

Radiological research on the structure of *Elephas falconeri* Busk

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ABSTRACT — Radiological study of *Elephas falconeri* mandibles revealed interesting characteristics of teeth birth, growth and replacement. The laminae of the tooth originate separated, and join during their growth. The first tooth has three laminae, the second seven, the third and fourth respectively have ten and twelve; the fifth and sixth tooth are yet not found entire.

RIASSUNTO — Lo studio radiografico di numerose mandibole di *Elephas falconeri* ha dato interessanti risultati. È stato possibile seguire la formazione, lo sviluppo e le modalità di sostituzione dei denti della serie mandibolare in ogni particolare. Si è così notato che le laminae costituenti il dente si formano isolate e si saldano l'una all'altra solo in un secondo tempo; in alcuni casi la parte anteriore del molare svolge già la funzione masticatrice mentre la parte posteriore, ancora interna alla branca mandibolare, non è completamente formata. Il cemento che colma gli spazi fra le laminae si forma solo quando il dente erompe dalla mandibola.

Per i primi quattro denti della serie mandibolare si è constatata una singolare costanza nel numero delle laminae, rispettivamente tre, sette, dieci e dodici. Non è stato invece possibile seguire la crescita del quinto e del sesto molare poichè, almeno nel materiale radiografato, l'aumento delle dimensioni della mandibola non è più proporzionato all'aumento dimensionale dei denti, per cui quando si formano le ultime laminae, la parte anteriore del molare è già stata usurata.

During the years between 1957-58 (Accordi, Campisi, Colacicchi, 1959) and 1959-60 (Accordi 1960, 1962; Accordi & Colacicchi 1962) numerous fossil remains of *Elephas falconeri* Busk were recovered in a cave in the Spinagallo district, near Siracusa (Sicily). The palaeontological study of the rich material was committed to P. Ambrosetti; this study was started, considering the great disponibility of series of pieces, on a prevalent statistical basis, so as to allow, as much as possible, a well defined morphometric description of the species studied.

Although up to the present no precise chronological determination has been pos-

sible, we believe that this fauna may be referred to the period included between the Tyrrhenian regression and the acme of the Würm glacial period.

During the study of the characteristics and measurements of the teeth, arose the exigency for an analysis of the numerous non-isolated pieces which were, however, still included in the mandibular or in the maxillary branches: such an analysis could be carried out either by making a section of the fragment under study or by radiographic observation.

Having decided to resort to a series of radiographies so as to avoid any possible damage to the precious fossil material, the

radiological study was committed to E. Salomoni.

From the very start it was clear that one could desume much more interesting elements than the mere counting of the enamel *laminae* or the measuring of the non-visible parts: the selective transparency at the X rays of the various textures has, in particular, allowed the reconstruction of the formation and growing process of the teeth in every detail.

In this brief paper we shall only consider the part of our work concerning the lower set of teeth because this appeared far more interesting, both owing the greater disponibility of findings and to the greater evidence of details.

TECHNICAL DATA AND INTERPRETATION

We examined about seventy pieces, many with two or more radiograms, as required from the situation.

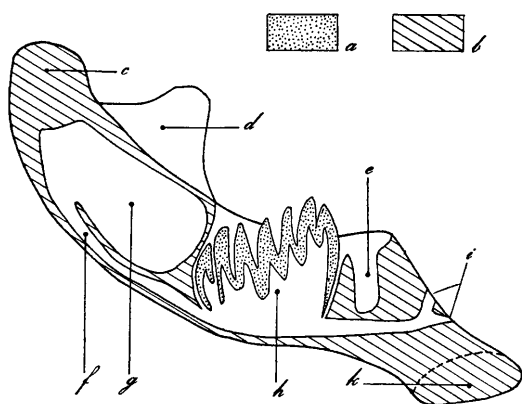


Fig. 1 - Graphic cast of the radiogram of plate 2, fig. 1; a) dental tissues; b) osseous parts; c) mandibular condyle; d) coronoid apophysis; e) 1st tooth alveolus; f) mandibular canal; g) cavity of the mandibular branch; h) pulp cavity; i) holes relating to the chin; k) mandibular section referred to the symphysis area. ($\frac{3}{4}$ nat. size).

The technique used was by hard rays when the study concerned the researches pertaining to the structure of the tooth; by

soft rays the study of the bone structures was possible.

The photographs present an inversion of tones in comparison with the radiograms, therefore the white parts are the most radiotransparent ones; sometimes calcareous incrustations change the radiogram with an abnormal opacity.

So as to facilitate the interpretation of the structures reproduced in the radiographies we show the graphic cast of a radiogram of a young subject (Fig. 1).

TEETHING IN PRESENT ELEPHANTS

It is well known that elephants have a very particular system of growing and substituting their teeth: in the course of life six teeth follow one another in each half mandible or maxillary bone. The first two are already formed at birth and the others are formed and start functioning through a substitution from the back to the front as the front teeth grow gradually old, respectively, the second at three years, the third at five years, the fourth at ten, the fifth at twenty and the sixth after thirty. These data, reported by Frade (1955), is the average of numerous observations on individuals of the two still living species. This same succession has already been described by Schaub (1948) on a rich fauna of *Elephas meridionalis* of Valdarno (Plio-Pleistocene of Tuscany).

The six teeth which follow one another in the course of the life of the elephant have been differently interpreted by the various A.A.; the most widespread theses are:

a) all the teeth are of the same kind and must be indicated by the symbol M1, M2, ... M6;

b) the first three are pre-molar teeth, the others molars and are, therefore, indicated as Pm2, Pm3, Pm4, M1, M2, M3, in which case the first pre-molar would be missing;

c) the first three teeth are milk molars, the three successive ones are the corresponding definitive molars; they are, therefore, to be indicated by m1, m2, m3, M1, M2, M3.

It is not object of this report to discuss this question, the teeth will, therefore, be indicated on the basis of their position, that is first, second, sixth.

TEETHING IN *ELEPHAS FALCONERI*

The first tooth — Amongst the numerous mandibular branches, which are usually well preserved, and in which we still have a first tooth in place, we have chosen, as the most representative ones, the specimens on pl. 49, figs. 1, 2 and 3. On fig. 1 we see the first tooth, just cutting from the mandibular branch: it is formed by a capsule of dentine with two inflections in the upper part of the crown: the indents are not however, deep enough to give place to different *laminae*. Only one root is present in this specimen and it is not very evident at a radiographic examination, an obvious sign that the textures had not yet gone through the enriching process in CaCO_3 .

In the immediately successive stage of development (Pl. 49, fig. 2), the first tooth presents a very obvious root, the crown stands out more from the margin of the mandibular branch, but there is no trace of smoothness due to mastication. It can be observed in the last specimen (Pl. 48, fig. 3), that the root becomes less evident and that, therefore, the process of radical reabsorption, which preludes to the fall of the tooth, has begun, without there being any smoothness in the crown yet. In the specimen shown in fig. 10 we may observe the strictly anomalous position of the teeth placed in such a way that it would have been very difficult for the individual to survive: it is difficult to tell if the anomaly was the cause of the decease, for the teeth do not present any trace of smoothness, and, therefore, a possible function-

nal insufficiency was not yet determinant for feeding.

The second tooth — This tooth is recognizable because of the morphological characteristics of both the crown and the radical part.

The crown is formed by seven *laminae*, the radical system is formed by two roots of which the anterior one is the smallest. From the series of pieces in our possession the process of development is easily recognizable.

The specimen of the fauna which is being studied at its youngest stage (Pl. 49, fig. 1), has its second tooth already completely formed: the first four *laminae* are well determined and united to one another at the base; the fifth is well formed, but not yet united to the fourth; the sixth and the seventh are merely outlined. In this specimen the complete absence of the roots can be noted.

Later (Pl. 49, figs. 2-4), the tooth appears to be cutting from the mandible more and more, but even in these specimens no trace of the mastication surface can be noted yet. The progressive formation of the radical apparatus can be also noted in the anterior part of the tooth.

Figure four of the plate shows the second tooth with the three anterior *laminae* which are worn; the first tooth is missing and the outline of its root is still recognizable: the alveolus is filled with bony substance which, in the presence of X rays, behaves very similarly to the spongy tissue which occupies the free part of the mandibular branch. Therefore, in this case, the first tooth has fallen out naturally, after the reabsorption of the root, not because of mechanical causes, *prae* or *post mortem*, as in the specimens appearing in plate 49, fig. 1 and fig. 5, where the alveolus remained empty.

The radical apparatus is, at this stage of the development, well delineated: it is formed by two big roots, of which the anterior one occupies the position corresponding to the first three *laminae*, the poste-

rior one corresponds to the last four and is bigger in dimension; the walls of the roots are presumably made of dentine, for they present the same opaqueness of the crown of the tooth.

The further growth allows changes which can be thus summarized:

a) the shifting of the tooth forwards as the wearing proceeds;

b) the formation of bony substance slightly radio-opaque in that part of the tooth which is already worn, that means cement;

c) the lengthening of the roots, which compensates the growth of the tooth in the mandibular branch, in such a way that the radical apex will always graze the mandibular inferior wall.

These changes can be followed in the specimens on pl. 49, figs. 6,9; in the latter we observe the presence of a posterior bifid root, as an anomaly.

The third tooth — For what concerns the third tooth, we can fully reconstruct the growing process from the specimens on plate 49, figs. 9-14.

In the mandibular branches of fig. 9 and fig. 11, two teeth are present at the same time: the anterior one is certainly the one which has, up to now, been considered the second, both owing to its dimensions and to the characteristics of its roots; the tooth which is forming posteriorly is, therefore, the third of the mandibular series.

The morphological characteristics can thus be synthesized: ten *laminae*, two roots of which the smallest corresponds to the three anterior *laminae*, and the biggest to the seven posterior *laminae*.

Essentially the radical apparatus of the third tooth corresponds to that of the second, only the height of the posterior root never reaches, in proportion, the values of the one of the second tooth, for the *laminae* are much higher and when the tooth assumes, in the mandibular branch, such a po-

sition that it requires a prolongation of the root to maintain the nourishing and innervation functions, the process of radical reabsorption has already started (Pl. 49, fig. 9).

The fourth tooth — As the development is, in all respects, similar to that of the third tooth, we believe it superfluous to describe it in detail. The observation of specimens on plate 49, figs. 13-17 will be sufficient.

The general characteristics of this tooth are:

twelve *laminae*, the radical apparatus formed by two roots of which the first occupies the interval of the anterior three *laminae*; it appears, from the tooth remains on figure 17 that the second root is formed, at least in its posterior part, by the fusion of several roots of minor dimensions, each corresponding to a *lamina*.

The fifth and sixth tooth — On plate 49, figure 17 there is already a fifth tooth in formation. For this tooth, and still more for the next one, we were unable to reconstruct the forming and development stages, both owing to the lack of pieces at our disposal and because the total dimensions of these last teeth were to be such that they did not allow the recovery of a complete tooth in a mandible: when the anterior part of the tooth was already utterly worn, the formation process of the new *laminae* in the posterior part was not yet finished. The coexistence of two different morphological types, pachyganal and endioganal forms of Vaufrey (1929), determines the dimensional superposition between the fifth tooth of the pachyganal type and the sixth of the endioganal one. These factors render impossible the distinction between the fifth and sixth tooth from the examination of only the radiographies.

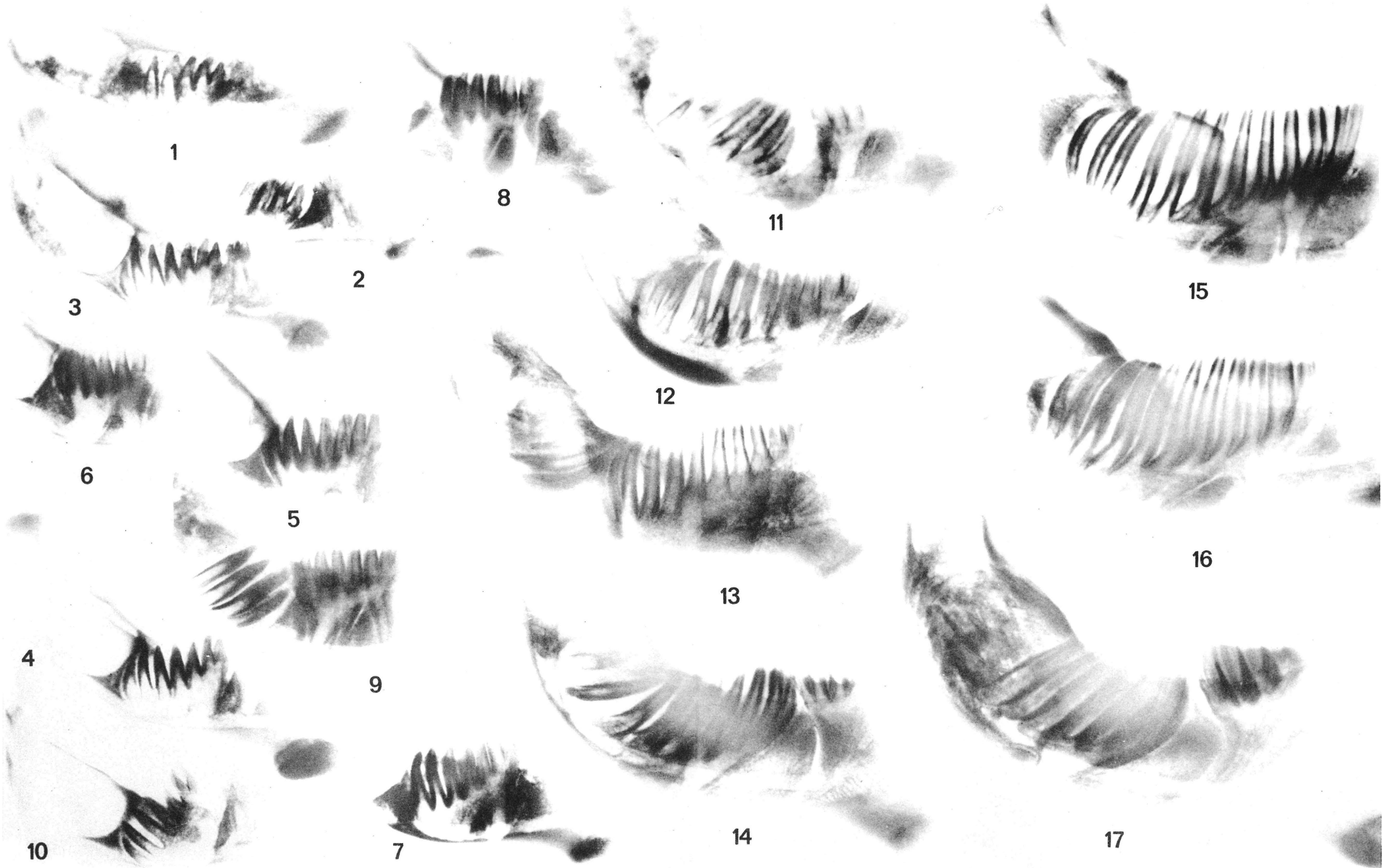
In the last two teeth the radical apparatus of a more complex type is realized: each *lamina* has its own small root which ends up in the great posterior root where, however, they maintain their own individuality.

EXPLANATION OF PLATE 49-50

- Figs. 1-3, 10 - Mandibles of young subjects of *Elephas falconeri*, with the first and the second tooth in place. On fig. 1 we see the first tooth just cutting from the mandibular branch; the specimens of fig. 10 shows an anomalous position of the teeth.
- 4-9 - Mandibles of *Elephas falconeri* with the second tooth in place. Note the increasing of radical apparatus formed by two roots. The specimen of fig. 9 shows a third tooth in formation in the cavity of the mandibular branch.
- 11-12 - Mandibles of *Elephas falconeri* with the third tooth in place.
- 13-14 - Mandibles of *Elephas falconeri* with the third and the fourth tooth present at the same time.
- 15-16 - Mandibles of *Elephas falconeri* with the fourth tooth in function.
- 17 - Mandible of *Elephas falconeri* with the fourth and the fifth tooth.

All figures $\frac{3}{4}$ natural size

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