GROWTH OF THE MAXILLA AND MOLARIFORM TEETH IN CATTLE

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Abstract

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This paper is aimed at an analysis of the dynamics of growth and development of bovine splanchnocranium (the directions and intensity of growth in time). The maxilla has been selected as an object of this study, as it considerably changes in shape and dimensions after birth. Since the os incisivum and os palatinum form a functional unit with the maxilla (the ceiling of the oral cavity), we included them in our study. We examined skulls of newborn calves up to 14 days of age, with erupted premolars (formula 0 0 3 0: P2-P4), those of individuals one year of age, with the first molar erupted (formula 0 0 3 1: P2-P4, M1), and those of adults three years of age, with complete dentition (0 0 3 3: P2-P4, M1-M3). We studied the metrical data and growth directions in the periods mentioned by means of Cartesian co-ordinates. It follows from their construction that the maxilla shows the greatest growth in the rostro-caudal direction. It increases in length in its rostral part (the margo interalveolaris), in the place of growth of molars and the tuber maxillae. On the contrary, at the level of the first molariform teeth (P2) this bone predominantly grows in height and width. Thus, the splanchnocranium becomes elongated and relatively more narrowed. Intense growth is only observed in the toothless part of the maxilla, the margo interalveolaris and tuber maxillae caudal of the molars. It is interesting to note that the Staphylion is invariably in line with the actual Postdentale.

Maxilla, molariform teeth, growth, ruminant, cattle

The skull of a newborn calf as well as of adult cattle shows the Postdentale at the same level as the Staphylion. However, the Postdentale is formed by the level of the distal face of a different tooth in these cases (P4 and M3). Since all molariform teeth grow from the maxilla, being the largest bone of the splanchnocranium and connecting with all other bones of it except the mandible and the hyoid bone, and participating in the delimitation of the oral and the nasal cavity, we began studying its development and growth in connection with the eruption of the molars.

The available papers contain sufficient statistical evaluation of craniometrical data and attention is paid to sexual dimorphism and differences between breeds (Stehlin 1893; Bartosiewicz 1980; Hayashi et al. 1981; Kobryn et Lasota-Moskalewska 1989), and the time of onset of ossification centres is determined (Gjesdal 1969; Rajtová 1976). Studies have also been made of the mechanism governing, and the factors affecting, maxillary growth (Petrowic 1986). We also paid attention to the allometric growth model employed by Moss (1986) in his study of the development of human neurocranium. However, since the above papers do not offer sufficient answers to our questions, we decided to establish the growth gradients and directions of the maxilla.

Materials and Methods

Our study is based on three age periods in the postnatal development of bovine splanchnocranium. We used macerated skulls of female newborn calves, with erupted praemolars (0 0 3 0: P2-P4), those of twelve-month-old female individuals, with erupted first molar (0 0 3 1: P2-P4, M1), and those of female adults three years of age, with a complete set of molariform teeth (0 0 3 3: P2-P4, M1-M3). In each of the above age periods, we examined five skulls and then worked with mean values, as their dimensions were very similar, and our study was not aimed at statistical evaluation of craniometrical data. To illustrate the directions of maxillary growth, we used

a superposition of drawings of the bones under study in two projections perpendicular to each other (lateral and ventral). For a better illustration of the growth gradients in the growth directions, we constructed Cartesian co-ordinates according to D'Arcy Thompson in the two projections mentioned above. Having failed to find the original source, we used the method according to Huxley (1932). Since the os incisivum and os palatinum form a functional unit with the maxilla, denoted as the palato-maxillary complex in the literature, we also included these bones in our study.

Results

It is evident from the superpositions of the bones in the three age periods under study that the growth of the maxilla is not uniform in all directions and in all its parts (Figs. 1 and 2). The Cartesian transformation of the maxilla at the age of one year shows intense growth of the processus alveolaris and the tuber maxillae not only in length in the caudal direction but

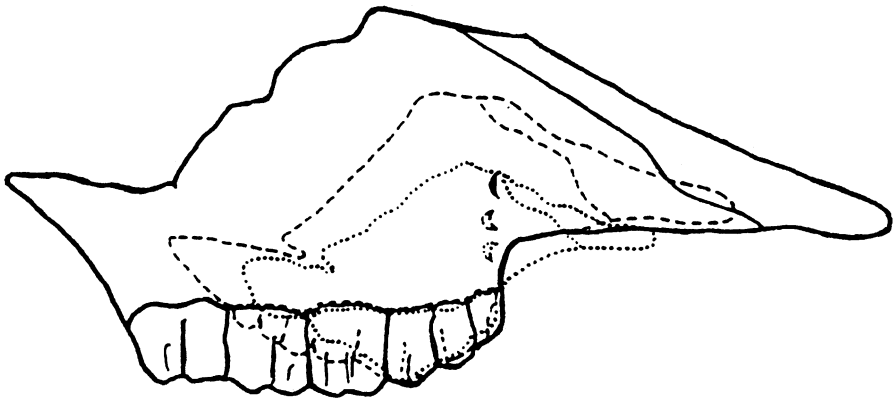

Fig. 1. Superpositions of growing bovine maxilla in lateral aspect. Dotted line, newborn calf; dashed line, age 12 months; solid line, age 36 months.

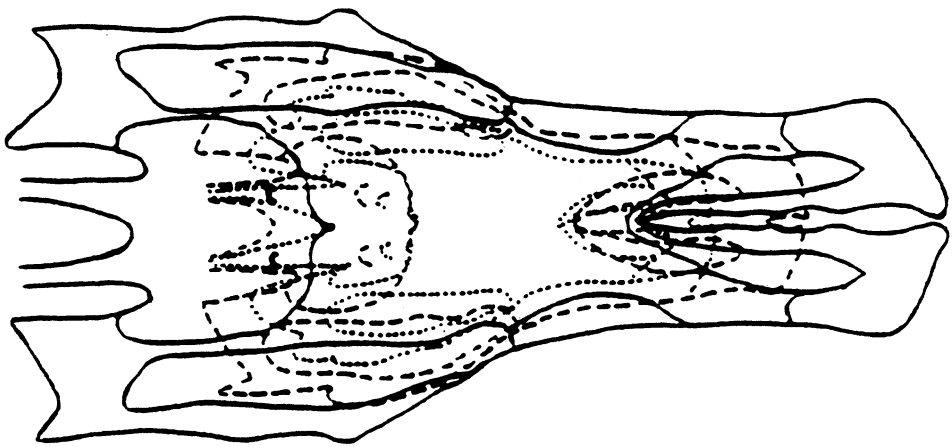

Fig. 2. Superpositions of growing bovine maxilla in ventral aspect. Dotted line, newborn calf; dashed line, age 12 months; solid line, age 36 months.

also in height (Fig. 3) and in width (Fig. 4). The facies facialis grows more intensely in height than in length. In its rostral part (the margo interalveolaris and the os incisivum), the co-ordinates show growth in length and particularly in width. This trend is still more distinctly seen in the skull of adults. Also, the processus alveolaris and the tuber maxillae show very intense growth in that period. On the other hand, the growth of the caudal part of the facies facialis is not very marked.

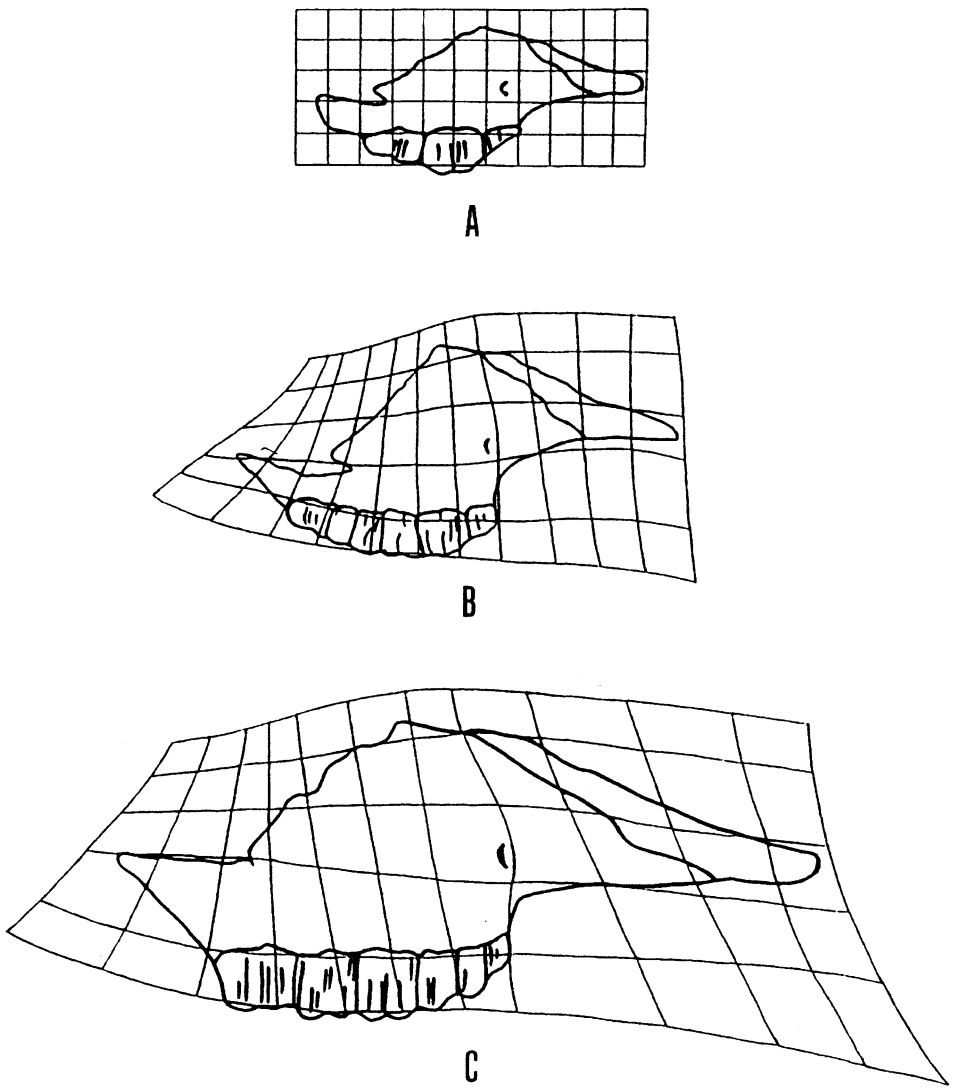

Fig. 3. Cartesian co-ordinates of growing bovine maxilla in lateral aspect. A, newborn calf; B, age 12 months; C, age 36 months.

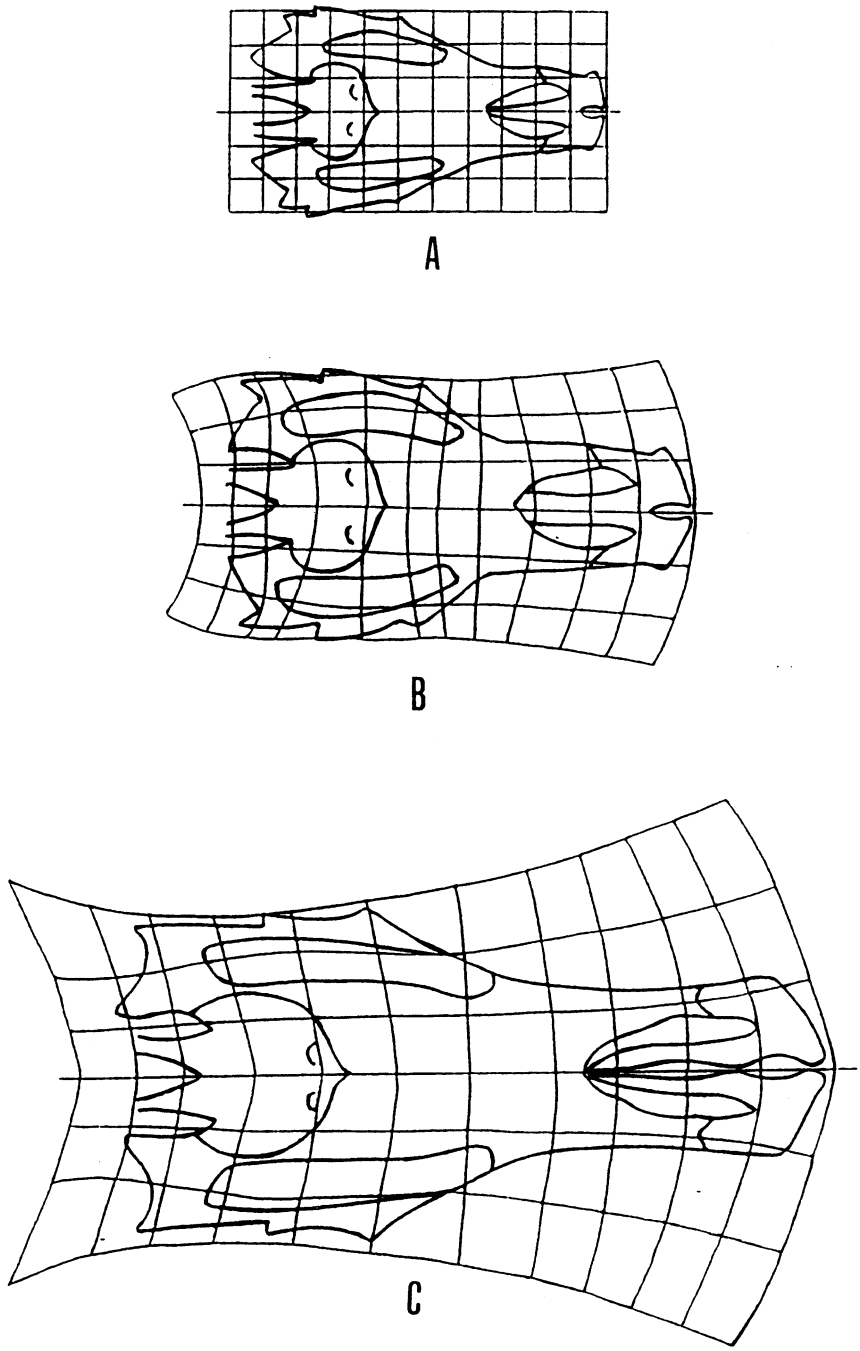

Fig. 4. Cartesian co-ordinates of growing bovine maxilla in ventral aspect. A, newborn calf; B, age 12 months; C, age 36 months.

Discussion

In constructing the directions of growth of the human neurocranium, Moss (1986) started from a point that was common to all age stages under his study. In our superpositions of the maxilla it was difficult to find such a point, as the growth of the splanchnocranium of cattle is not uniform, adapting, in our opinion, to the requirements of the individual functional units (mouth, oral cavity, nasal cavity, orbita). In searching for a common point, we had the option between the Molare, Premolare, Palatinoorale, Staphylion and other craniometric points. Since the mesial face of P2, i.e. the Premolare does not change, this was the suitable common point for our construction. While a simple superposition does show that the growth is not uniform, the growth gradients in the individual directions are shown by the Cartesian co-ordinates (Figs. 3 and 4). The combination of two projections perpendicular to each other (lateral and ventral) covers the growth of the bones under study in all three dimensions (length, height, width), and their development in time may be considered to be a fourth one (Moss 1986).

The intense longitudinal growth of the processus alveolaris and the tuber maxillae in the caudal direction, observed at the age of one year, does not surprise, as this is the part of the bone that contains rudiments of the future molars. Also, the marked growth of this part (even in height) in the adult skull probably reflects the increase in size of the caudal part of the oral cavity and the oropharynx, which is important for ruminants when regurgitating the cud. The marked growth of the margo interalveolaris and the os incisivum indicates an increase in the size of the rostral part of the oral cavity and of the osseous support for the pulvinus dentalis opposing the growing lower incisives. The trend of the development of the facies facialis is also related to the growth of the nasal cavity whose delimitation is participated in by the maxilla. The non-significant growth of the caudal parts of the facies facialis is connected by us with the intense growth of the os zygomaticum and os lacrimale, which delimit the orbit, another important functional unit of the splanchnocranium.

In our opinion, studies of individual functional units of the splanchnocranium (orbit, nasal and oral cavity) and especially of their mutual relations are of advantage for understanding the development and growth of the splanchnocranium as a whole.

Vývoj maxily a molariformních zubů skotu

Cílem práce bylo analyzovat dynamiku vývoje a růstu splanchnokrania skotu (směry a intenzitu růstu v čase). Zabývali jsme se maxilou, která po narození značně mění svůj tvar a rozměry. Vzhledem k tomu, že os incisivum a os palatinum tvoří s maxilou funkční celek (tvoří strop dutiny ústní), zkoumali jsme je společně. Použili jsme lebky novorozených telat do stáří 14 dnů s prořezanými premoláry (zubní formule 0 0 3 0: P2-P4), lebky jedinců ve věku jednoho roku s prvním prořezaným molárem (zubní formule 0 0 3 1: P2-P4, M1) a lebky tříletých dospělců s úplným chrupem (0 0 3 3: P2-P4, M1-M3). Sledovali jsme metrické údaje a směry růstu v uvedených obdobích pomocí kartézských souřadnic. Z jejich konstrukce vyplynulo, že maxila rostla nejvíce ve směru rostro-kaudálním. Prodlužovala se v rostrální části (margo interalveolaris), v místě růstu molárů a tuber maxillae. V úrovni prvních molariformních zubů (P2) naopak převládal růst této kosti do výšky a do šířky, splanchnokranium se tedy prodlužovalo a relativně zužovalo. K intenzívnímu růstu docházelo pouze v neozubené části maxily - margo interalveolaris a tuber maxillae kaudálně od molárů. Bylo zajímavé, že Staphylion byl vždy ve stejné linii s aktuálním Postdentale.

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