# Deciduous Tooth Chronology in the Mandible of the Domestic Pig

W. Sheldon Bivin and Robert C. Mc Clure

*J DENT RES* 1976 55: 591
DOI: 10.1177/00220345760550040701

# Deciduous Tooth Chronology in the Mandible of the Domestic Pig

*W. SHELDON BIVIN and ROBERT C. MC CLURE*

*Department of Clinical Sciences, School of Veterinary Medicine, Louisiana State University, Baton Rouge, Louisiana 70803, USA, and Department of Veterinary Anatomy, University of Missouri, Columbia, Missouri 65201*

*Specimens of known age, weight, and crown-rump length were used to characterize the chronology and histological development of the deciduous teeth in the right mandible of swine. Special observations were made concerning the deciduous origin of the first premolar tooth.*

The basic stages of tooth development have been classified and described in detail for man[1] and modified to some extent for swine.[2] Other studies have described the onset of calcification as it relates to human crown formation.[3] Among the domestic animals, a detailed work was prepared on the initiation and calcification of the deciduous dentition in the dog.[4] However, very little information is available for swine that describes specific stages of tooth development, including onset of enamel formation, that occur for a particular tooth.

Comparative studies that involve tooth development in swine require more information concerning specific stages of tooth development and onset of enamel formation. The present study outlines in descriptive and tabular form the developmental chronology for the mandibular deciduous teeth of the domestic pig.

## Materials and Methods

Specimens for this study were obtained from a herd of 32 sows and two boars (Hampshire and Chester White). These sows were observed daily for estrus by placing them with a boar. Those sows that were receptive and bred were recorded by ear tag number. Timed pregnancies were determined starting with the day following breeding.

Developing embryos and fetuses of known age were obtained every three days by hysterotomy, beginning with the 20th day of gestation and continuing through term which is approximately 114 days. After surgical removal, the embryos and fetuses were immediately prepared for study. Crown-rump measurements (C-R) in millimeters were taken using techniques established for human fetuses and later adapted for swine.[5] The specimens were weighed on a precision balance[a] and the weights and lengths were recorded. The mean body weight and length for each embryo and fetus were recorded and used to compare with the individual specimens used for histological study (Table 1). Specimens for histological study were chosen by random selection from each specific age group litter and preserved in 10% Formalin. Those specimens 50 days of age and older were placed in a rapid bone decalcifying agent.[b] All tissues were cut serially in either sagittal or transverse sections at 10 micrometers thickness, with every section being kept for detailed study. Sections of the whole body were made on those embryos that were 20 to 38 days old. The right mandible was removed and sectioned from those fetuses that were 41 to 47 days old. The right mandible, which had been previously decalcified, was sectioned from those that were more than 50 days old. The tissues were mounted on 2 × 3-inch slides and

This investigation was done by Dr. Bivin in partial fulfillment of the doctor of philosophy degree.

This investigation was supported by USPHS Grant DE-02181 and by the University of Missouri School of Veterinary Medicine VMRC Grants 139 and 195.

Received for publication June 30, 1975.

Accepted for publication January 16, 1976.

[a] Dec-O-Gram, Ohaus Scale Corp., Union, NJ.

[b] Rapid Bone Decalcifying Agent, RDO, Dupage Kinetic Laboratories, Inc., Downers Grove, Ill.

TABLE 1

MEAN BODY WEIGHTS AND CROWN-RUMP LENGTHS FOR EACH LITTER

| Age (days) | Sow No. | Length (mm) | Wt (gm) |
|---|---|---|---|
| 20 | L27R1 | 7.3 | 0.36 |
| 23 | L30R5 | 15.3 | 0.85 |
| 26 | L30R5 | 22.0 | 1.28 |
| 29 | 58 | 34.5 | 1.66 |
| 38 | 53 | 29.0 | 1.90 |
| 35 | 56 | 46.2 | 6.01 |
| 38 | 7 | 46.6 | 6.62 |
| 41 | 48 | 61.2 | 18.05 |
| 44 | L3R4 | 76.9 | 19.62 |
| 47 | 54 | 98.5 | 35.35 |
| 50 | 27 | 102.5 | 50.40 |
| 58 | 51 | 115.5 | 67.57 |
| 56 | 51 | 127.5 | 99.50 |
| 59 | 57 | 141.1 | 117.07 |
| 62 | 51 | 139.0 | 150.30 |
| 68 | 20 | 148.3 | 172.20 |
| 71 | L23R10 | 180.0 | 290.80 |
| 74 | L12R13 | 184.8 | 350.40 |
| 77 | 54 | 192.2 | 423.80 |
| 80 | 57 | 198.5 | 422.90 |
| 83 | L1R2 | 218.1 | 597.50 |
| 86 | 40 | 222.7 | 631.90 |
| 89 | 29 | 237.7 | 706.00 |
| 92 | 31 | 245.6 | 763.00 |
| 95 | L27R4 | 262.0 | 896.80 |
| 98 | L9R11 | 279.0 | 1,152.00 |
| 101 | 28 | 285.0 | 978.00 |
| 104 | 55 | 267.0 | 1,006.10 |
| 107 | L18R19 | 275.0 | 1,267.00 |
| 110 | L7R8 | 275.0 | 1,165.40 |
| 114 | 33 | 302.5 | 1,361.00 |

stained with Mallory trichrome and hematoxylin and eosin.

Postnatal radiographs were taken of 38 pigs, 8 to 152 weeks old. These pigs were killed and the heads sectioned on a midsagittal plane and radiographed.

## Results

Tabulated results on the chronology of tooth development in the right mandible of domestic swine were recorded (Fig 1). At 32 days (30 mm C-R) of embryonic development, there was a thickening and invagination of the oral epithelium to form the epithelial dental organ for the deciduous third molar. By 35 days' (46.2 mm C-R) embryonic development, the dental lamina had differentiated to form the bud stage for the deciduous first and third incisors, and the deciduous second molar ($M_2$). The deciduous canine and the deciduous third molar had now differentiated to form a cap stage of development.

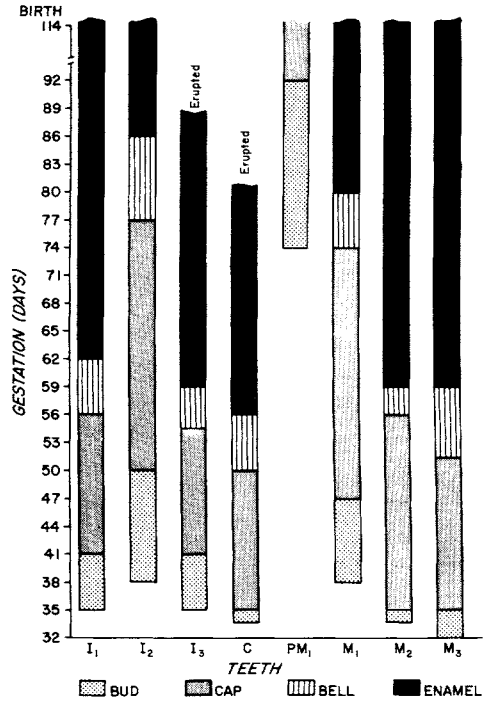


FIG 1.—Tooth chronology.

By 38 days' (46.6 mm C-R) embryonic development, the bud stage for the deciduous second incisor and deciduous first molar had appeared. A late bud stage was observed for the deciduous third and first incisors, whereas the deciduous canine and second and third molars were observed in a cap stage of development. At 41 days' (61.2 mm C-R) fetal development, the deciduous second incisor and the deciduous first molar remained in a bud stage, and all other teeth were observed in an early-to-late cap stage of development.

The cap stage for the deciduous first molar did not appear until 47 days' (93.5 mm C-R) fetal development and the last cap stage to appear was the deciduous second incisor at 50 days (102 mm C-R). In the latter age group, the deciduous canine had now differentiated to form an early bell stage of development.

By 53 days (115.5 mm C-R), the deciduous canine and third molar were observed to be undergoing dentinogenesis. Caudal to the


FIG 2.—*A*, deciduous first molar; *C*, deciduous canine; *F*, first premolar tooth bud (sagittal section, 74 days' fetal development, × 40).

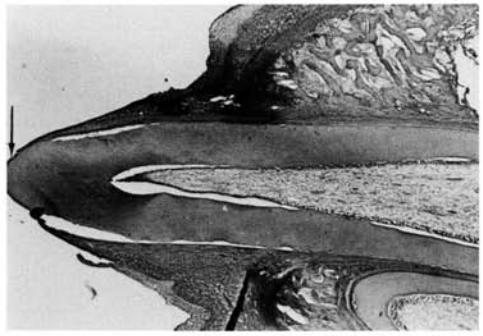

FIG 4.—Arrow points to emergence of deciduous canine tooth through oral epithelium (transverse section, 80 days' fetal development, × 40).

deciduous third molar, a cap stage for the permanent first molar was observed. At 56 days' (127.5 mm C-R) fetal development, predentin and dentin were identified in the deciduous third incisor, and the deciduous canine had begun enamel formation. Also observed on the lingual aspect of the deciduous second and third molars was the dental lamina for the permanent third and fourth premolars.

At 59 days' (141 mm C-R) fetal development, predentin had formed in association with the deciduous first incisor; whereas the deciduous second incisor and first molar were still in a cap stage. The deciduous third incisor, canine, and second molar were more advanced, with the deciduous canine showing enamel matrix over two thirds of the cusp. It was at this stage that the deciduous third molar was observed to have enamel matrix.

Minor changes were observed in succeeding stages until the 74th day (184.8 mm C-R) of fetal development. At this time, two items of importance were noted. A definite bud stage of development was present for the first and third permanent incisors, the permanent canine tooth, and the permanent second and third premolars. In addition, there was a small tooth bud located close to the oral epithelium and just caudal to the canine tooth (Figs 2, 3).

By 80 days' (192 mm C-R) fetal development, the deciduous canine tooth had erupted through the oral epithelium (Fig 4) and the first deciduous molar had begun enamel formation. By 89 days (212.7 mm C-R), the third deciduous incisor erupted through the oral epithelium (Fig 5). Also, the second deciduous incisor now had enamel deposition over the cusp area.

The small tooth bud observed adjacent to the oral epithelium, dorsal to the canine

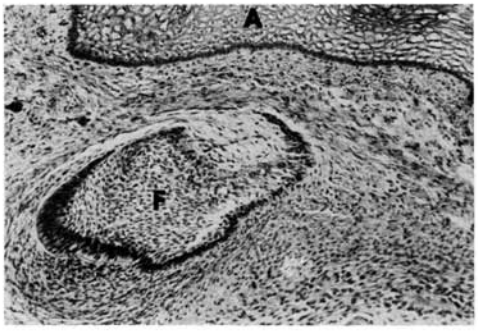


FIG 3.—*A*, oral mucosa; *F*, bud stage of first premolar as it lies close to oral mucosa (transverse section, 74 days' fetal development, × 160).

FIG 5.—Arrow points to emergence of deciduous third incisor through oral epithelium (transverse section, 89 days' fetal development, × 40).

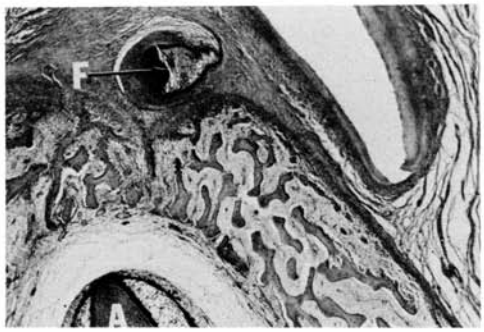


FIG 6.—*A*, deciduous first molar; *F*, cap stage of first premolar tooth (transverse section, 92 days' fetal development, × 40).

tooth, and just rostral to the deciduous first molar remained in a bud stage through the 89-day prenatal age. At 92 days' (245 mm C-R) fetal development, an early cap stage of development was observed in this tooth and it was now located just rostral and dorsal to the deciduous first molar. The dental lamina at this time was directed ventrocaudally to provide developmental support for the tooth (Fig 6). By 104 days (267 mm C-R) the tooth had developed into a mature cap stage, with a dental papilla pushing its way into the base of the ingrowing epithelial dental organ (Fig 7). In the 107-day-old (275 mm C-R) fetal specimen, another observation was made. There was an extension of the lingual side of the dental lamina for this tooth (Figs 8, 9). The tooth still occupied a position close to the oral epithelium; however, alveolar bone was observed as it began to surround the base of the tooth and form an alveolar socket. At 110 days (275 mm C-R) the tooth had retracted somewhat from its relationship with the oral epithelium and assumed a position within the alveolar bone at a level above the basal one third of the canine tooth and just rostral to the deciduous first molar (Fig 10).

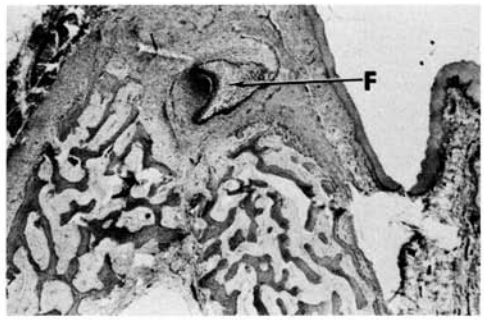


FIG 7.—*F*, cap stage of first premolar (transverse section, 104 days' fetal development, × 40).

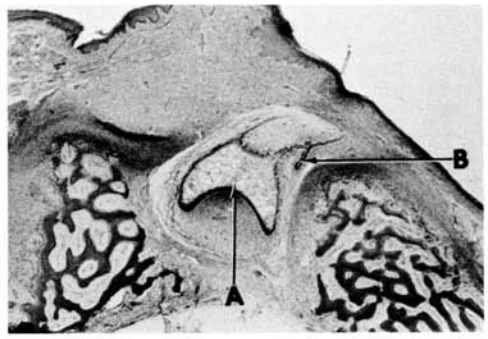


FIG 8.—*A*, cap stage of first premolar; *B*, arrows point to secondary dental lamina, thought to be permanent dental lamina, as it branches ventrally from dental lamina for first premolar (transverse section, 107 days' fetal development, × 40).

Histological sections of postnatal specimens were not made in the current study. However, an attempt was made to establish the proper terminology and permanency of the deciduous first molar through the use of postnatal radiographs. Tabulated results of this study are given in Table 2.

## Discussion

The repetitive use of undocumented statements concerning prenatal odontogenesis, without critical evaluation of the antiquated sources from which they have been copied,

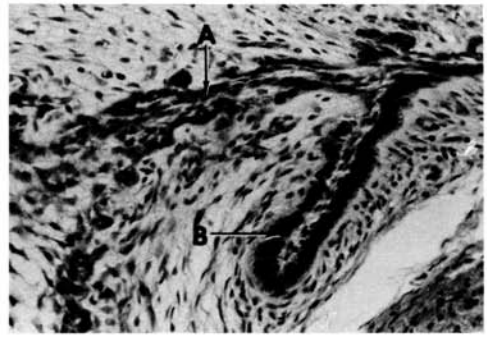


FIG 9.—*A*, dental lamina for cap stage of first premolar; *B*, higher magnification of secondary lamina shown in previous figure (transverse section, 107 days' fetal development, × 40).

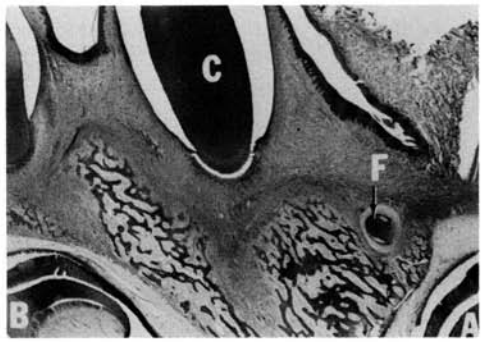


FIG 10.—*A*, deciduous first molar; *C*, deciduous second incisor; *C*, deciduous canine; *F*, advanced cap stage of first premolar (sagittal section, 110 days' fetal development, ×16).

is a current problem in the literature.[6] Undoubtedly, the difficulties associated with obtaining fetuses of known age has hindered the study of prenatal odontogenesis. The present study was designed to cover in detail the development of teeth within the right mandible with the use of pigs of known age ranging from 20 days' gestation to term.

The deciduous dentition within the right mandible began at 32 days' (30 mm C-R) embryonic development with the deciduous third molar. During the following five days, the remaining deciduous dentition began its development. Although the initial histological appearance of these teeth covered a short period of time, it was apparent that each tooth continued to develop at its own rate (Fig 1).

A previous report indicated that all deciduous teeth are forming enamel by the 160 mm C-R stage, or at about 68 days' fetal development.[2] However, the current study showed that the deciduous second incisor and first molar closely parallel each other,

TABLE 2
RADIOGRAPHIC OBSERVATIONS OF FIRST PREMOLAR

| Age (wk) | Presence of First Premolar in Jaw: Lower | Presence of First Premolar in Jaw: Upper | Litter Pig No. | Comments |
|---|---|---|---|---|
| 8 | — | × | L5R8 | Very small tooth in the upper jaw and no evidence of this tooth could be found in the lower jaw; tooth of permanent canine was large and extended caudally to level of deciduous first molar in lower jaw |
| 18 | — | × | L52R6 | |
| 20 | — | × | L56R3 | |
| 25 | — | × | L56R1 | |
| 30 | — | × | L52R4 | |
| 40 | × | × | L29R6 | Tooth appeared just caudal to the emerging crown of the deciduous canine and dorsal to its root; space for tooth was crowded |
| 43 | × | × | L31R7 | |
| 51 | × | × | L30R9 | |
| 52 | × | × | L31R5 | Roots for first premolar were shallow and were being crowded by large canine root; portions of the roots for the first premolar were showing signs of resorption |
| 52 | × | × | L3R4 | |
| 56 | × | × | L30R7 | |
| 57 | × | × | L24R6 | |
| 60 | — | × | L39R2 | No tooth or alveolar socket in lower jaw |
| 63 | × | × | L30R3 | Very shallow roots and tooth were located superficially over the enlarged canine tooth in lower jaw. |
| 68 | — | × | L5R3 | |
| 70 | — | × | L29R3 | |
| 81 | × | × | L7R4 | Very shallow roots for lower first premolars |
| 94 | × | × | L6R3 | Very little root visible in lower jaw |
| 105 | × | × | L25R1 | |
| 120 | — | × | L10R4 | No evidence of first premolar in the lower jaw |
| 124 | — | × | L7R5 | |
| 144 | — | × | L3R4 | |
| 152 | — | × | L2R2 | |

with enamel formation occurring at the 212 to 220 mm C-R stage or 80 to 86 days' fetal development (Fig 1). This is obviously a much later stage than previously described for beginning enamel formation. The cap stage for these two teeth was prolonged in relation to that of the other deciduous teeth. However, the cap stage was the longest developmental stage for each tooth studied (Fig 1).

Two deciduous teeth emerged through the oral epithelium during prenatal development. The deciduous canine was the first to emerge at 80 days, followed closely by the deciduous third incisor at 89 days' fetal development.

A special effort was made to determine the stage of development at which a bud for the first premolar tooth was initiated. It was hopeful that some information could be obtained as to whether this tooth was of the first or second dentition. In this report, the first premolar did not make its initial appearance until the 74th day of fetal development. This was also the age at which the permanent buds for the incisors, canine teeth, and second, third, and fourth premolars became distinct. The dental lamina anlagen for these teeth had been present for some time before this; however, this was the first time that a distinct tooth bud could be identified within the distal free end of the dental lamina for each of these teeth. Also, recall that the deciduous first molar was observed in a bud stage as early as 53 days. These facts suggest that the first premolar differentiates in sequence with the second dentition for the remaining teeth.

By following the first premolar through succeeding age groups, it was observed to reach cap stage of development by 89 days of fetal development and remained in this stage of development at birth. There was, however, an additional observation made in the 107- and 110-day-old age groups. A lingual branching of the deciduous dental lamina for this tooth gave every indication of being the dental lamina anlagen for a permanent tooth. Since a lack of material prevented the study of histological sections after birth to determine the fate of this dental lamina anlagen, it remains a question as to whether the tooth observed postnatally as the first premolar is actually a deciduous or a permanent tooth. There have been limited reports indicating that the first premolar and molar of the pig develop from the deciduous dental lamina.[7] The current work would partially substantiate these findings in the instance of the first premolar since the tooth bud observed at 74 days of fetal development had its origin from the deciduous dental lamina. However, the fate of the lingual branching of this deciduous dental lamina for a permanent tooth could not be determined from this study.

A radiographic analysis of midsagittally sectioned pig heads from 8 to 152 weeks of age indicated that the first premolar underwent calcification and erupted about 40 weeks' postnatally (Table 2). A review of the literature on this point suggested varying times from five through nine months for eruption of the first premolar.[8] The point is the first premolar did not make its initial emergence into the oral cavity for at least 150 days after birth. From histological studies presented, it was apparent that this tooth was in a cap stage at the time of birth. Although the cap stage was the longest period in the development of each individual tooth, the first premolar would have had to remain in the cap stage for an exceptionally long period if indeed the tooth that emerges into the oral cavity is the same tooth as that observed at 74 days' fetal development. This would also indicate that the dental lamina observed for the permanent tooth must regress with age and fail to form a mature tooth.

The other possibility is that the cap stage observed at birth may become dormant and fail to develop further. This would indicate that the dental anlagen observed on its lingual aspect may be the origin of a permanent first premolar that emerges at five to nine months. This would not be entirely unreasonable as we know teeth have failed to develop in the dentition of certain animals during their period of evolution. Certainly, based on the amount of time that the previous mandibular teeth have taken to develop from the bud to the bell stage, the secondary lingual lamina invagination observed has sufficient time to develop into the tooth that emerges as the first premolar.

In addition, radiographic analysis indicated that the roots for the first premolar were shallow and showed signs of being resorbed as a result of the pressure from the enlarging root of the canine. Its shallow alveolar attachment would help explain the

low incidence for the first premolar that investigators have reported.[7] In all probability, abrasive acts of chewing and fighting result in this tooth being torn from its shallow attachment and lost early in life. Therefore, it is recommended that early postnatal histological studies be done to further determine the nature of this tooth.

## Conclusions

Fetuses of known age, collected from 20 days' gestation to term, were used to characterize the chronology of deciduous tooth development within the right mandible of swine. Tooth development was first observed at 32 days' embryonic development, with the differentiation of the deciduous third molar. Bud stages for the remaining deciduous teeth differentiated within the period of 32 to 38 days of embryonic development. Although the initial histological appearance of these teeth covered a short period of time, it was apparent that each tooth continued to develop at its own rate. The deciduous second incisor and first molar reached a stage of enamel formation by the 80th to 86th day of fetal development. This is a much later stage than previously recorded for beginning enamel formation. The stages of tooth development and enamel formation for each tooth are summarized. A previous report on the distribution of the dental lamina and deciduous tooth development in the mandible of the domestic pig[9] combined with the information presented in this report on tooth chronology provide much of the information required for future studies using the domestic pig in dental research.

A fetus observed at the 74th day of development demonstrated a tooth bud for the deciduous first premolar. The development of this tooth was followed closely throughout the remainder of fetal development with the cap stage representing its most definitive form at 110 days' development. The suggested deciduous origin for this tooth could result in a reevaluation of the nomenclature for the dental formula of swine.

The authors thank research technician Mrs. Gladys Clark and laboratory technicians, Mrs. Mildred Floyd and Mrs. Christa Cooper, for their work in preparing the slide materials.

## References

1. Schour, I., and Massler, M.: Studies in Tooth Development: The Growth Pattern of the Human Teeth, Part I, *JADA* 27: 1918-1931, 1940.
2. Avery, J.K.: New Concepts Concerning the Development of the Teeth of the Domestic Pig and Man, PhD dissertation, University of Rochester, Rochester, NY, 1952.
3. Nomata, N.: A Chronological Study on the Crown Formation of the Human Deciduous Dentition, *Bull Tokyo Med Dent Univ* 11: 55-76, 1964.
4. Williams, R.C.: Observations on the Chronology of Deciduous Dental Development in the Dog, PhD dissertation, Cornell University, Ithaca, NY, 1961.
5. Patton, B.M.: *Embryology of the Pig*, Philadelphia: The Blakiston Co., 1948.
6. Kraus, B.S.: Calcification of the Human Deciduous Teeth, *JADA* 59: 1128-1136, 1959.
7. Kubota, K., and Togawa, S.: Developmental Study of the Monophydont Teeth in the Northern Fur Seal, *J Dent Res* 49: 235-331, 1970.
8. Bodegom, J.C.: Experiments on Tooth Eruption in Miniature Pigs, PhD dissertation, Department of Orthodontics, School of Dentistry, Faculty of Medicine, University of Nijmegen, Netherlands, 1969.
9. Bivin, W.S., and McClure, R.C.: Distribution of the Dental Lamina and Deciduous Tooth Development in the Mandible of the Domestic Pig, *J Dent Res* 54: 244-250, 1975.