




**Figure 1** Parts of the dental enamel in sections through teeth of *Artibeus lituratus*. Tip and root situated upward and downward, respectively; d: dentin; s: surface of tooth; all  $\times$  about 300.

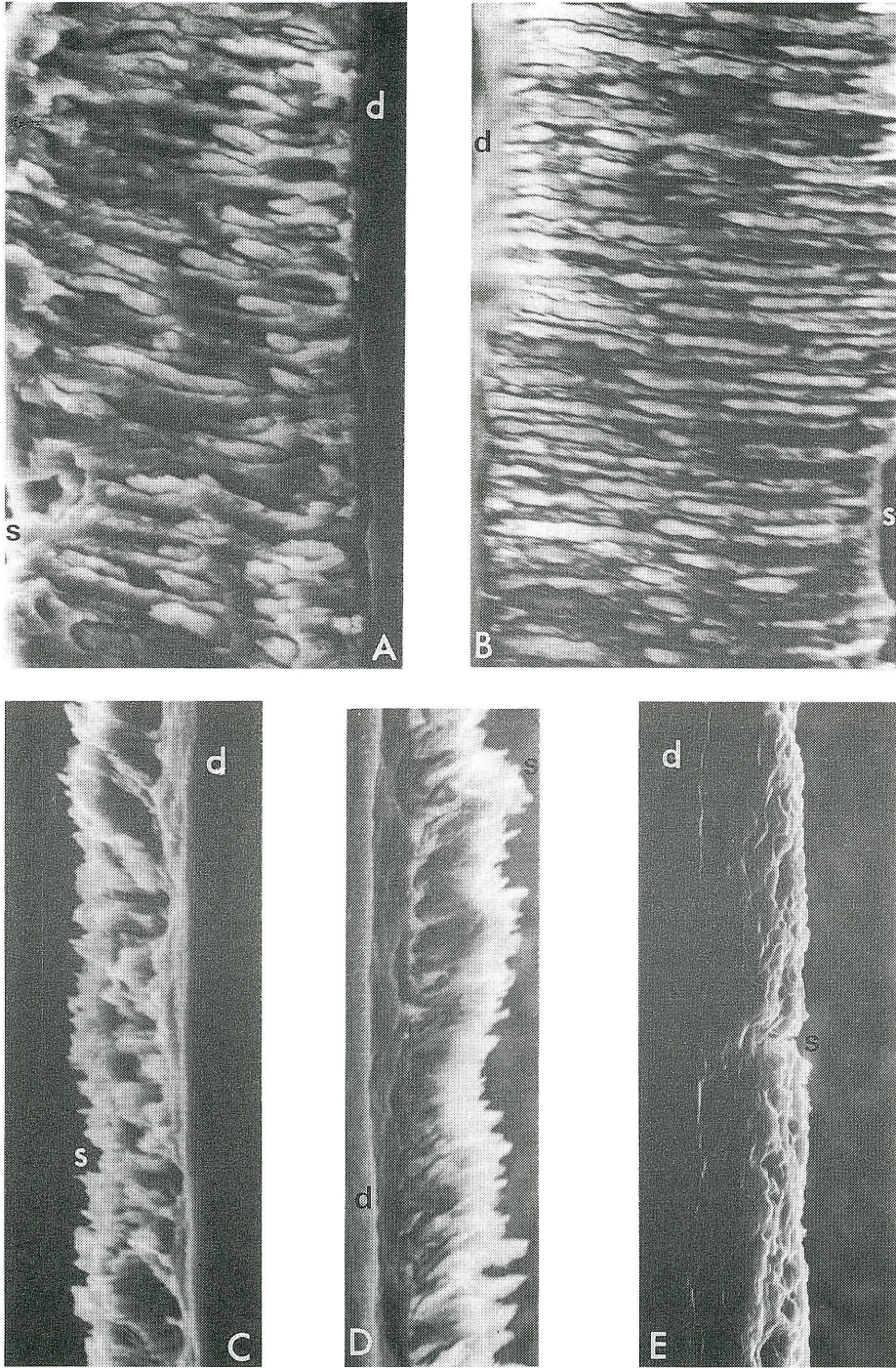
A. Labial side in labio-lingual section through upper first incisor; B. Labial side in labio-lingual section through upper canine; C. Labial side of the paracone in mesio-distal section through upper fourth premolar; D. Labial side of the paracone in mesio-distal section through upper second molar; E. Labial side in labio-lingual section through lower canine; F. Labial side of the paracone in mesio-distal section through lower fourth premolar.





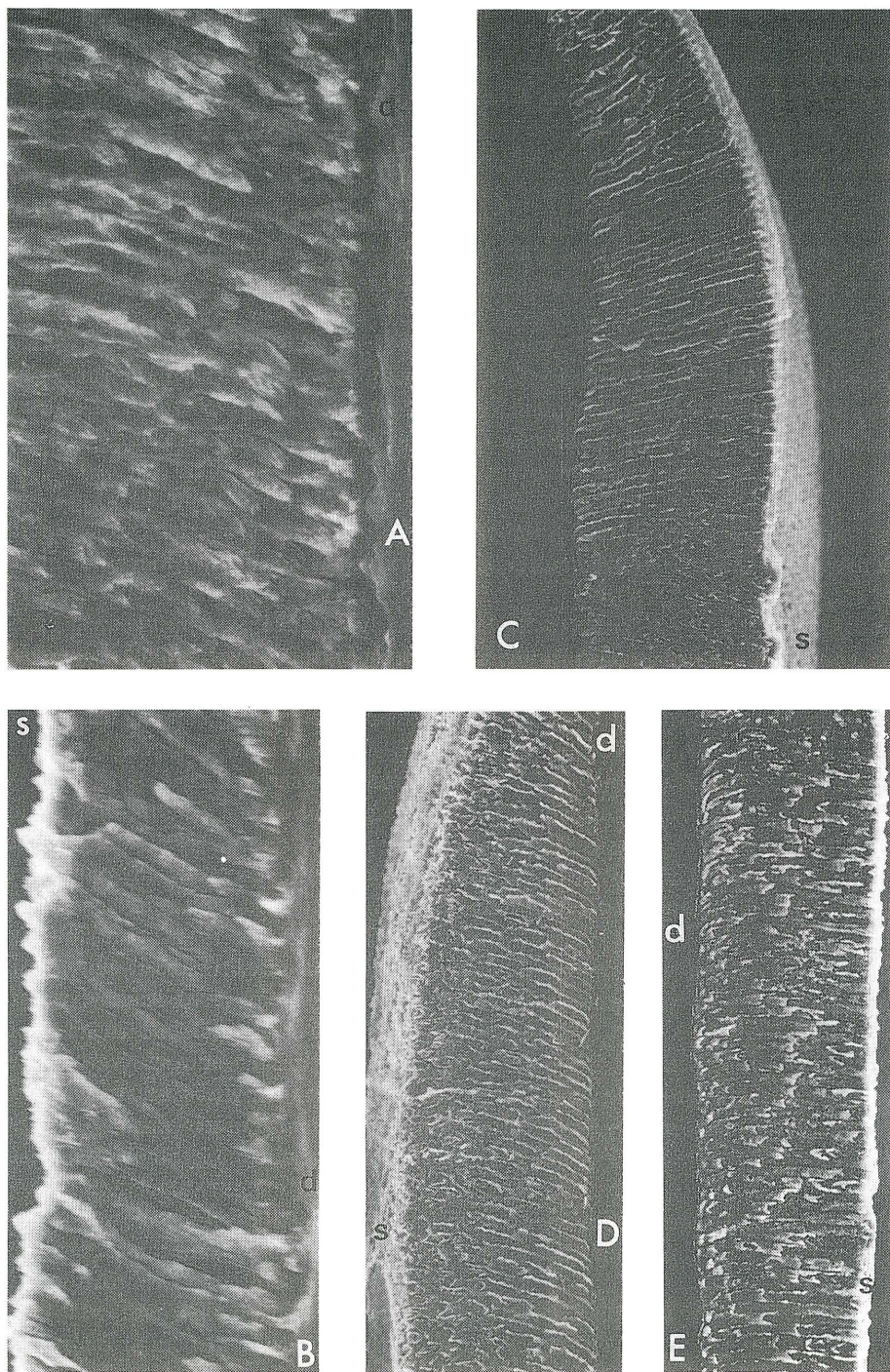
**Figure 2** Parts of the dental enamel in labio-lingual sections through upper canine. Tip and root situated upward and downward, respectively; d: dentin; s: surface of tooth; all  $\times$  about 1,000.  
 A. *Phyllostomus hastatus*, labial side; B and C. *Desmodus rotundus*, lingual side and labial, respectively; D. *Sturnira lilium*, labial side; E. *Carollia perspicillata*, labial side.





**Figure 3.** Parts of the dental enamel in labio-lingual sections through upper canine. Tip and root situated upward and downward, respectively; d: dentin; s: surface of tooth; all  $\times$  about 1,000. A. *Noctilio albiventris*, labial side; B. *Saccopteryx bilineata*, lingual side; C. *Mormoops megalophylla*, labial side; D. *Glossophaga soricina*, lingual side; E. *Thyroptera tricolor*, lingual side.





**Figure 4.** Parts of the dental enamel in labio-lingual sections. Tip and root of tooth situated upward and downward, respectively; d: dentin; s: surface of tooth. A. *Eptesicus fuscus*, upper canine, labial side,  $\times$  about 1,000; B. *Molossus molossus*, upper canine, labial side,  $\times$  about 1,000; C to E. *Pteropus vampyrus*, labial side through lower first incisor, labial and lingual side through lower canine, respectively; all  $\times$  about 300.



## OBSERVATIONS

*Artibeus lituratus* (OLFERS, 1818), Fig. 1 A to 1 F

Based on many sections through all teeth from an individual, and also on section through upper canine from another. Labial sides near tip of upper first incisor, canine, fourth premolar, second molar, lower canine and fourth premolar illustrated partly. Enamel rather thick to moderate at both labial and lingual sides.

Prism rods almost straight to slightly convex toward tip, regularly arranged in labio-lingual plane, and not folded in mesio-distal direction at all. Accordingly, any conspicuous minor structure is not observed throughout the length and width of both labial and lingual enamel.

As shown in Fig. 1, no essential difference is confirmed among all teeth, so far as the minor structure of the enamel is concerned. Therefore, other species were represented by a single upper canine, except for some special cases.

*Phyllostomus hastatus* (PALLAS, 1767), Fig. 2 A

Labial side illustrated partly. Enamel rather thick to moderate at both labial and lingual sides. Enamel rods almost vertical to enamel-dentin junction, slightly folded in labio-lingual plane, but fairly zigzagged near tip. Accordingly, at lower magnification of microscope the enamel is to be observed, as if it were partly provided with SCHREGER's bands.

*Glossophaga soricina* (PALLAS, 1766), Fig. 3 D

Lingual side illustrated partly. Enamel very thin at both sides. Enamel rods straight and regularly inclined toward tip. No characteristic minor structure observed throughout the length and width of both sides of enamel.

*Carollia perspicillata* (LINNAEUS, 1758), Fig. 2 E

Labial side illustrated partly. Enamel thickness moderate at labial side, and moderate to thin at lingual side. Enamel rods almost straight, rather strongly inclined toward tip, and not twisted in both labio-lingual and mesio-distal directions. No conspicuous minor structure present.

*Sturnira lilium* (E. GEOFFROY, 1810), Fig. 2 D

Labial side illustrated partly. Enamel thickness moderate at both labial and lingual sides. Enamel rods almost straight and vertical to enamel-dentin junction, showing the most simple "nonserial" pattern.

*Desmodus rotundus* (E. GEOFFROY, 1810), Fig. 2 B and C

Labial and lingual sides illustrated partly. Enamel only rudimentarily present at both sides.

*Saccopteryx bilineata* (TEMMINICK, 1838), Fig. 3 B

Lingual side illustrated partly. Enamel rather thick to moderate at both sides. Enamel rods almost straight, vertical to enamel-dentin junction to slightly inclined toward tip, and not folded in labio-lingual and mesio-distal directions.

*Noctilio albiventris* DESMAREST, 1818, Fig. 3 A

Labial side illustrated partly. Enamel rather thick to moderate at both sides. Enamel rods almost vertical to enamel-dentin junction to fairly inclined toward tip, and rarely folded in labio-lingual and mesio-distal directions.

*Mormoops megalophylla* (PETERS, 1864), Fig. 3 C

Labial side illustrated partly. Enamel very thin at both sides. Enamel rods straight and regularly inclined toward tip. No conspicuous minor structure present at all.

*Natalus tumidirostris* MILLER, 1900

Represented by two labio-lingual sections through upper canines from two individuals. Enamel rather thick to moderate at both sides.

*Eptesicus fuscus* (BEAUVOIS, 1796), Fig. 4 A

Labial side illustrated partly. Enamel rather thick to moderate at both sides. Enamel rods almost straight, more or less inclined toward tip, and not folded at all.

*Molossus molossus* E. GEOFFROY, 1855, Fig. 4 B

Lingual side illustrated partly. Enamel moderate to thin at both sides. Enamel rods almost



straight, more or less inclined toward tip, and not folded at all.

*Pteropus vampyrus* (LINNAEUS, 1758), Fig. 4 C to E

Eased on three labio-lingual sections through lower first incisor, second incisor and canine from an individual. Enamel rods almost straight to slightly convex toward tip, more or less inclined toward tip to nearly vertical to enamel-dentin junction, and scarcely folded in labio-lingual and mesio-distal directions. Accordingly, no conspicuous minor structure observed throughout the length and width of both sides.

## RESULTS AND DISCUSSION

All materials examined are classified into three groups, concerning the developed degree of the enamel. *Phyllostomus hastatus*, *Carollia perspicillata*, *Artibeus lituratus*, *Sturnira lilium*, *Saccopteryx bilineata*, *Noctilio albiventris*, *Natalus tumidirostris*, *Eptesicus fuscus*, *Molossus molossus* as well as *Pteropus vampyrus* are belonging to the first group, in which the canine is more or less round in cross section, and provided with rather thick to moderate enamel at both labial and lingual sides.

*Glossophaga soricina*, *Mormoops megalophylla* and *Thyroptera tricolor* are belonging to the second group, in which the canine is mesio-distally compressed, and provided with very thin enamel at both sides. On the other hand, *Desmodus rotundus* is so remarkably specialized that the canine is strongly compressed mesio-distally, and that the enamel of the canine is only rudimentarily retained at both sides. Accordingly, the neck of the canine is not swollen at all. These features might be reflected by feeding habits, as mentioned later.

In the first group, *Phyllostomus hastatus* and *Noctilio albiventris* are slightly different from other species. The enamel of both named species is a little thicker than that of other species. The enamel rods of both species are faint folded in the labio-lingual plane, as well as in the mesio-distal direction, as shown in Fig. 2 A and Fig. 3 A. While those of other species are more or less strongly inclined, or weakly convex toward the tip, but not folded at all. These differences seem to be effected by the thickness of the enamel.

The Family Phyllostomidae are widely diversified in general characters and habits. The enamel of the canine is also variable from one extreme to another, so far as examined. An insectivorous species, *Phyllostomus hastatus*, has relatively thick enamel, of which the rods are faint folded, especially near the tip. *Carollia perspicillata*, *Artibeus lituratus* and *Sturnira lilium* are mainly frugivorous. They have rather thick to moderate enamel at both labial and lingual sides, and the rods remain still as the most simple state of the "nonserial" pattern. *Glossophaga soricina* is nectivorous and has very thin enamel at both sides, of which the rods are regularly inclined toward the tip and not folded at all, as shown in Fig. 3 D. According to some specialists, the enamel of a sanguivorous bat, *Desmodus rotundus*, is extremely thin at the labial side, but perfectly lost at the lingual side. Fig. 2 B shows clearly, however, the presence of the enamel, although the labio-lingual section through the canine was slightly etched by diluted hydrochloric acid. 20 to 50 micron thick enamel could not be usually confirmed by normal binocular microscope, because of its transparency. In the near future, another canine will be examined in detail, being embedded in plastic material prior to the treatment adapted in this work.

## REFERENCES

- HONACKI, J. H., K. E. KINMAN, & J. W. KOEPL, 1982. Mammalian Species of the World. Assoc. Syst. Collections, Lawrence, pp. ix + 694.  
 KOOPMAN, K. F., 1984. Bats. In: Orders and Families of Recent Mammals of the World. S. ANDERSON & J. K. JONES, Jr. (eds.), John Wiley & Sons, New York, pp. 145-186.