

From: The Biological Station of the University of Oslo, Dröbak, Norway.

**THE TEETH OF *ALLIGATOR*  
*MISSISSIPPIENSIS* DAUD  
VII. REPLICA STUDY OF THE ENAMEL\***

*by*

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In an earlier paper (*Kvam*, 1959) the morphology of the alligator enamel was studied in ground sections. The method of studying metal-shadowed collodion replicas of ground surfaces, originally introduced for use in electron microscopy, has been shown to be of value in optical microscopy as well (*Scott & Wyckoff*, 1947). It is utilized in this investigation in a further study of the alligator enamel.

**MATERIAL AND METHODS**

For this investigation teeth from adult animals living in captivity were used. The teeth were shed in the alligator pool and collected from the mud at the bottom when the pool was cleaned. Most of the teeth had been kept dry for a varying length of time, but some were taken directly from the water when the work started. The teeth were fixed in 4 per cent neutral formaldehyd for two years or more.

As the teeth are small and the enamel layer very thin, the teeth had to be embedded in a suitable material to get a larger working surface after the grinding.

The teeth were dehydrated in absolute alcohol and xylene and

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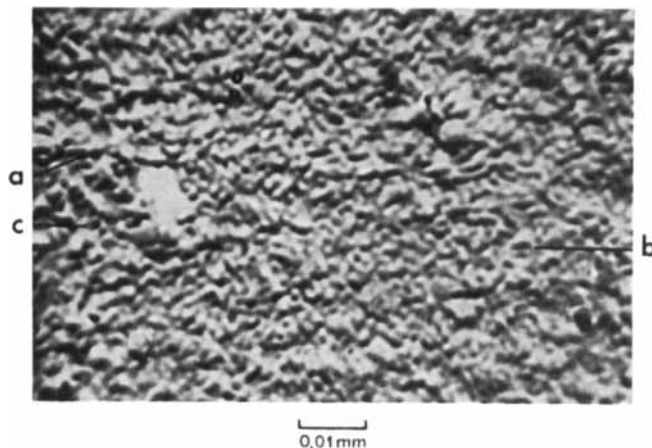


Fig. 1. Replica from longitudinal section.  
 a, longitudinal section of fiber; b, oblique section of fiber;  
 c, transverse section of fiber.

kept in Beetle Polyester Resin 4116\* for several days. Each tooth was then embedded in the resin to which was added the prescribed quantity of accelerator and catalyst. Rectangular boxes of thin aluminum were used for this procedure. The specimens were left for two days at room temperature and the hardening of the blocks was finished in another two days in an incubator at 50° C.

The embedded teeth were ground to the desired level with abrasive wheels under running water, followed by rough polishing on a lap covered with carborundum of increasingly finer grit, and final polishing on cloth with Magnesia Usta (MgO) and magnetic rouge in water.

The polished sections were etched for 5 seconds with 1/10 N HCl.

Replicas were taken by covering the sections with a collodion solution and stripping off the films after drying.

The replicas were shadowcast in vacuum with gold at an angle  $\alpha$ , with  $\text{tg } \alpha = 0.5$ . The thickness of the gold layer was of the order of 100 Å.

\* Manufactured by British Industrial Plastics Ltd., Tat Bank House, Oldbury, England.

## OBSERVATIONS

In longitudinal sections of the tooth, the enamel is traversed by fibers running more or less perpendicularly from the dentino-enamel junction to the surface of the tooth. The individual fibers can ordinarily be followed only for a short distance and they are in most cases undulated (Figs. 1 a and 2 a), often only a very short line is seen (Figs. 1 b and 2 c), and frequently circular points come to sight (Figs. 1 c and 2 d). Sometimes, however, one of the fibers can be traced more or less unbroken through the whole thickness of the enamel (Fig. 2 b). In a few cases a

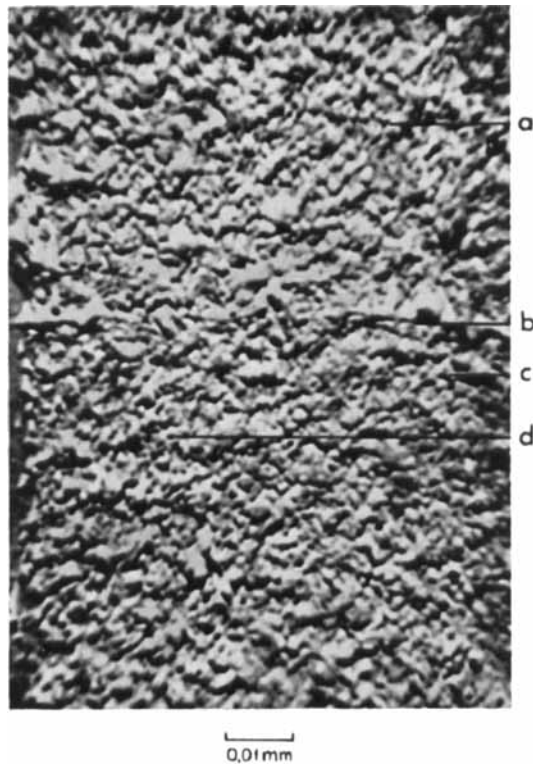


Fig 2. Replica from longitudinal section.

a, longitudinal section of fiber; b, fiber traceable through the whole enamel layer; c, oblique section of fiber; d, transverse section of fiber.

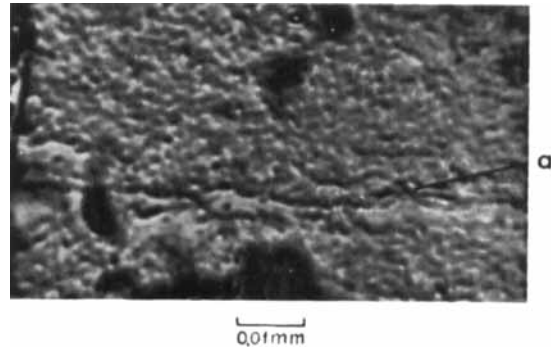


Fig. 3. Replica from longitudinal section.  
a, parallel fibers traceable through most of the enamel layer.

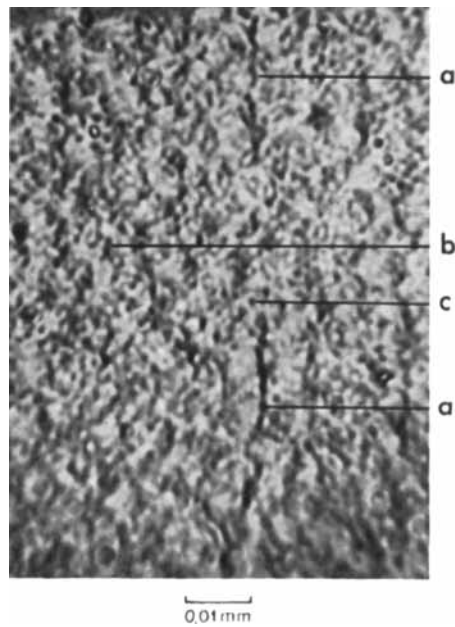


Fig. 4. Replica from transverse section.  
a, fiber traceable through the greater part of the enamel; b, oblique section of fiber; c, transverse section of fiber.

small bunch of two or three fibers can be seen running through most of the enamel layer (Fig. 3 a).

In a transverse section of a tooth, fibers are likewise seen in the enamel running in a main direction from the dentino-enamel junction to the surface of the tooth. Some of the fibers can be

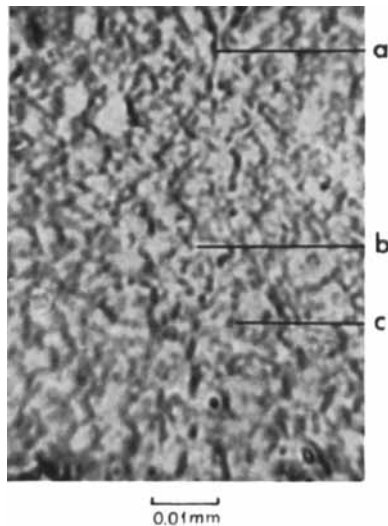


Fig. 5. Replica from transverse section.  
a, longitudinal section of fiber; b, oblique section of fiber;  
c, transverse section of fiber.

followed through the greater part of the enamel layer (Fig. 4 a), most of them appear as short (Fig. 5 a) or very short lines (Figs. 4 b and 5 b). Some of the fibers are even seen as circular points (Figs. 4 c and 5 c).

An attempt was also made of obtaining sections tangentially through the enamel layer (Fig. 6). The fibers in these sections too had a main direction with some fiber strokes visible through most of the section (Fig. 6 a). The greatest part of the fibers, however, deviated to some extent from this direction, and some of them ran almost perpendicular to it (Fig. 6 b). The length of the visible fibers varied also to a great extent in these sections.

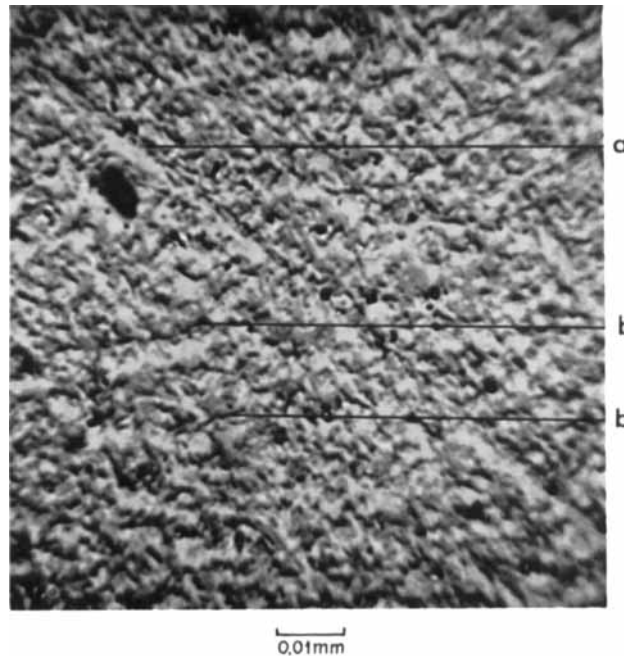


Fig. 6. Replica from tangential section.  
a, fibers traceable through most of the enamel layer;  
b, fibers deviating from the main direction.

#### DISCUSSION

The structural details are brought out on the polished section by etching it with dilute acid, whereupon the parts being little or not at all calcified stand out in contrast to the more strongly calcified parts. This shows that the alligator enamel is built up of uncalcified or weakly calcified fibers surrounded by a strongly calcified interfibrillar substance.

The main direction of the fibers is from the dentino-enamel junction to the surface of the tooth. It is, however, only in few instances that a fiber or a small bunch of fibers can be followed through most of the enamel layer (Figs. 2 b, 3 a, 4 a and 6 a) and thus seem to take this straight course. In all other cases where only a piece of the fiber, longer (Figs. 1 a, 2 a and 5 a),

shorter (Figs. 1 b, 2 c, 4 b and 5 b) or even dot-formed (Figs. 1 c, 2 d, 4 c and 5 c) is seen, the fibers are cut in the sections longitudinally, obliquely or transversely as they take directions deviating to a greater or lesser extent from the main course. These observations indicate that the fibers do not run parallel to each other, but that they probably wind and twist around each other in their main course through the enamel.

The fibers which can be followed almost unbroken through the enamel layer (Figs. 2 b and 4 a) and specially where bundles of such fibers (Fig. 3 a) are seen, may be the lamellae-like structures which are so often observed in ground sections of alligator enamel. The frequency and coarseness of these structures in ground sections make it likely that many of them are cracks having arisen during preparation of the material.

The incremental lines which are a general finding in the enamel in all ground sections of alligator teeth, were not found in the replicas. The assumption set forth in the ground section study (*Kvam, 1959*) that the incremental lines come into existence by variations in the degree of calcification does not, therefore, seem to hold true.

#### ACKNOWLEDGEMENT

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#### SUMMARY

The dental enamel in *Alligator mississippiensis* Daud is composed of uncalcified or weakly calcified fibers and a strongly calcified interfibrillar substance. The fibers run in a main direction from the dentino-enamel junction to the surface of the tooth. Most of the fibers wind and twist during their course through the enamel, but some go straight through, single or in bundles, forming lamellae-like structures. The incremental lines are not formed by variations in the degree of calcification.

## RÉSUMÉ

LES DENTS DE L'*ALLIGATOR MISSISSIPPIENSIS* DAUD  
VII. ÉTUDE SUR L'ÉMAIL AU MOYEN DE RÉPLIQUES

L'émail dentaire chez *Alligator mississippiensis* Daud est formé de fibres non calcifiées ou faiblement calcifiées et d'une substance interfibrillaire fortement calcifiée. Les fibres sont orientées dans une direction principale depuis la jonction dentine-émail jusqu'à la surface de la dent. La plupart des fibres traversent l'émail en ondulant et en spirales, mais quelques unes le traversent d'une façon rectiligne, isolées ou en faisceaux, formant des structures ressemblant à des lamelles. Les lignes de croissance ne sont pas formées par des variations dans le degré de calcification.

## ZUSAMMENFASSUNG

DIE ZÄHNE BEIM *ALLIGATOR MISSISSIPPIENSIS* DAUD  
VII. REPLIKA-UNTERSUCHUNGEN DES ZAHNSCHMELZES

Beim *Alligator mississippiensis* Daud besteht der Zahnschmelz aus nicht-mineralisierten Fasern und einer stark mineralisierten interfibrillären Substanz. Die Fasern verlaufen hauptsächlich in Richtung von der Dentin/Schmelzgrenze bis zur Oberfläche des Zahns. Die meisten der Fasern winden sich während ihres Verlaufes durch den Schmelz, aber einige gehen gerade durch, einzeln oder in Bündeln, ein lamellenartiges Gefüge bildend. Die Wachstumslinien sind nicht auf Schwankungen des Mineralisationsgrades zurückzuführen.

## REFERENCES

- Kvam, T., 1959: The teeth of *Alligator mississippiensis* Daud. V. Morphology of the enamel. Acta odont. scand. 17: 45.  
Scott, D. B. & R. G. Wyckoff, 1947: Shadowed replicas of ground sections through teeth. Publ. Hlth. Rep. (Wash.) 62: 422.

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