SOME ASPECTS OF THE TOOTH DEVELOPMENT IN SORICIDAE

by

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In my investigation of the tooth development in Insectivora I have earlier published observations in Tupaia javanica (1957), Elephantulus myurus Jamesoni (1958), and Talpa europaea (1958). In the present paper I will give an account of the tooth development in Soricidae.

The existence of a lacteal dentition in Soricidae has been much debated. According to *Owen* (1868), *Tauber* (1872), and *Winge* (1882) a lacteal dentition exists, but *Leche* (1895) refuted this, because he did not find any traces of lacteal teeth in some embryos of different stages of Sorex vulgaris. *Woodward* (1896), however, discerned distinct rudiments in an embryo slightly younger than those examined by *Leche,* but in a somewhat older embryo he found them already wholly resolved. *Ärnbäck-Christie-Linde* (1912) observed more rudimentary lacteal tooth anlages than *Woodward,* and found that some of them are calcified. She considered that one of them, the lower last premolar anlage, remains in young animals, though without erupting, while the other rudiments probably are resolved before birth. In Neomys fodiens and Crocidura russula, *Ärnbäck-Christie-Linde* noticed uncalcified lacteal tooth anlages which resolve during embryonic life. She has also described a supernumerary tooth anlage between the last premolar and the first molar in the upper jaw of an embryo of Crocidura russula, which she supposed would belong to the lacteal dentition.

The interpretations of the permanent dentition also differ. The number of the lower incisors, and the question whether a canine or an anterior premolar is present have, in particular, been discussed by *Brandt* (1869) and *Leche.* An upper fourth incisor, described by *Leche*, is considered by *Woodward* to be a canine. The anterior premolar in the upper jaw was called the canine by *Brandt* as well as by *Leche*. *Woodward* identified the three upper premolars as P^2, P^3, and P^4, and, in accordance with *Leche*'s earlier interpretation, the only lower one as P_4. *Ärnbäck-Christie-Linde* described a rudimentary lower second premolar and a small trace of a third premolar.

By *Ärnbäck-Christie-Linde* the functioning first permanent incisor is designated as I^3 in the upper jaw and I_4 in the lower jaw. In front of them she believes to have found tooth rudiments in Sorex araneus, but only two bends of the oral epithelium in Crocidura russula. The latter, however, she did not dare to interpret as remnants of the dental lamina. She supposed that earlier stages of the development can provide an answer, for she was of the opinion that Soricidae originates from the same ancestor as the Polyprotodontia of the mammalian order Marsupialia.

Traces of a praelacteal as well as of a postpermanent dentition in the form of labial and lingual processes are also mentioned by *Ärnbäck-Christie-Linde*.

As I have had the opportunity to study an unbroken series of stages of Sorex araneus and Suncus (Crocidura) orangiae, comprising those stages in which *Ärnbäck-Christie-Linde* supposed that the rudimentary incisor anlages, in particular, should appear clearly, I am able to give a description of the main part of the tooth development in these species, in the hope of removing some uncertainties.

The investigated material consists of the following embryos,

Sorex araneus: 8.7 mm, 9.5 mm, 10 mm, 10.5 mm, 11 mm, 12 mm, 14 mm, 15 mm, 16.5 mm, 17 mm, and 17.5 mm;

Neomys fodiens: 19 mm and 20.5 mm;

Suncus (Crocidura) orangiae: 6.25 mm, 7.5 mm, 8 mm, 9.8 mm, 10 mm, 11 mm, 12 mm, 15 mm, 18 mm, 22 mm, and adult animals.

Crocidura araneus (russula): adult animals.

Most of the embryos were fixed in Bouin's fluid, the thickness of the sections varied between 8 μ and 15 μ, and the staining was made by the method of Azan-Mallory. Graphic reconstructions were made of several stages.

SOREX ARANEUS

Upper jaw

In the upper jaw of the youngest embryo of Sorex araneus, 8.7 mm in length, a broad commissure connects the dental lamina of each side (Fig. 1, com). Five bud-shaped germs of the enamel

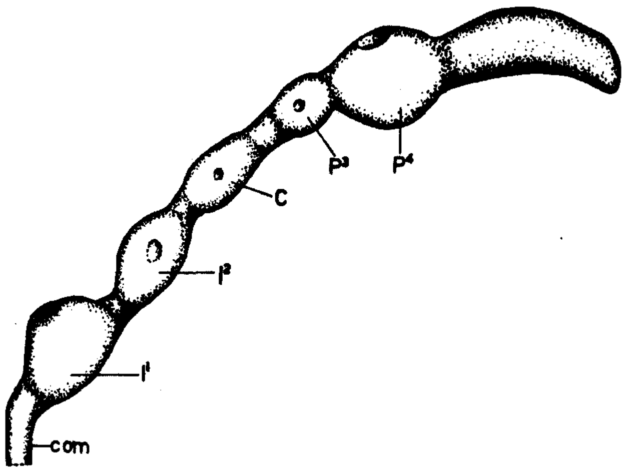

Fig. 1. *Sorex araneus.* Embryo 8.7 mm. Graphic reconstruction of the dental lamina of one side of the upper jaw with the germs of the enamel organ. × 66.5.

organ, each with a shallow invagination situated laterally or slightly dorsally, have developed. The first germ (I^1) is immediately behind the commissure, and on its lateral side near the oral epithelium there is a small accumulation of cells, which is not seen in the graphic reconstruction. The second germ (I^2) is smaller than the first one, and in front of its dorsal invagination there is also a cell concentration. The third bud (C) is still smaller but otherwise of the same appearance as the second one. The fourth germ (P^3) is not distinctly separated from the next one (P^4), which is bigger and, like the first tooth anlage, has a shallow invagination lingually. A condensation of cells is seen in front of this invagination. Thus, the first and the last tooth anlages are the biggest and those between them diminish succes-

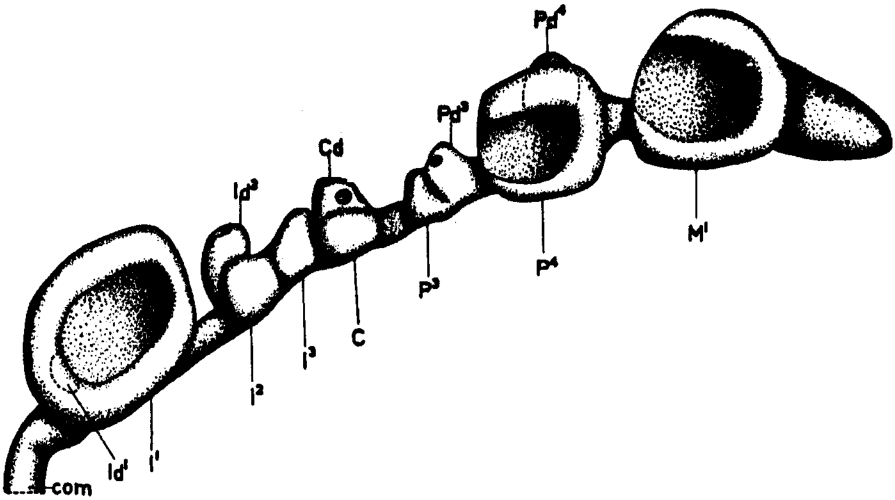

Fig. 2. *Sorex araneus*. Embryo 10.5 mm. Graphic reconstruction of the dental lamina of one side of the upper jaw with the germs of the lacteal and the permanent teeth. × 66.5.

sively in size backwards. The dental lamina continues a good distance behind the last tooth germ and in its whole length is connected with the oral epithelium.

In the embryo a little older, 9.5 mm in length, the commissure is slightly longer and thinner. At the site of the small concentration of cells labially to the first tooth germ in the younger embryo a diminutive, bell-shaped enamel organ anlage is observed. It is presumably the rudimentary predecessor anlage of the first incisor, being more developed but smaller than the permanent tooth anlage, which is in a very early cup-shaped stage. At the fifth tooth germ, which probably represents the fourth premolar anlage, a lateral invagination of the dental lamina appears, exactly where the lacteal rudiment should be found. A vestige of a first molar anlage can be seen a short distance behind. In the small tooth germs the papilla invagination is situated dorsolaterally, in the bigger ones slightly medially.

The commissure has increased further and has become slightly wave-like in a 10 mm and a 10.5 mm embryo (Fig. 2, com). The central part of it bends towards the oral epithelium, and its

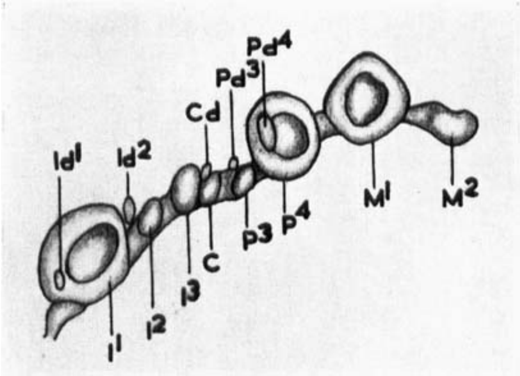

Fig. 3. *Sorex araneus.* Embryo 11 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the upper jaw. × 33.3.

somewhat wider side-portions appear rounded in transverse sections. The permanent first incisor anlage (I^1) is big and bell-shaped. Its lacteal rudiment (Id^1), which is situated close to the labial side, is very insignificant in the 10 mm embryo, but a little bigger in the 10.5 mm embryo, in which it is about the width of the neck of the enamel organ. The second lacteal incisor anlage (Id^2) has reached the bell-shaped stage, but its successor anlage (I^2) is only represented by a bud-shaped thickening of the dental lamina. The next bud may be the anlage of the third incisor (I^3). No predecessor anlage is seen here. The canine anlage (C) is like the second incisor germ and has a bell-shaped lacteal rudiment (Cd). The third premolar anlage consists of a bud-shaped thickening (P^3). Its lacteal rudiment (Pd^3) is bell-shaped but slightly smaller than that of the second incisor and of the canine. The fourth premolar anlage (P^4) is cup-shaped and equal in size to the first incisor anlage, but its predecessor (Pd^4) is bell-shaped and almost entirely isolated. The first molar anlage (M^1) is big and cup-shaped. The dental lamina continues distally.

The dentine formation has begun in an 11 mm embryo (Fig. 3). The lacteal first incisor rudiment (Id^1) has a thin layer of dentine, and in the second one traces of dentine are found. The third incisor anlage, which here appears slightly more clearly than in the preceding stages, is still entirely without a lacteal rudiment. In the canine and premolar anlages no remarkable changes are noticed. The second molar anlage now appears as a thickening of the dental lamina.

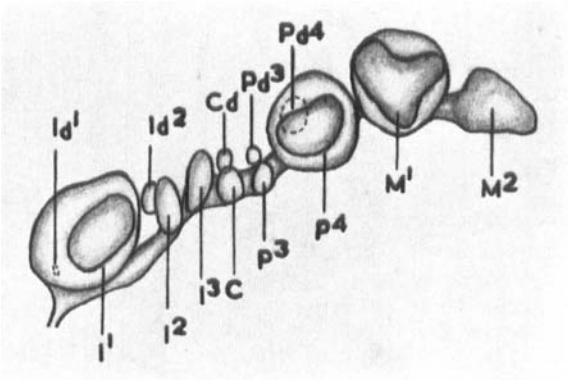

Fig. 4. *Sorex araneus.* Embryo 12 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the upper jaw. × 33.3.

The germ of the permanent first incisor in a 12 mm embryo has increased in size, so that its front part is slightly anterior to the commissure (Fig. 4, I^1). The outer and the inner enamel epithelia of the enamel organ are distinctly separated by a layer of star-shaped cells, and the formation of dentine has begun. Here the lacteal rudiment is a little smaller than in the younger embryos. The second incisor anlage (I^2) is slightly cup-shaped, and its predecessor rudiment (Id^2) has a thin layer of dentine. The third incisor anlage (I^3) has still no lacteal rudiment. The anlages of the canine (C) and the third premolar (P^3) are in the bud-shaped stage, but the corresponding lacteal tooth rudiments (Cd and Pd^3) have reached the same stage of development as the lacteal second incisor anlage and have a layer of dentine. The fourth premolar germ (P^4) is big and almost equal in size to the first molar anlage (M^1), and its predecessor (Pd^4), which is the biggest and the most developed of all the lacteal rudiments, is situated immediately beneath the oral epithelium and ventrally to the successor. The second molar germ (M^2) is slightly cup-shaped. The dental lamina has lost its connection with the oral epithelium in a few places.

The resorption of the lacteal dentition has started in a 14 mm embryo. The first incisor rudiment is entirely resolved, and in the fourth premolar rudiment a clear degeneration has begun. The other deciduous rudiments seem to be equal to those in the

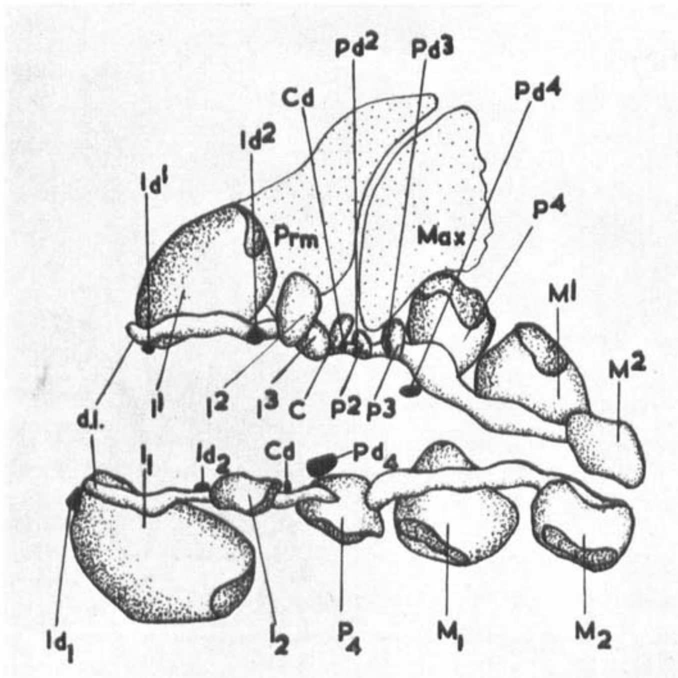

Fig. 5. *Sorex araneus*. Embryo 15 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the upper and the lower jaws. The premaxillo—maxillary suture is seen. d. l. = dental lamina. × 33.3.

12 mm embryo. The permanent first incisor anlage has become bigger, and a thick layer of dentine has formed. The anlages of the permanent second and third incisors are in the cup-shaped stage, and the canine anlage has a very shallow papilla invagination. A very small thickening of the dental lamina probably represents the second premolar germ. The third premolar anlage seems to be in the same stage as in the 12 mm embryo, but the fourth premolar anlage has increased in size, as have the two molar anlages. The dental lamina is entirely separated from the oral epithelium, except at the extreme front at the commissure and the extreme back at the molar anlages.

A very small fragment of the rudimentary lacteal first incisor germ is still present in a 15 mm embryo (Fig. 5, Id^1). The permanent second premolar anlage (P^2) is now slightly cup-shaped,

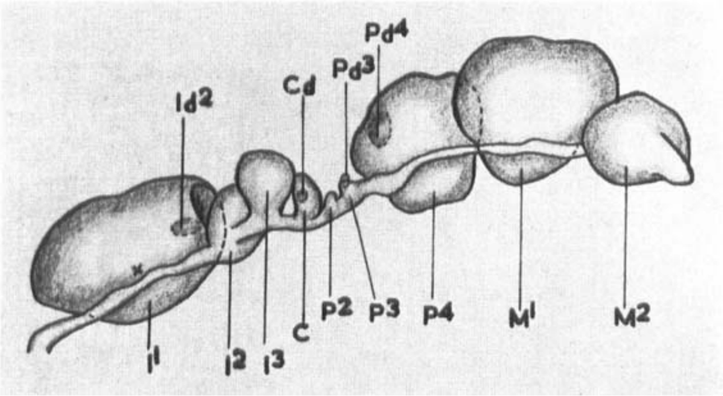

Fig. 6. *Sorex araneus*. Embryo 16.5 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the upper jaw, viewed from the lingual side. *x* indicates the point up to which the dental lamina is separated from the tooth sac. × 33.3.

and labially to it its very small predecessor rudiment (Pd^2) appears. As in the 14 mm embryo the degeneration of the lacteal fourth premolar rudiment (Pd^4) is in progress. Concerning the other tooth germs no remarkable changes are noticed.

The commissure and a great part of the dental lamina are about to degenerate in the 16.5 mm, 17 mm, and 17.5 mm embryos. The rudiment of the lacteal first incisor is represented only by a very small accumulation of degenerated cells, but that of the second incisor (Fig. 6, Id^2) still appears clearly, as do the canine rudiment (Cd), which is slightly bigger, and the rudiments of the two posterior lacteal premolars (Pd^3 and Pd^4). The permanent tooth anlages have developed. The first incisor anlage (I^1) has increased remarkably in size. The second one (I^2) is now in an early bell-shaped stage, and the third one (I^3) is a little smaller and cup-shaped, as is also the canine anlage (C). The second and the third premolar germs (P^2 and P^3) consist only of thickenings of the dental lamina, the third being bigger than the second. In the large fourth premolar anlage (P^4) a thick layer of dentine has developed. The anlage of the first molar (M^1) has become much broader. Posterior to the second molar anlage (M^2) the dental lamina is markedly enlarged, forming the germ of the third molar.

Lower jaw

The commissure between the dental lamina on each side of the lower jaw in an 8.7 mm embryo (Fig. 7, com) is shorter than that in the upper jaw (Fig. 1, com), because the anterior connection between the dental lamina and the oral epithelium is situated nearer to the medial line. Four germs of enamel organ appear as thickenings of the dental lamina (Fig. 7). A slight

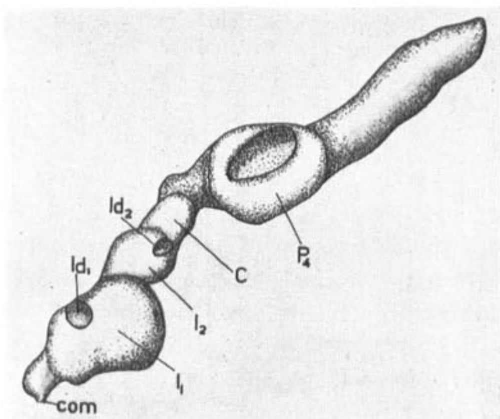

Fig. 7. *Sorex araneus.* Embryo 8.7 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the lower jaw. × 66.5.

ventro-lateral concavity with a condensation of mesenchymatic cells outside the first bud indicates the rudiment of the first lacteal incisor (Id_1). An anlage of a gland (glandula submandibularis) is seen here as a process of the oral epithelium lingually to the dental lamina. The lacteal second incisor rudiment (Id_2) is indicated by a lateral concavity on its successor anlage (I_2) which develops from the second bud. The third, slightly smaller, thickening represents the canine anlage (C) and the big fourth thickening is the fourth premolar anlage (P_4) which is cup-shaped with a ventral concavity for the dental papilla. The dental lamina continues uniformly thickened.

The rudiment of the lacteal first incisor appears clearly in a 9.5 mm embryo (Fig. 8, Id_1) as a small invagination on the dental lamina laterally to the anlage of the permanent incisor, the papilla invagination of which is situated a little posteriorly. The rudimentary lacteal second incisor anlage is also seen as a small invagination close to the anlage of its successor. The canine germ

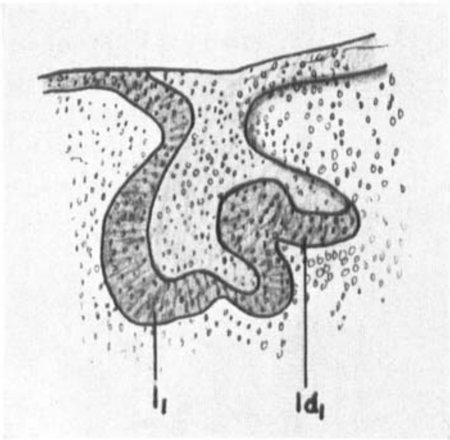

Fig. 8. *Sorex araneus*. Embryo 9.5 mm. Transverse section through the dental lamina with the anlages of the lacteal and the permanent first incisors. × 133.

is less developed than the two incisor germs. Behind the big fourth premolar germ the first molar anlage has formed as a thickening of the dental lamina.

The commissure has become slightly longer in the 10 mm and 10.5 mm embryos (Fig. 9). Four lacteal rudiments are present. At the lateral edge of the commissure there is the rudiment of the lacteal first incisor (Id_1) and immediately behind it is the very big anlage of the permanent first incisor (I_1). The second

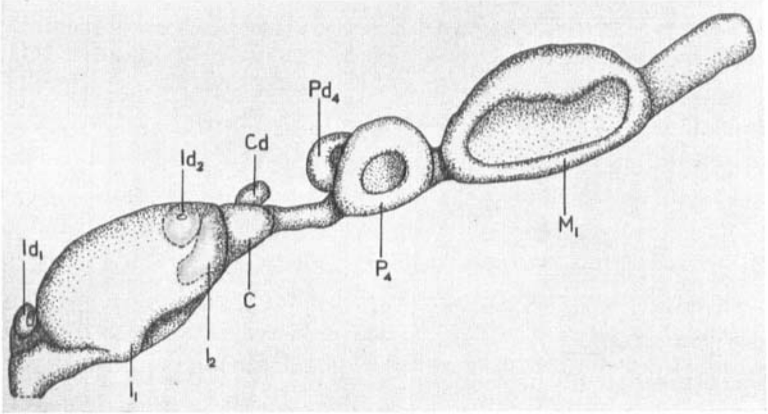

Fig. 9. *Sorex araneus*. Embryo 10.5 mm. Graphic reconstruction of the dental lamina with the tooth germs on one side of the lower jaw. × 66.5.

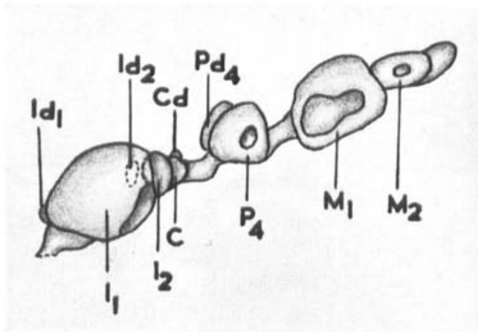

Fig. 10. *Sorex araneus.* Embryo 11 mm. Graphic reconstruction of the dental lamina with the enamel organ anlages on one side of the lower jaw. × 33.3.

incisor germs (Id_2 and I_2) are obscured by it in the figure, which is a reconstructed ventral view. The dental lamina is here almost circular in the sections. At the outer wall of the enamel organ it looks like a semicircular thickening, which caudally decreases in thickness and finally completely fuses with the wall, so that a dental lamina is no longer distinguishable. Both lacteal incisor rudiments are cup-shaped with a narrow papilla opening. The permanent second incisor anlage is bud-shaped and situated immediately behind its rudimentary predecessor. The lacteal canine rudiment (Cd) is bud-shaped and smaller than the incisor rudiments. A permanent canine germ (C) appears only in the 10.5 mm embryo. Anterior to the premolar anlage (P_4) there is a gap, representing the wanting first, second, and third premolars, where the dental lamina is seen as a thin band. The lacteal fourth premolar rudiment (Pd_4) is bell-shaped. As in the upper jaw, it is the biggest and most developed tooth anlage in the lacteal dentition and has a thin layer of dentine. The permanent premolar anlage is big but is only in the cup-shaped stage. The first molar anlage (M_1) is of the same size as the permanent first incisor germ; it is deeply cup-shaped. In the 10 mm embryo there are on the labial surface of its neck two buds which probably are folds. The posterior part of the dental lamina is thickened but no further tooth germ has formed.

The tooth anlages are at about the same stage of development in an 11 mm embryo (Fig. 10), but the canine anlage seems to be slightly smaller, and a bud-shaped second molar germ now appears.

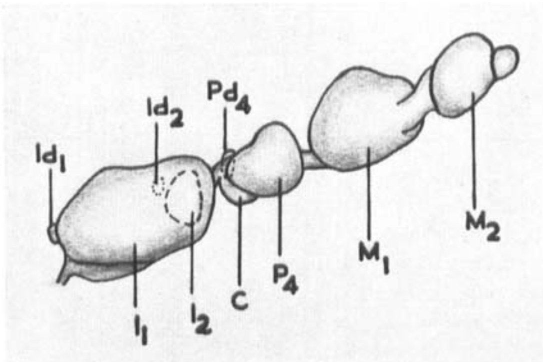

Fig. 11. *Sorex araneus*. Embryo 12 mm. Graphic reconstruction of the dental lamina with the enamel organ anlages on one side of the lower jaw. × 33.3.

The dental lamina in a 12 mm embryo makes a small forward bend proximal to the commissure, so that the connection of the first incisor anlage with the dental lamina is situated immediately in front of the commissure. At its lacteal rudiment there are two small folds on the dental lamina, which could possibly correspond to the rudimentary incisor anlages described by *Ärnbäck-Christie-Linde*. A thin layer of dentine has now developed in the small lacteal rudiment as well as in the permanent first incisor germ, which has increased so much in size that it now extends past the second incisor anlage to the canine germ (Fig. 11). These two tooth anlages are situated dorsally to the big first incisor germ immediately beneath the oral epithelium. The rudimentary lacteal second incisor germ has also a thin layer of dentine, but its successor anlage is at an early cup-shaped stage. The lacteal canine rudiment consists of a very small labial bud of the dental lamina, appearing only in one section (15 μ in thickness). The corresponding permanent tooth anlage is also represented only by a thickening, though a somewhat bigger one. In the lacteal fourth premolar germ a thick layer of dentine has now developed.

The only rudimentary tooth anlage that is clearly visible in a 14 mm embryo is the lacteal fourth premolar germ, but its outer and inner enamel epithelia are so close together that no enamel pulp can be seen. The lacteal second incisor germ has shrunk, and the germs of the first incisor and the canine have become

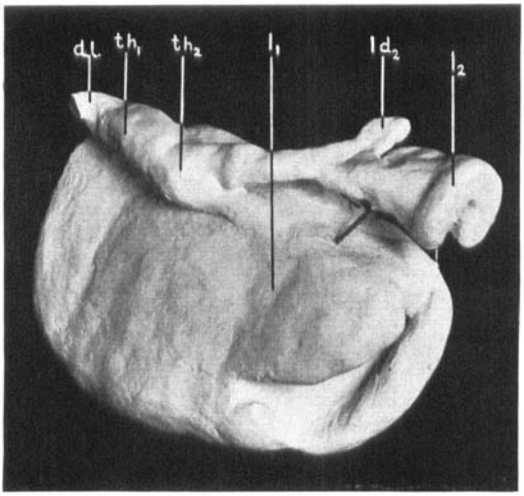

Fig. 12. *Sorex araneus*. Embryo 15 mm. A graphic model of the anterior part of the dental lamina of the lower jaw with the first and the second incisor anlages. d. l. = dental lamina, th_1, th_2 = thickenings.

entirely resorbed. The permanent first incisor anlage is very well developed; in its enamel pulp star-shaped cells are seen. The permanent second incisor anlage has reached the cup-shaped stage, but the permanent canine germ has become resorbed. The germs of the fourth premolar, the first and the second molars have developed markedly, and the third molar anlage appears as a bud.

There are two small thickenings on the dental lamina posteriorly to the commissure in a 15 mm embryo (Fig. 12, th_1 and th_2) which very likely could correspond to the rudimentary anterior incisor anlages described by *Ärnbäck-Christie-Linde*. They do not represent any tooth anlages but are merely folds of the dental lamina. A very small fragment of the lacteal first incisor anlage is found in this embryo (Fig. 5, Id_1), as a concentration of cells, which is connected with the oral epithelium near the commissure by means of a thin string of cells. Nor has the lacteal second incisor rudiment become completely resorbed (Figs. 5 and 12, Id_2). The corresponding permanent tooth germ (I_2) is still in the cup-shaped stage, but it has grown bigger and its invagination has deepened. A small fragment of the lacteal canine

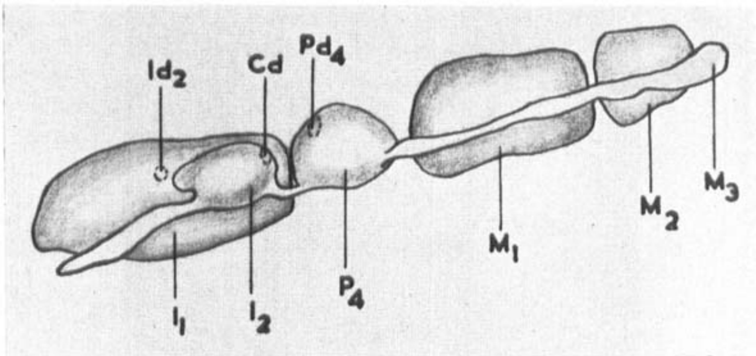

Fig. 13. *Sorex araneus.* **Embryo 16.5 mm. Graphic reconstruction of the dental lamina on one side of the lower jaw with the enamel organ anlages. × 33.3.**

rudiment is also present (Fig. 5, Cd), but there is no trace of its successor germ. The permanent fourth premolar anlage (P_4) has increased in volume. It extends in front of the lacteal rudiment. The gap anterior to it, representing the wanting third incisor, the degenerated canine, and the anterior premolars, has become much smaller. The first molar germ (M_1) is well developed. Immediately in front of the second molar anlage (M_2) there is a sac-like thickening on the labial side of the dental lamina but only on one side of the jaw, probably an anomaly. The dental lamina is partly separated from the oral epithelium and at the second molar germ it is laid in folds.

The commissure is being resorbed and only fragments remain in the 16.5 mm, 17 mm, and 17.5 mm embryos. Large portions of the dental lamina are degenerating. The lacteal first incisor germ is completely resorbed. Of the second one a small fragment still remains (Fig. 13, Id_2), as well as of the lacteal canine (Cd), which is here situated at the posterior edge of the permanent second incisor anlage (I_2). The lacteal premolar rudiment (Pd_4) remains unchanged. The tooth germs of the permanent dentition have become much bigger. The first incisor anlage (I_1), in which the formation of dentine is in progress, has increased in volume so that it extends downwards behind the second incisor germ. This tooth anlage (I_2) and the adjacent premolar germ (P_4) are still without any formation of dentine in spite of the increase in volume. In the first molar germ (M_1) the formation of dentine has begun. At the posterior part of the second molar anlage (M_2) the dental lamina is still well developed and connected with the oral epithelium, and most posteriorly it has a big, slightly cup-shaped thickening which forms the germ of the third molar (M_3).

NEOMYS (CROSSOPUS) FODIENS

In the two old embryos of Neomys fodiens, 19 mm and 20.5 mm in length, which I have investigated, the commissure between the dental lamina on each side of the upper jaw still remains. The formation of dentine has begun in the first incisor and fourth premolar anlages of both jaws. Rudimentary lacteal tooth germs are observed at the enamel organ anlages of the upper canine, the third and fourth premolars; the latter is the most developed one and has a thin layer of dentine. The dental lamina is degenerating at the permanent first incisor anlage.

SUNCUS (CROCIDURA) ORANGIAE

Upper jaw

In the upper jaw of the youngest embryo of Suncus orangiae, 6.25 mm in length, the dental lamina consists of a thickening of the oral epithelium with a few slightly swollen parts surrounded by condensations of cells.

A broad commissure between the dental lamina on each side has formed in the 7.5 mm embryo (Fig. 14, com). Level with it there is labially a very small bell-shaped enamel organ anlage, representing the rudimentary lacteal first incisor germ (Id^1). Very close to this anlage the dental lamina is markedly thickened. This swollen part is slightly cup-shaped dorso-medially and forms the anlage of the permanent first incisor (I^1). The lacteal second incisor anlage (Id^2) is smaller and situated dorsally. The corresponding permanent tooth anlage (I^2) is in the bud-shaped stage. The gap behind it is larger than that between the other tooth germs and marks the site of the third incisor anlage, which has completely disappeared. The next thickening of the dental lamina represents the anlages of the canine (C) and its rudimentary predecessor (Cd). The fourth bud has a labial invagination with a condensation of cells, which is the germ of the lacteal third premolar (Pd^3). This thickening increases further, also

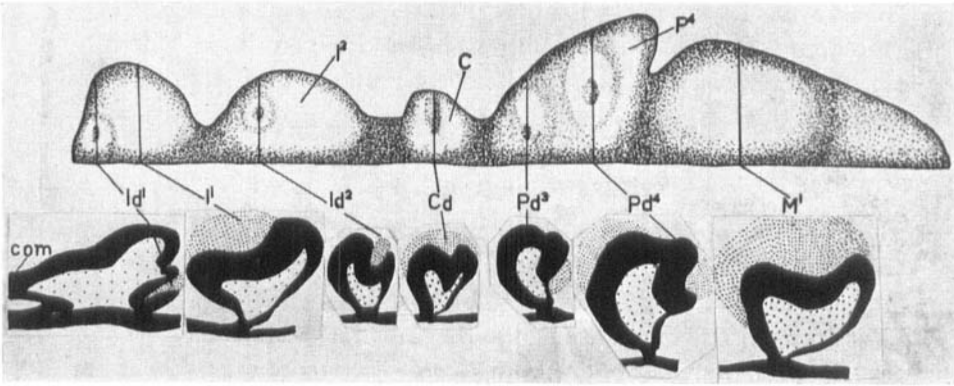

Fig. 14. *Suncus orangiae.* Embryo 7.5 mm. Graphic reconstruction of the dental lamina on one side of the upper jaw with the tooth germs, and transverse sections of certain parts, viewed from the labial side. × 100.

forming the anlage of the fourth premolar (P^4). A shallow labial invagination on it represents the anlage of the lacteal predecessor (Pd^4) which consists of cells equal in size to those in the permanent tooth anlage and, hence, differing from the other lacteal tooth anlages, the cells of which are smaller, and indicating a less prominent degeneration. The last tooth bud is the anlage of the first molar (M^1), clearly separated from the anterior one, and with a papilla invagination situated dorso-medially. The dental lamina continues caudally, becoming fairly wide for a short distance, and is wholly connected with the oral epithelium.

The lacteal first incisor germ is slightly smaller in the 8 mm embryo (Fig. 15, Id^1) than in the 7.5 mm embryo, and the papilla opening is narrower. It seems to be on the point of resolving. The permanent first incisor anlage (I^1) is big and more developed. The lacteal second incisor germ (Id^2) is small and cup-shaped with a lateral papilla invagination. The corresponding permanent tooth anlage (I^2) is still in the bud-shaped stage but bigger. The canine anlage (C), situated on the premaxillo-maxillary suture (pm—m), has a shallow dorso-lateral invagination with a small concentration of cells, which probably is the remnant of the degenerating predecessor. At the anterior edge of the next tooth bud, there are two small labial processes from the dental lamina, which presumably are the anlages of the lacteal third and fourth

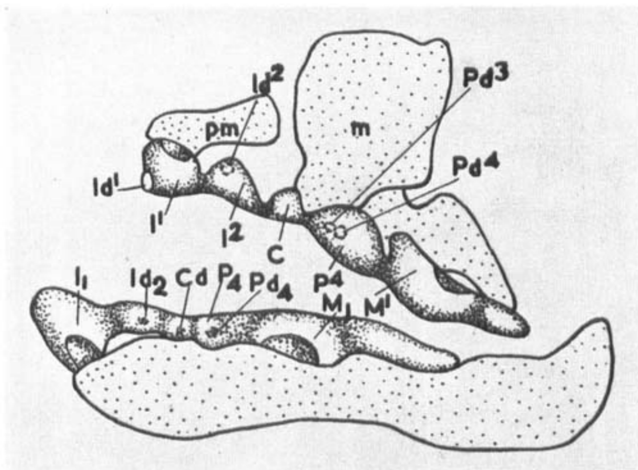

Fig. 15. ***Suncus orangiae.*** **Embryo 8 mm. Graphic reconstruction of the dental laminae with the tooth germs on one side of the upper and the lower jaws, viewed from the lingual side. × 33.3.**

premolars (Pd^3 and Pd^4); the latter is more developed than the former. No germ of a permanent third premolar is found. The permanent fourth premolar anlage (P^4) is very big and slightly cup-shaped. The first molar anlage (M^1) is of about the same size as the permanent first incisor anlage. It is cup-shaped with a big papilla invagination. The posterior part of the dental lamina does not differ from that in the younger embryo.

There are only a few remnants of the lacteal first incisor in a 9.8 mm embryo. The second incisor anlage, too, is all but resolved. The canine rudiment consists of a slightly cup-shaped labial process. The rudiment of the third premolar is entirely resolved, and of the fourth premolar rudiment nothing remains but a large number of degenerated cells. The anlage of the first incisor of the permanent dentition has grown considerably, as has that of the second incisor which now has a papilla situated lingually. The canine anlage appears very indistinctly. The germ of the fourth premolar is slightly smaller than that of the first incisor, whereas the first molar anlage is somewhat bigger. A second molar anlage appears as a very slightly cup-shaped thick-

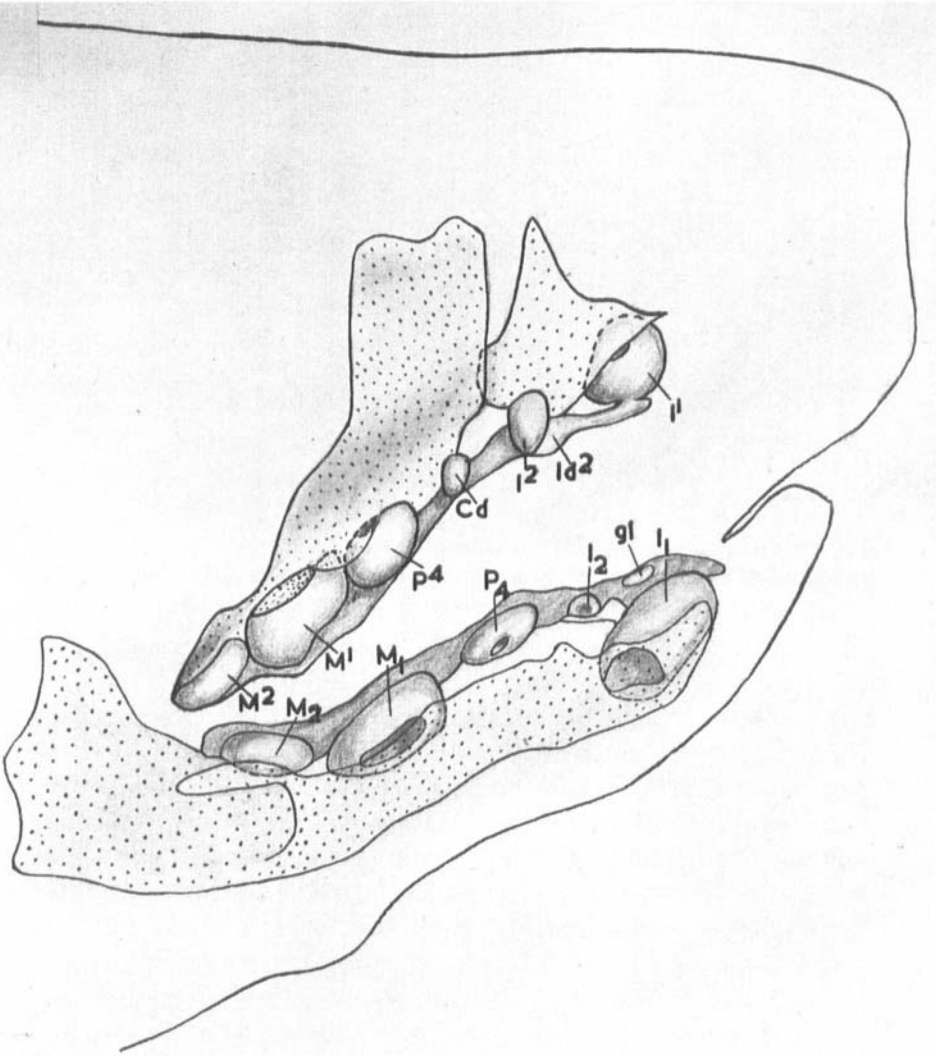

Fig. 16. *Suncus orangiae.* Embryo 10 mm. Graphic reconstruction of one side of the upper and the lower jaws with the dental laminae and the tooth germs, viewed from the lingual side. × 33.3.

ening. The dental lamina continues for a short distance and in places is separated from the oral epithelium.

The lacteal first incisor anlage is completely resolved in a 10 mm embryo. The second one (Fig. 16, Id^2) appears as a very small bud on the labial side of its successor anlage. The lacteal canine anlage (Cd) consists of a small cup-shaped bud on the dental lamina, which is here only slightly swollen. Some distinct traces of the lacteal fourth premolar anlage also remain. The anlages of the permanent teeth have developed. The outer epithelium of the enamel organ of the first incisor is extremely swollen lingually at the point where it joins the dental lamina, immediately behind the commissure, but there are no traces of anterior tooth anlages as those described by *Ärnbäck-Christie-Linde.* The second incisor anlage (I^2) has reached the cup-shaped stage. No permanent canine germ is seen. The fourth premolar anlage (P^4) is bell-shaped as is the much bigger first molar anlage (M^1). The second molar anlage is scarcely any more developed than in the younger embryo. Posteriorly the dental lamina is laid in many folds.

All traces of lacteal tooth rudiments have completely disappeared in the 11 mm embryo. The commissure has shrunk a little. The permanent tooth anlages are much more developed. The first incisor anlage extends slightly in front of the commissure and a thin layer of dentine has developed. The second incisor anlage is at a considerably younger stage. Immediately beside it the dental lamina is markedly swollen. This thickening could possibly represent the third incisor anlage. The canine anlage is cup-shaped and situated immediately above it. In front of the fourth premolar anlage, which now has a thin layer of dentine, there is a thickening of the dental lamina with a concentration of mesenchymal cells dorsally, which probably is the third premolar anlage. In the big first molar germ the formation of dentine has also begun. The second molar anlage has become bigger and a third one appears as a slightly cup-shaped thickening of the dental lamina.

The commissure is markedly degenerated in a 12 mm and a 15 mm embryo. A small fragment of the lacteal second incisor still remains. The permanent first incisor anlage (Fig. 17, I^1) has a thick layer of dentine and at the tip of the germ a thin layer of enamel as well. It has increased so much in volume that it now extends behind the smaller second incisor anlage (I^2), in which the formation of dentine has just begun. In one of the two investigated 12 mm embryos the third incisor anlage (I^3) is

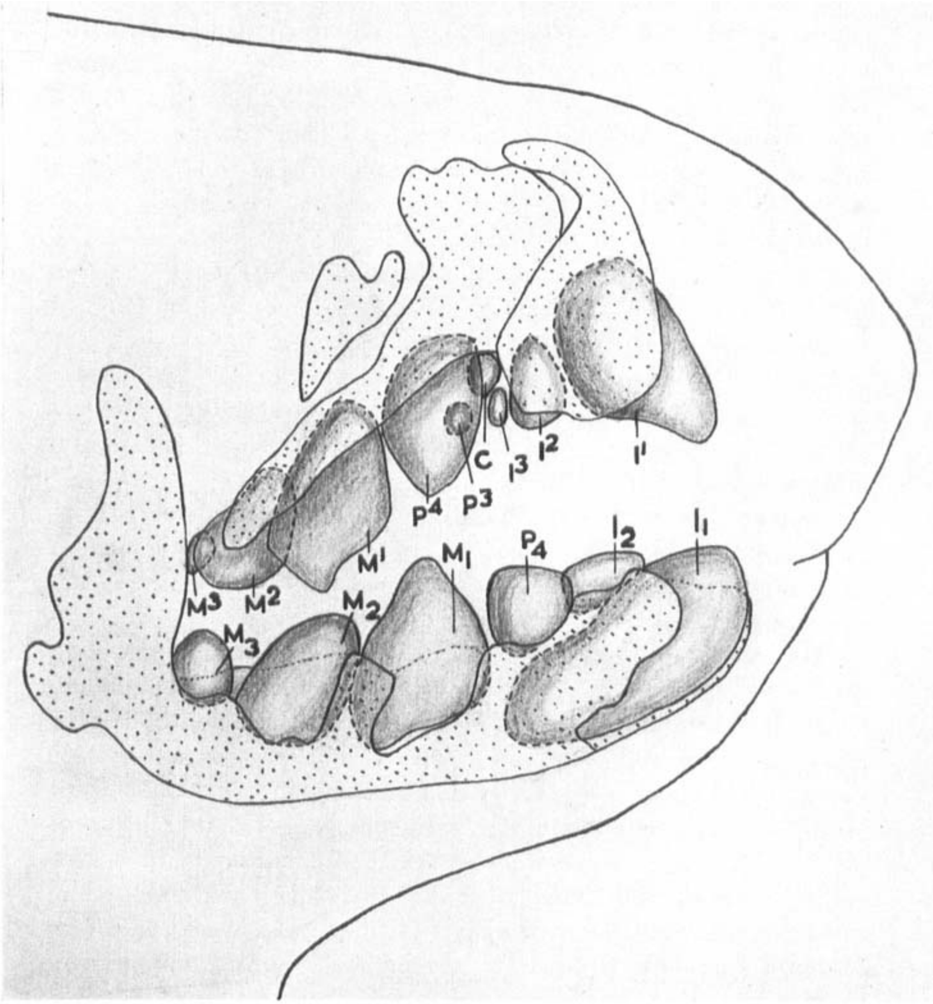

Fig. 17. *Suncus orangiae*. Embryo 12 mm. Graphic reconstruction of one side of the upper and the lower jaws with the dental sacs, viewed from the labial side. × 33.3.

a little bigger than the canine anlage, but in the 15 mm embryo the two anlages are about equal in size. Both are in the cup-shaped stage. The third premolar anlage (P^3) consists only of a thickening of the dental lamina. The fourth premolar (P^4) as well as the first and second molar anlages (M^1 and M^2) are very well developed with many cusps in which the formation of dentine is in progress. The third molar anlage (M^3) is cup-shaped. The dental lamina has degenerated at the most developed tooth anlages, where only some fragments remain, but at those tooth germs which appear last and are least developed, *viz.*, the third incisor, the canine, and the third premolar, it still remains unchanged.

The commissure is broken in an 18 mm embryo and only a few fragments remain. The same is the case with the dental lamina. The tip of the permanent first incisor has now forced its way into the oral epithelium, which is very thick in this area. The second incisor anlage has grown bigger. The third incisor and the canine anlages are about equal in size and still very slightly developed. The dental lamina remains well preserved here. The third premolar anlage has not developed further but the fourth premolar is much bigger. The first molar has now two cusps with dentine. In the second molar anlage the formation of dentine is scarcely discernible. The third molar anlage is only slightly developed.

A few remnants of the commissure still remain in a 22 mm embryo. All tooth anlages have developed considerably. In the second incisor germ the formation of enamel has begun. The third incisor and the canine anlages have increased in volume, but they are still without any formation of dentine. The third premolar germ is in the cup-shaped stage. The fourth premolar anlage has a thin layer of enamel on the biggest of the cusps, as has the first molar anlage. The third molar germ has become much bigger, but the formation of dentine has not yet begun.

There are nine teeth on each side of the upper jaw in an adult animal, *viz.*, three incisors, one canine, two premolars, and three molars. The first incisor is very big, bends forward, and is reminiscent of the teeth of rodents. It has two cusps, a small one inside the big one. The second incisor is small and has one cusp but is provided with a talon. The third incisor is about half the size of the second incisor, but in other respects identical with it. The canine, which is quite like the third incisor, is situated at the maxillo-intermaxillary suture. The third premolar is very small, labially barely discernible. It is inside the big fourth premolar, which has a large talon. The two anterior molars are about equal in size. They have three exterior and two interior cusps and two small ones on the talon. The much smaller third molar also has several cusps. In the palate between the first incisors on each side of the jaw there are still some remnants of the degenerated commissure, clearly discernible in the sections.

Lower jaw

The anterior part of the dental lamina appears as a thickening of the oral epithelium in the lower jaw of a 6.25 mm embryo of Suncus orangiae. Towards the back it becomes lower and broader and disappears gradually, farthest back, however, it reappears.

In the 7.5 mm embryo the germ of the permanent first incisor is a big cup-shaped thickening with a wide invagination lingually (Fig. 18, I_1). Labially, at the anterior part of the germ there is the rudimentary predecessor anlage (Id_1), which is developed a little further but smaller and provided with a narrow papilla invagination. A small bud on the lingual side of the neck of the permanent first incisor germ is the anlage of a gland (glandula submandibularis) (gl). The fact that the gland has developed from the neck of the enamel organ anlage and not directly from the oral epithelium, as is often the case, is of no fundamental importance, since the dental lamina itself arises from this epithelium and is still connected with it. The lacteal second incisor anlage (Id_2) is less developed than the first one. The dental lamina is very slightly swollen in this area and does not show a corresponding permanent tooth anlage. The lacteal canine germ (Cd) is equal in shape and size to that of the second incisor and is also without a successor anlage. The rudimentary predecessor of the fourth premolar (Pd_4) is bigger and more developed. The permanent fourth premolar anlage is in an early cup-shaped stage with a concentration of cells in front of a shallow papilla invagination. The first molar anlage (M_1) is almost equal in size to the first incisor anlage. The dental lamina continues backwards.

The resorption of the rudimentary lacteal tooth anlages has started in the 8 mm embryo. Only a very small fragment of the first incisor remains. The second incisor (Fig. 15, Id_2) is only represented by a shallow invagination with a small concentra-

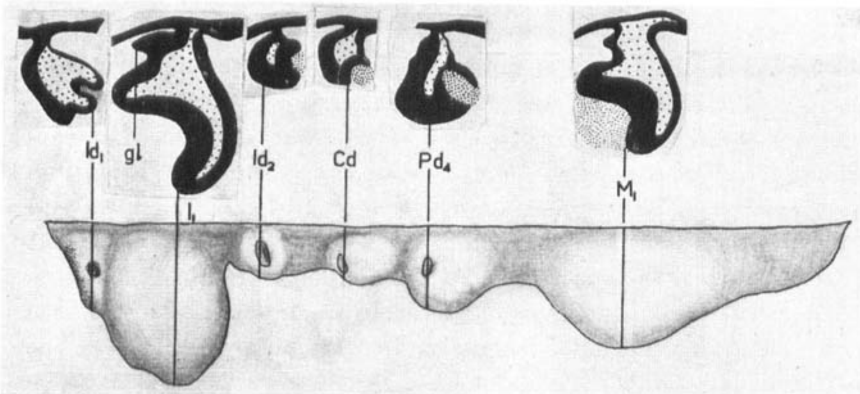

Fig. 18. *Suncus orangiae.* Embryo 7.5 mm. Graphic reconstruction of the dental lamina on one side of the lower jaw with the tooth germs, and transverse sections through the latter, viewed from the labial side. × 100.

tion of cells on the labial side of the dental lamina. The lacteal canine anlage (Cd) is also very small. The lacteal fourth premolar anlage (Pd_4) still appears with a distinct papilla invagination. The big permanent first incisor anlage (I_1) is in the bell-shaped stage. In this embryo the gland anlage near it is in direct connection with the oral epithelium, thus, indicating its origin from this epithelium. The permanent fourth premolar anlage (P_4) is less developed than in the 7.5 mm embryo. It is in the bud-shaped stage. The first molar germ (M_1) is big and bell-shaped with a distinct neck. The dental lamina continues caudally to become fairly thickened, but without showing any signs of more tooth germs.

The lacteal first incisor rudiment is wholly resolved in a 9.8 mm embryo. Of the second incisor there remains only a very small concentration of cells in front of a shallow labial invagination on the dental lamina. The remnant of the lacteal canine is similar. The rudimentary predecessor of the fourth premolar is represented by a small concentration of cells on the labial side of the successor. In front of the permanent first incisor anlage a small bud-shaped projection on the dental lamina is observed, but only on one side of the jaw. Such formations are also found further back and do not indicate rudimentary tooth anlages. In the enamel organ of the permanent first incisor a thin outer and a thicker inner layer of tall cylindrical cells can be distinguished, and between the two layers there is an enamel pulp with star-shaped cells. The dental lamina itself appears in sections as a bud situated lingually on the enamel organ. The gland anlage at this incisor germ now consists of a pocket of the oral epithelium filled with cells similar to those in the upper layer of this epithelium. It has made its way through the dental lamina and ends lingually to the tooth anlage. A first sign of the permanent second incisor is seen as a small thickening of the dental lamina. The permanent fourth premolar germ is cup-shaped and has a papilla anlage situated lingually. In development and size the first molar anlage is equal to the first incisor anlage, and the second molar germ appears as a large thickening with a shallow lingual papilla invagination.

The anterior part of the dental lamina is laid in numerous folds in the 10 mm embryo. Its connection with the oral epithelium is almost completely broken, remaining only in places, except at the less developed tooth germs where it is still intact. It extends as a band immediately beneath the oral epithelium. The permanent first incisor anlage has now a thin layer of dentine (Fig. 16, I_1). The second one (I_2) is cup-shaped with a small papilla anlage. Close to it there is a small concentration of cells, forming the rest of the lacteal predecessor. The lacteal canine remnant is slightly bigger and situated labially to the dental lamina. The permanent fourth premolar anlage (P_4) and its predecessor still seem to be unchanged. The first molar anlage (M_1) has developed a thin layer of dentine. The second one (M_2) is in the cup-shaped stage. The dental lamina continues distally for a short distance.

The first incisor anlage has increased in volume in an 11 mm embryo so that it extends below the second one and up to the fourth premolar germ. The layer of dentine has become thicker. The second incisor anlage is also much developed. The fourth premolar anlage is in the same stage of development but a little larger. The first molar anlage has formed many cusps, and on the most developed cusp is a layer of dentine. The second molar anlage has also many cusps, but its layer of dentine is very insignificant. The third molar has now appeared. The dental lamina does not continue behind it.

The dental lamina is still laid in folds at the first incisor anlage in a 12 mm embryo. The rest of it is dissolving; fragments are found in solitary places. Only at the third molar anlage does it remain unchanged. The first incisor anlage (Fig. 17, I_1), in addition to a thick layer of dentine, has a thin layer of enamel. It now extends under the entire fourth premolar germ (P_4). In the latter tooth anlage, which is slightly bigger than the second incisor (I_2), the formation of dentine has begun. The three molar anlages are much developed, but the third is still without dentine.

In a 15 mm embryo the formation of dentine has also begun in the second incisor anlage, and on the most developed cusp of the first molar anlage there is now a thin layer of enamel.

The anterior part of the dental lamina is markedly lobated at the first incisor anlage in an 18 mm embryo. By making a graphical reconstruction of this part of the dental lamina I found that it was possible to discern faintly two main lobes. Contrary to *Ärnbäck-Christie-Linde,* however, I do not consider it probable that these should be interpreted as rudimentary tooth germs. The dental lamina is much degenerated, yet it appears distinctly at the least developed tooth anlages, *viz.,* the second incisor, the fourth premolar, and the third molar.

The formation of enamel is proceeding in all the tooth germs of a 22 mm embryo, except in the third molar anlage in which the formation of dentine has just begun.

In adult animals the lower first incisor on each side is directed straight forward, thus resembling the teeth of the rodents. The second incisor and the premolar are cone-shaped and small. The first molar is a little broader than the second molar, but in other respects they are alike. Both have five cusps. The third molar is narrower and has only four cusps.

CROCIDURA ARANEUS (RUSSULA)

In Crocidura araneus the small upper third premolar is wanting, while in Suncus (Crocidura) orangiae it seems to be rudimentary. The rest of the teeth are identical in the two species.

DISCUSSION

This investigation has shown that the lacteal dentition in Sorex araneus as well as in Suncus orangiae consists of small rudimentary tooth anlages, one at each antemolar, except at the third incisor. On both sides of the jaws there are rudiments of two incisors and one canine, in the upper jaw of three premolars in Sorex araneus but of two in Suncus orangiae, and in the lower jaw in both species only of one premolar. All tooth rudiments are resorbed at a very early stage of the development, earlier in Suncus orangiae, where they are less developed and without any formation of dentine. The most developed tooth rudiment in both species is the distal premolar.

I wish to emphasize that I have not found any persistent lower lacteal premolar anlage in young specimens of Sorex araneus as those described by *Ärnbäck-Christie-Linde*. Her interpretation of the number of the lacteal tooth rudiments and her identification of them has not been wholly verified by my investigation. She considered, for instance, that there are four premolars and that each of them, except the lower third one, has a lacteal predecessor in Sorex araneus, and that in Crocidura russula the first premolar is also represented by a rudimentary lacteal tooth anlage, but not the upper second and the upper and lower third premolars.

According to my findings the premolars develop successively postero-anteriorly and the rate of their development decreases in the same order. A less developed tooth anlage has seemed to degenerate earlier than a more developed one. Thus, the degeneration of the premolars must take place antero-posteriorly. The first premolar has completely disappeared in both dentitions.

A supernumerary lacteal tooth anlage in front of the upper first molar, as the one *Ärnbäck-Christie-Linde* claims to have observed in Crocidura russula, has not been seen by me in Suncus orangiae or Sorex araneus.

In Sorex araneus an anterior commissure between the dental lamina of each side of the jaw is found in the upper as well as in the lower jaw, while in Neomys fodiens and Suncus orangiae such a commissure is seen only in the upper jaw. This is in agreement with *Ärnbäck-Christie-Linde*'s observations.

In the permanent dentition in Sorex araneus and Suncus orangiae there are three incisors in the upper jaw, the first being the most developed and the third being the smallest. As to an upper fourth incisor mentioned by *Leche*, *Woodward* questioned its existence and suggested the possibility that the canine anlage has been interpreted as the fourth incisor. This supposition by *Woodward* has been verified by my investigation. In the lower jaw there are only two incisors, the third is missing. *Ärnbäck-Christie-Linde* and *Winge* (1923) considered that the lower second incisor was also missing.

The upper canine anlage does not degenerate, as stated by *Ärnbäck-Christie-Linde*, but develops and remains in the adult animal. In the lower jaw, the canine anlage only reaches the bud-shaped stage and degenerates early. *Winge* was of the opinion that the canine remains in both jaws. He has probably confused the canine in the lower jaw with the second incisor.

In accordance with *Woodward*'s opinion the premolars are three in number, not four as claimed by *Ärnbäck-Christie-Linde*, in each side of the upper jaw in Sorex araneus, but only two in Suncus orangiae. The first premolar has disappeared in both species, and in Suncus orangiae the second one as well. According to *Winge* the upper third premolar is missing, but the upper second premolar remains in Crocidura and, according to *Ärnbäck-Christie-Linde*, the upper first and fourth premolars remain. In the lower jaw, only the fourth premolar remains in both species, as held by *Leche* and *Woodward*, and would correspond to the most developed premolar in the upper jaw. This is in agreement with *Winge*'s reports, but *Ärnbäck-Christie-Linde* considered that the lower first and fourth premolars remain both in Sorex araneus and in Crocidura russula. However, the reduction of the permanent premolars occurs in an antero-posterior direction. The statements by *Winge* and *Ärnbäck-Christie-Linde* would seem to be a misinterpretation.

Conformity exists as regards the three molars in both jaws of Sorex araneus and Suncus orangiae. The first molar is the most developed and the other two diminish successively.

The dental formula would thus be as follows (the rudimentary tooth anlages in parenthesis):

$$\text{In Sorex araneus: } \begin{array}{cccccccccc} I^1 & I^2 & I^3 & C & P^2 & P^3 & P^4 & M^1 & M^2 & M^3 \\ (Id^1) & (Id^2) & - & (Cd) & (Pd^2) & (Pd^3) & (Pd^4) & & & \\ \hline (Id_1) & (Id_2) & - & (Cd) & - & - & (Pd_4) & & & \\ I_1 & I_2 & - & (C) & - & - & P_4 & M_1 & M_2 & M_3 \end{array}$$

$$\text{In Suncus orangiae: } \begin{array}{ccccccccc} I^1 & I^2 & I^3 & C & P^3 & P^4 & M^1 & M^2 & M^3 \\ (Id^1) & (Id^2) & - & (Cd) & (Pd^3) & (Pd^4) & & & \\ \hline (Id_1) & (Id_2) & - & (Cd) & - & (Pd_4) & & & \\ I_1 & I_2 & - & (C) & - & P_4 & M_1 & M_2 & M_3 \end{array}$$

Ärnbäck-Christie-Linde believes that she has found traces of rudimentary tooth anlages anterior to the permanent first incisor anlage, but I have not been able to discern any. In all probability she has interpreted folds in the anterior part of the dental lamina as rudimentary tooth anlages. Sometimes the dental lamina is slightly thickened immediately posterior to the commissure, but this does not indicate any traces of tooth anlages. Since the material which I have investigated consists of an uninterrupted series of stages and *Ärnbäck-Christie-Linde* had only a few stages at her disposal, it is most probable that my observations are more plausible than hers and that no anterior supernumerary rudimentary incisor anlages exist. I cannot share *Ärnbäck-Christie-Linde*'s opinion that Soricidae is of the same origin as the Polyprotodontia of the Marsupialia because of rudimentary supernumerary incisor anlages.

I have not found any traces of a prelacteal and a postpermanent dentition, described by *Ärnbäck-Christie-Linde.*

The degeneration of the teeth is more advanced in the lower jaw, where it is identical in Sorex araneus and Suncus orangiae; in the upper jaw it has progressed further in Suncus than in Sorex. The tooth formula of Sorex araneus seems to be more primitive than that of Suncus orangiae, in which the reduction of the teeth is more advanced.

A rule of general application, at least as far as the teeth in the Insectivora are concerned, seems to be that a less developed tooth anlage degenerates earlier than a more developed one. The degeneration of the premolars occurs antero-posteriorly, while that of the incisors and the molars occurs postero-anteriorly. The present author calls in question that the course of the reduction of the premolars in Man should be reversed, i.e. occur in a postero-anterior direction, as maintained by *Grahnén* (1956).

RESUME

DEVELOPPEMENT DENTAIRE CHEZ LES SORICIDES

Cette investigation a montré que la dentition temporaire chez Sorex araneus et Suncus orangiae est composée de petits germes dentaires rudimentaires, un germe au niveau de chaque antémolaire excepté au niveau la troisième incisive. De chaque côté des deux mâchoires se trouvent les rudiments de deux incisives et d'une canine; au maxillaire supérieur les rudiments de trois prémolaires chez Sorex araneus, mais de deux seulement chez Suncus orangiae; et au maxillaire inférieur chez les deux espèces on trouve une seule prémolaire. Tous les rudiments se résorbent à une période précoce du développement, plus tôt chez Suncus orangiae où ils sont plus petits et totalement dépourvus de dentine. La prémolaire distale est la plus développée de tous les rudiments chez les deux espèces.

Je tiens à souligner que je n'ai pas constaté la persistance de germes de prémolaires inférieures temporaires chez de jeunes individus de Sorex araneus comme *Ärnbäck-Christie-Linde* en décrit. Son opinion concernant le nombre de germes dentaires temporaires et leur identification n'a pas été vérifiée complètement lors de mon investigation. Elle croyait, par exemple, qu'il y avait quatre prémolaires et que chacune d'elles, exceptée la troisième prémolaire inférieure, avait un prédécesseur temporaire chez Sorex araneus, la première prémolaire chez Crocidura russula étant aussi représentée par un germe dentaire temporaire rudimentaire, tandis que ce n'était le cas ni pour la seconde prémolaire supérieure, ni pour les troisièmes prémolaires.

Il ressort de mon investigation que les prémolaires se développeraient successivement d'arrière en avant, et que le degré de leur développement diminuerait dans le même ordre. Un germe dentaire moins développé a semblé dégénérer plus tôt qu'un germe plus développé. Par conséquent, la dégénération des prémolaires se ferait d'avant en arrière. La première prémolaire a disparu complètement dans les deux dentitions.

En ce qui concerne un germe dentaire temporaire surnuméraire devant la première molaire supérieure, comme cela a été décrit par *Ärnbäck-Christie-Linde* chez Crocidura russula, je n'en ai trouvé ni chez Suncus (Crocidura) orangiae ni chez Sorex araneus.

Une connexion antérieure entre la lame dentaire des deux côtés de la mâchoire a été constatée à la mâchoire supérieure et à la mâchoire inférieure chez Sorex araneus, mais chez Neomys fodiens et Suncus orangiae cette connexion n'a été constatée qu'au maxillaire supérieur, et cela concorde avec les observations d'*Ärnbäck-Christie-Linde.*

Dans la seconde dentition chez Sorex araneus et Suncus orangiae, il y a trois incisives supérieures, la première étant la plus développée et la troisième la plus petite. Quant à une quatrième incisive supérieure, décrite par *Leche, Woodward* a mis son existence en doute et il a indiqué la possibilité que le germe de la canine ait été pris pour la quatrième incisive. Cette hypothèse de *Woodward* est confirmée dans mon enquête. Il n'y a que deux incisives au maxillaire inférieur, la troisième manque. *Ärnbäck-Christie-Linde* et *Winge* (1923) croyaient que la deuxième incisive inférieure manquait aussi.

Le germe de la canine supérieure ne dégénère pas comme le croyait *Ärnbäck-Christie-Linde,* mais se développe et persiste chez l'animal adulte. Au maxillaire inférieur, le germe de la canine atteint seulement la phase "bourgeon" et dégénère tôt. Selon l'opinion de *Winge* la canine persiste aux deux maxillaires. Il a probablement confondu la canine de la mâchoire inférieure avec la deuxième incisive.

De chaque côté du maxillaire supérieur chez Sorex araneus, il y a trois prémolaires, conformément à l'opinion de *Woodward,* et non pas quatre comme *Ärnbäck-Christie-Linde* l'a cru, mais chez Suncus orangiae il n'y en a que deux. La première prémolaire a disparu chez les deux espèces, et la deuxième aussi chez Suncus orangiae. D'après l'opinion de *Winge* la troisième prémolaire supérieure a disparu, mais la deuxième prémolaire supérieure persiste chez Crocidura. L'avis d'*Ärnbäck-Christie-Linde* est que la première et la quatrième prémolaires supérieures persistent. Au maxillaire inférieur, chez les deux espèces, seule la quatrième prémolaire persiste, comme *Leche* et *Woodward* l'ont affirmé, et elle correspondrait à la prémolaire la plus développée au maxillaire supérieur. Cela confirme les indications de *Winge*. *Ärnbäck-Christie-Linde,* cependant, croyait que la première et la quatrième prémolaires inférieures persistaient chez Sorex araneus et chez Crocidura russula. La réduction des prémolaires persistantes se fait pourtant d'avant en arrière. Il semblerait que les opinions de *Winge* et *Ärnbäck-Christie-Linde* proviennent d'une erreur d'interprétation.

Quant aux trois molaires, il y a conformité aux deux mâchoires chez Sorex araneus et Suncus orangiae. La première molaire est la plus développée et les deux autres diminuent successivement.

La formule dentaire (avec les germes dentaires rudimentaires entre parenthèses) serait ainsi: (voir tableau à la page 230).

Ärnbäck-Christie-Linde croyait avoir trouvé des vestiges de germes dentaires rudimentaires devant le germe de la première incisive persistante, mais je n'en ai pas découvert. Elle a probablement pris les plis de la partie antérieure de la lame dentaire pour des germes dentaires rudimentaires. La lame dentaire est parfois un peu épaissie immédiatement derrière la connexion antérieure, mais cela ne peut être interprété comme des vestiges de germes dentaires. Comme les matériaux que j'ai examinés se composent d'une série ininterrompue de stades et comme *Ärnbäck-Christie-Linde* n'avait que peu de stades à sa disposition, il est fort probable que mes observations sont plus plausibles que celles d'*Ärnbäck-Christie-Linde,* et que, par conséquent, il n'existe pas de germes d'incisive antérieure surnuméraire rudimentaire. Je ne peux partager l'avis d'*Ärnbäck-Christie-Linde,* suivant qui Soricidae aurait la même origine que les Polyprotodontia des Marsupialia en raison des germes des incisives rudimentaires surnuméraires.

Je n'ai pas trouvé trace d'une dentition prélactéale et d'une dentition postpermanente décrites par *Ärnbäck-Christie-Linde.*

La dégénération des dents est plus avancée au maxillaire inférieur, où elle est identique chez Sorex araneus et Suncus orangiae; au maxillaire supérieur elle a progressé plus chez Suncus que chez Sorex. Il semble que la formule dentaire de Sorex araneus soit plus primitive que celle de Suncus orangiae, chez qui la réduction des dents est plus avancée.

Il semblerait qu'en règle générale, au moins en ce qui concerne les dents chez les Insectivora, un germe dentaire moins développé dégénère plus tôt qu'un germe plus développé. La réduction dentaire numérique des prémolaires se fait d'avant en arrière tandis que celle des incisives et des molaires se fait d'arrière en avant. D'après *Grahnén* (1956), la réduction des prémolaires chez l'Homme se produirait dans l'ordre inverse, c'est-à-dire d'arrière en avant, ce dont je doute fort.

ZUSAMMENFASSUNG

UNTERSUCHUNGEN ÜBER DIE ZAHNENTWICKLUNG BEI SORICIDAE

Diese Untersuchung zeigt, dass das Milchgebiss bei sowohl Sorex araneus als Suncus orangiae aus kleinen rudimentären Zahnanlagen an jedem Antemolar mit Ausnahme des dritten Incisivus, besteht. Es gibt Rudimente von zwei Incisivi und einem Caninus in jeder Kieferhälfte, im Oberkiefer von drei Prämolaren bei Sorex araneus, von zwei bei Suncus orangiae, und im Unterkiefer bei beiden Species nur von einem Prämolare. Alle diese Zahnrudimente werden in einem jungen Entwicklungsstadium resorbiert, früher bei Suncus orangiae, wo sie weniger entwickelt sind, und wo kein Dentin gebildet wird. Der letzte Milchprämolar ist die am meisten entwickelte Zahnanlage bei beiden Species.

Ich möchte betonen, dass ich keine bestehende Anlage eines Milchprämolars im Unterkiefer junger Tiere von Sorex araneus gefunden habe, wie von *Ärnbäck-Christie-Linde* beschrieben ist. Ihre Auffassung von der Anzahl an Milchzahnrudimenten und deren Identifizierung ist nicht ganz von meiner Untersuchung bestätigt. Sie war zum Beispiel der Ansicht, dass vier Prämolaren vorkommen, und dass jeder, bis auf den unteren dritten, bei Sorex araneus ein Deciduum habe, und dass der erste Prämolar bei Crocidura russula auch eine rudimentäre Milchzahnanlage aufweise, aber nicht der obere zweite und der obere und untere dritte.

Nach meiner Untersuchung entwickeln sich die Prämolaren allmählich von hinten nach vorne, und der Grad ihrer Entwicklung nimmt in derselben Reihe ab. Eine weniger entwickelte Zahnanlage erscheint früher zu degenerieren als eine mehr entwickelte. Die Degenerierung der Prämolaren muss demnach von vorne nach hinten stattfinden. Der erste Prämolar ist vollständig verschwunden in beiden Zahnsystemen.

Eine überzählige Milchzahnanlage vor dem oberen ersten Molar, wie *Ärnbäck-Christie-Linde* glaubt bei Crocidura russula beobachtet zu haben, habe ich weder bei Suncus orangiae, noch bei Sorex araneus gefunden.

Eine vordere Kommissur zwischen der Zahnleiste jeder Kieferhälfte kommt bei Sorex araneus sowohl im Ober- als im Unterkiefer vor, aber bei Neomys fodiens und Suncus orangiae nur im Oberkiefer. Dieses ist in Übereinstimmung mit *Ärnbäck-Christie-Linde*'s Beobachtungen.

Die zweite Dentition besteht bei Sorex araneus und Suncus orangiae aus drei oberen Incisivi, der erste ist am meisten entwickelt und der dritte ist der kleinste. *Leche* hat auch einen oberen vierten Incisivus beschrieben, dessen Existenz *Woodward* in Frage stellt und die Möglichkeit andeutet, dass die Caninusanlage als der vierte Incisivus erklärt worden sei, und diese, *Woodward*'s Vermutung, ist von meiner Untersuchung bestätigt worden. Im Unterkiefer sind nur zwei Incisivi vorhanden, der dritte fehlt. *Ärnbäck-Christie-Linde* und *Winge* (1923) meinten, dass auch der untere zweite Incisivus fehle.

Die obere Caninusanlage degeneriert nicht wie *Ärnbäck-Christie-Linde* glaubt, sondern entwickelt sich und bleibt bei dem erwachsenen Tier bestehen. Im Unterkiefer erreicht die Caninusanlage nur das knospenförmige Stadium und degeneriert früh. Nach *Winge*'s Auffassung bleibt der Caninus in beiden Kiefern erhalten. Er hat wahrscheinlich den Caninus mit dem zweiten Incisivus im Unterkiefer verwechselt.

In Übereinstimmung mit *Winge*'s Auffassung weist jede Oberkieferhälfte bei Sorex araneus drei Prämolaren auf, nicht vier, wie *Ärnbäck-Christie-Linde* behauptet, dagegen bei Suncus orangiae nur zwei. Der erste Prämolar ist bei beiden Spezies verschwunden und auch der zweite bei Suncus orangiae. Gemäss der Auffassung *Winge*'s ist der obere dritte Prämolar verschwunden, der zweite aber soll bei Crocidura bestehen bleiben. Nach der Meinung von *Ärnbäck-Christie-Linde* bleiben die oberen ersten und vierten Prämolare bestehen. Im Unterkiefer beider Spezies bleibt nur der vierte Prämolar erhalten, wie sowohl *Leche* als auch *Woodward* festgestellt haben, und dieser entspricht dem bestentwickelten im Oberkiefer. Dieses stimmt mit der Angabe von *Winge* überein, aber *Ärnbäck-Christie-Linde* glaubte, dass die unteren ersten und vierten Prämolare sowohl bei Sorex araneus als auch bei Crocidura russula erhalten bleiben. Die Reduktion der permanenten Prämolaren geschieht indessen von vorne nach hinten. Die Behauptung von *Winge* und *Ärnbäck-Christie-Linde* dürfte eine Missdeutung sein.

Gleichförmigkeit existiert betreffs der drei Molare in beiden Kiefern bei Sorex araneus und Suncus orangiae. Der erste ist am meisten entwickelt, und die zwei anderen nehmen allmählich ab.

Die Zahnformel mit den rudimentären Zahnanlagen siehe Seite 230.

Ich habe keine Spuren von rudimentären Zahnanlagen, wie sie *Ärnbäck-Christie-Linde* vor der permanenten ersten Incisivusanlage glaubt gefunden zu haben, entdecken können. Aller Wahrscheinlichkeit nach hat sie Falten in dem vorderen Teile der Zahnleiste als rudimentäre Zahnanlagen aufgefasst. Bisweilen ist die Zahnleiste unmittelbar hinter der Kommissur etwas verdickt, aber das kann keine Spur von Zahnanlagen sein. Da mein Untersuchungsmaterial aus einer ununterbrochenen Serie von Stadien besteht und *Ärnbäck-Christie-Linde* nur einige Stadien zu ihrer Verfügung gehabt hat, ist es sehr wahrscheinlich, dass meine Beobachtungen plausibler sind als die ihrigen und dass keine vorderen überzähligen rudimentären Incisivianlagen hier existieren. Ich kann mich nicht *Ärnbäck-Christie-Linde*'s Meinung anschliessen, dass die Soriciden denselben Ursprung haben sollen wie die Polyprotodontia der Marsupialia infolge rudimentärer überzähliger Incisivianlagen.

Von einer prälactealen und einer postpermanenten Dentition habe ich, im Gegensatz zur Meinung von *Ärnbäck-Christie-Linde*, keine Spuren finden können.

Die Degenerierung der Zähne ist am weitesten fortgeschritten im Unterkiefer, wo sie bei Sorex araneus und Suncus orangiae identisch ist; im Oberkiefer ist sie beim Suncus weiter fortgeschritten als beim Sorex. Sorex araneus hat eine primitivere Zahnformel als Suncus orangiae, wo die Reduktion der Zähne grösser ist.

Eine allgemeine Regel scheint zu sein, wenigsten so weit es die

Zähne der Insectivora betrifft, dass eine weniger entwickelte Zahnanlage früher als eine mehr entwickelte degeneriert. Die Degeneration der Prämolaren geschieht von vorne nach hinten, während die der Incisivi und der Molaren von hinten nach vorne geschieht. Beim Menschen soll die Reduktion der Prämolaren nach *Grahnén* (1956) in entgegengesetzter Ordnung verlaufen, folglich von hinten nach vorne, was ich jedoch bezweifle.

REFERENCES

Ärnbäck-Christie-Linde, A., 1912: Der Bau der Soriciden und ihre Beziehungen zu anderen Säugetieren. Gegenbauers morph. Jahrb. Bd 44.

Brandt, Ed., 1869: Untersuchungen über das Gebiss der Spitzmäuse (Sorex Cuv.) Bull. Soc. Imp. Nat. Moscou. T. 41: 22—43.

Grahnén, H., 1956: Hypodontia in the permanent dentition. Odontologisk Revy, vol. 7, suppl. 3.

Kindahl, M., 1957: On the development of the tooth in Tupaia javanica. Arkiv för zoologi. Ser. 2, Bd 10.

—»— 1958: Some observations on the development of the tooth in Elephantulus myurus Jamesoni. Arkiv för zoologi. Ser. 2, Bd 11.

—»— 1958: Notes on the tooth development in Talpa europaea. Arkiv för zoologi. Ser. 2, Bd 11.

Leche, W., 1895: Zur Entwicklungsgeschichte des Zahnsystems der Säugetiere, zugleich ein Beitrag zur Stammesgeschichte dieser Tiergruppe, Stuttgart.

Owen, R., 1868: Comparative Anatomy and Physiology of Vertebrates. Vol. III, London.

Tauber, P., 1872: Om tandsæt og Levemaade hos de danske Flagermuus og Insektædere. Naturhist. Tidskrift. Bd 8.

Winge, H., 1882: Om Pattedyrenes Tandskifte især med Hensyn til Tændernes Former. Videnskabelige Meddelelser, Kjøbenhavn.

—»— 1923: Pattedyr-slægter, København.

Woodward, M. F., 1896: Contributions to the study of mammalian dentition. Proc. Zool. Soc., London.

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