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Tooth replacement in *Eusthenopteron* and *Ichthyostega*

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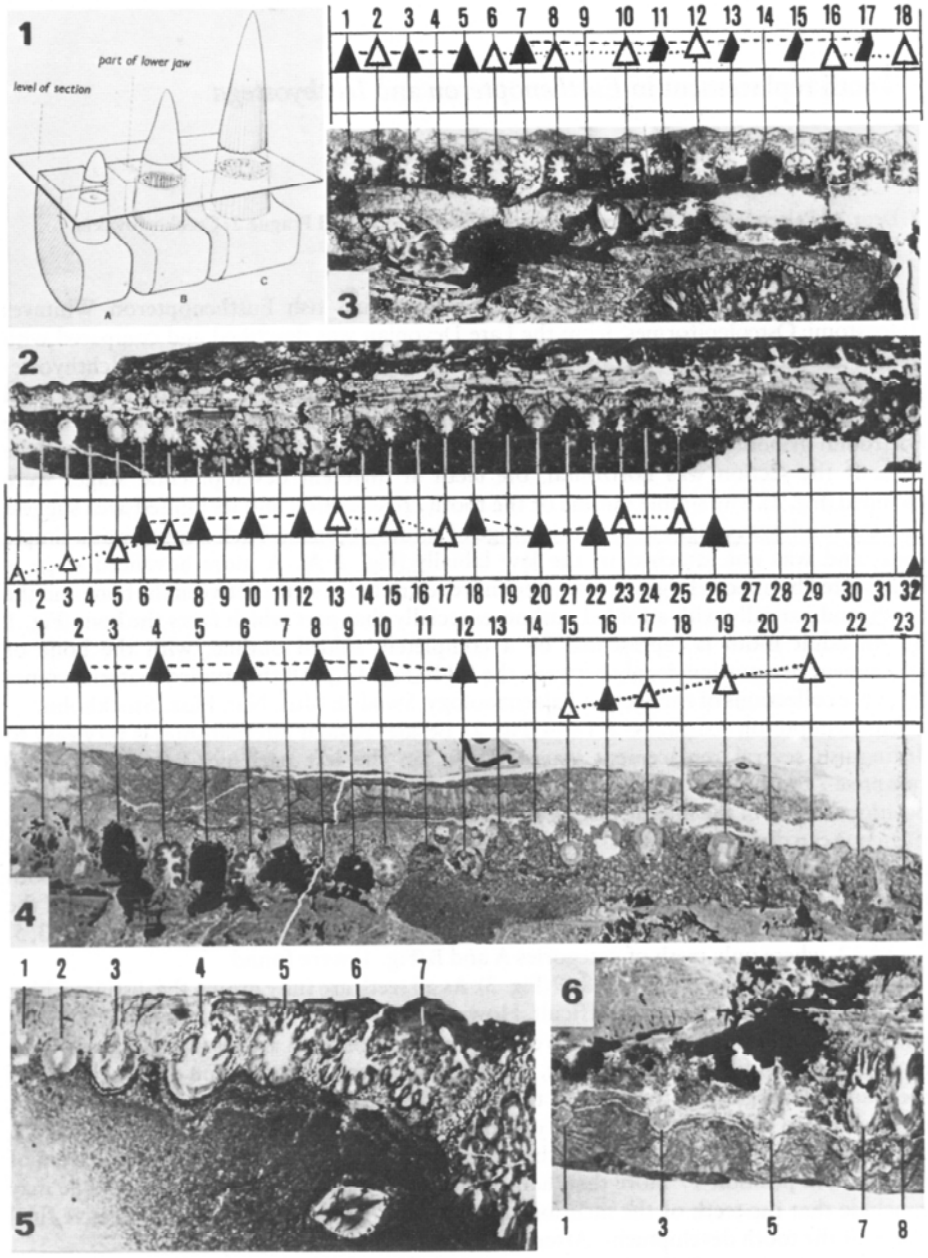
The mode of tooth replacement in crossopterygian fish Eusthenopteron Whitaves (Teleostomi: Osteolepiformes) from the Late Devonian was described and compared with that of the earliest known tetrapod Ichthyostega Säve-Söderbergh (Amphibia: Ichthyostegalia) of the same geological age. The former may be considered an evolutionary level immediately preceding that of first amphibians. Dentitions were studied mostly on the horizontal grinding sections through the tooth row, partly also on the latex casts of the jaws. If the section was horizontal, the teeth at different developmental stages were included (Fig. 1). The simple outline of the tooth cross-section and its limited area suggest that the tooth was caught at the initial stage of its development. Such a tooth was a simple cone, and was not attached to the jaw labially (Fig. 1 A). A more advanced stage is represented by a tooth larger in diameter, more restricted in space between the bone and the tooth, and partially with a folded outline, especially that part which faces the bone (Fig. 1 B). An adult tooth is represented by a completely folded outline, with the bone of attachment penetrating deeply between the folds (Fig. 1 C). All the studied material comes from the collections of the Sect. of Palaeozoology, Swedish Mus. Nat. Hist., Stockholm.

Eusthenopteron – Coll. N° S 1854 (Fig. 2). Besides regular alternation it is very easy to distinguish several replacement waves. Those on the left part (positions 1–7, 6–12) comprise 7 tooth positions or probably even more; those remaining discernible ones only 5 positions. Teeth in the middle belong to the category of fully grown teeth, but also within them one can distinguish successive stages according to the thickness of the tooth walls and the depth of the surface grooves. Positions 8–26 suggest that extensive parts of the tooth row carry teeth of approximately the same stage of development. The adjacent parts of the tooth row carry teeth of quite different stages. This may be inferred from positions 1, 3, 5, 7 and 32, where only teeth of categories A and B (Fig. 1) were found.

Eusthenopteron – Coll. N° S 1849 (Fig. 3). As all teeth are fully grown the distinguishing of replacement waves is rather difficult. However, the teeth in the positions 7, 9, 11, 13, 15 and 17 have thin walls, spacious pulp cavity, and most of them are resorbed lingually. The resorbed space is filled with sediment, hence it was caused by resorption during the life of the animal. Disregarding the tooth in the position 9 where the condition is rather obscure, it is possible to follow up the gradually increasing degree of this resorption in positions 11, 13, 15 and 17. While in position 11 the resorption is limited only to the lingual margin of the tooth, in position 17 more than half of the tooth diameter is affected. Thus one may conclude that the teeth of the mentioned series 7–17 probably represent successive final stages of the tooth development. After them the tooth was shed away.

Eusthenopteron – Coll. N° S 1855 (Fig. 4). Here is the true wave of replacement (positions 15–21), as well as the series of alternating teeth of nearly the same degree of development (positions 2–12). It seems that the specimen displays the boundary between


1
part of lower jaw
level of section
A
B
C
3
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
4
1 2 3 4 5 6 7
5
6
1 3 5 7 8

the tooth row part with completely developed teeth and that with regular replacement in waves.

Eusthenopteron – Coll. N° S 1861 (Fig. 5) and S 1860 (Fig. 6). Both specimens, compared with each other, display contradictory conditions. Whereas the latter represents a regular replacement wave comprising both very young teeth and those more developed, as well as transitions between them, the former displays a peculiar condition which could be interpreted either as only one replacement wave without any alternation, or as consisting of two parallel waves of almost the same rate of development. The latter interpretation seems to be more probable and is supported indirectly by the occurrence of alternation in other specimens examined.

Ichthyostega – Coll. N° S 1932–1935 (Fig. 7). This specimen was examined by means of series of four grinding sections taken at different levels. All 4 positions were occupied by teeth at approximately the same developmental stage; this means that no trace of alternation could be found. Teeth in their upper parts are of the same diameter and although they are placed rather irregularly it is possible to ascertain that they were approximately of the same height. Near their bases the teeth are close to each other which suggests that there is no free tooth position. In all teeth there is no sign of resorption at all.

Ichthyostega – Coll. N° S 1940 (Fig. 8). The section comprises that part of the tooth row which consists of clearly alternating teeth. The wave of replacement seems to be rather steep, judging by the comparison of two teeth having their hollows filled with sediment.

Contradictory conditions of the above specimens of Ichthyostega may also be found when examining the latex casts of the jaws. In some of them regular alternating pattern was observed, while in other ones teeth of the approximately same degree of development occupy the adjacent positions.

Deducing the general pattern of tooth replacement in Eusthenopteron and Ichthyostega one can say that alternating pattern is probable in both forms. Since in addition to replacement waves also extensive parts of the tooth row with teeth in almost the same degree of development occur, the replacement probably proceeded separately in different tooth row parts. In other words we can distinguish not only alternative tooth positions but also alternative tooth row parts. While in a certain part the replacement was very slow, in the adjacent ones it was considerably rapid. Hence it should be assumed that changes of tooth generations in a given part of the tooth row were not continuous in time. It rather seems that adult teeth in functional positions were not shed and persisted for quite a long period, while teeth in the interpositions grew quite rapidly in comparatively short waves until they reached the same size as those of functional teeth. Only then the functional teeth

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Fig. 1. Diagram of the horizontal section through the teeth in different stages of their development (A, B, C).

Fig. 2. Grinding section of a jaw of Eusthenopteron (S 1854) with its odontogram. The size of tooth-like symbols are approximately proportional to the actual teeth. Odd-numbered series of the teeth is shown in solid black; even-numbered one in white.

Fig. 3. Grinding section of a jaw of Eusthenopteron (S 1849) with its odontogram. Odd-numbered series of teeth is shown in white, even-numbered teeth are solid black. Where basal resorption of the old tooth occurs, it is depicted by a bite out of the symbol.

Fig. 4. Grinding section of a jaw of Eusthenopteron (S 1855) with its odontogram. For other explanation see Figs. 2 and 3.

Fig. 5. Grinding section of a jaw of Eusthenopteron (S 1861); the tooth positions are numbered above.

Fig. 6. Grinding section of a jaw of Eusthenopteron (S 1860); the tooth positions are numbered below.

were shed away which resulted in the condition that interpositions were vacant. Short periods of rapid growth of replacement teeth were thus followed by long periods of growth inactivity.

Above statements rather complete description by EDMUND (1960) who investigated one specimen of Eusthenopteron and came to the conclusion that also in this form alternative tooth replacement occurred. However, he did not mention a fact that the rate of replacement may be dependent on the time and on the position of the replaced part of the dentition within the tooth row.

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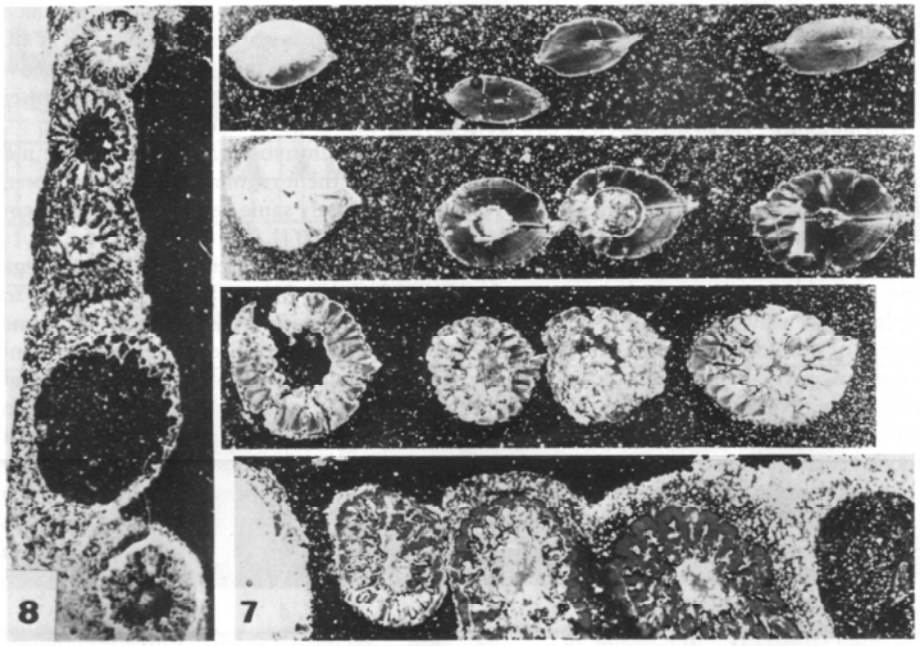

Fig. 7. Series of grinding sections of a jaw of Ichthyostega (S 1932–1935); the sections are taken in four different levels from the top of a tooth (above) to its base (below).
Fig. 8. Grinding section of a jaw of Ichthyostega (S 1940).

Reference

Edmund, A.G.: Evolution of dental patterns in the lower vertebrates. In: «Evolution: Its science and doctrine». R. Soc. Can. Studia Varia, Ser. 1960, 4, 45–60 (1960).