EUROPEAN RESEARCH ON CETACEANS - 11

Proceedings of the Eleventh Annual Conference

of the European Cetacean Society,

Stralsund, Germany

10-12 March 1997

Editors: P.G.H. Evans, E.C.M. Parsons & S.L. Clark

Date of Publication: December 1997

Place of Publication: Kiel, Germany

THE PHYLOGENY OF THE HOMODONTAL SET OF TEETH AND THE DENTITION OF TOOTHED WHALES (*ODONTOCETI*)

Günther Behrmann

Nordseemuseum, D-27570 Bremerhaven, Germany

In all mammals, two sets of teeth are developed, but up to now a second set of teeth in archaeocetes and cetaceans has been unknown. Boschma (1938a) first discovered rudimentary tooth generations in sperm whales. He also found a deviation from the normal dentition of mammals in a longitudinal section through one tooth of the lower jaw: "On peu observer une formation intéressante d'ostéodentine dans une dent d'origine inconnue qui se présenté ici en coupe longitudinale." (Boschma, 1951, p. 10).

The examination of several toothed whale species and sperm whales proves that, in dolphins, the mammal-like vestigial set of milk-teeth becomes the permanent set of teeth, and that the second set is very poor and disappears in the postnatal phase. The second set of the harbour porpoise shows premolars with two supplying nerves and two embryonic teeth like a multiple-crowned tooth (Fig. 1): this is a heritage from the ancient whales. The great number of teeth in the common dolphin *Delphinus delphis* Linné, 1758 seems to be evidence for the presence of many embryonic teeth, which can be restored if there is enough space in the jaw. But more embronic teeth than necessary are found in the jaws of toothed whales.

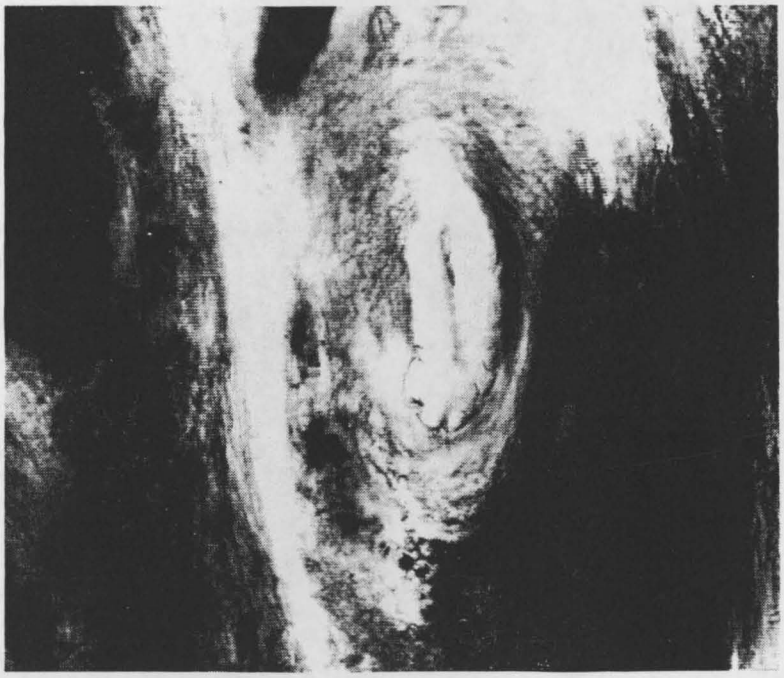

Fig. 1 Harbour porpoise *Phocoena phocoena* L.: an alveolus of the second set of teeth containing a rudimentary tooth, 25x

The development of the set of teeth in sperm whales (Fig. 2) with a great number of polycronic teeth (Boschma, 1938b) shows many relationships to the archaeocetes and to their ancestors, and reminds us of the development of teeth in reptiles (Peyer, 1968). In contrast to mammals, the tooth buds of the replacement teeth of reptiles originate below the first tooth buds (Edmund, 1969). Secondly, in reptiles many more embryonic teeth are formed than in mammals. The set of teeth in sperm whales represents a transitional stage, where the replacement teeth do not grow out. Instead, they are preserved and may become very large. Below the teeth of sperm whales, in the tissue of the alveolars, one can find many small teeth.

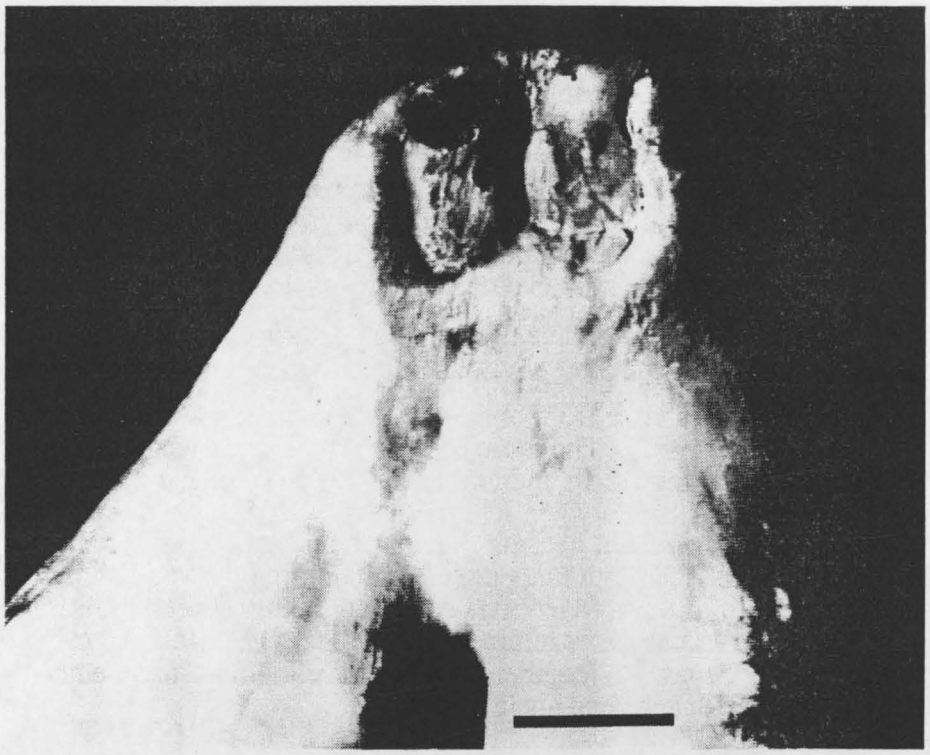

Fig. 2. *Physeter macrocephalus* L.: two incisors grown together, scale 1 cm. In each tooth a multiple crown core-tooth is enclosed

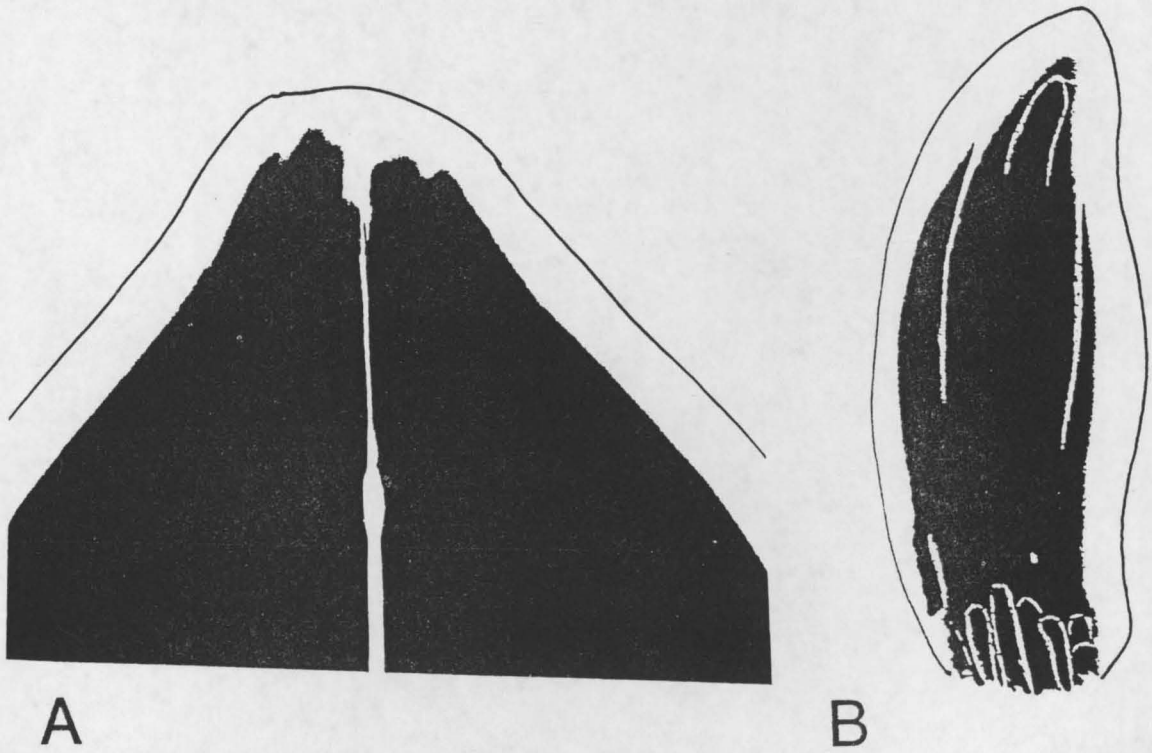

Fig. 3 Sperm whale *Physeter macrocephalus*:
A: X-ray photograph of both incisors (Fig.2), irradiation 40 KV, 45 min.
B: X-ray photograph of a molar with replacement teeth, irradiation 40 KV, 60 min.

The multiple-crown core teeth of the sperm whales have a shape comparable to the one which Kükenthal (1889) discovered in embryos of baleen whales (Mysticeti). The thick layer of enamel covering the dominant and multiple-crown teeth is comparable to the thick enamel cover of the milk-teeth in mammals.

The determination of age in toothed whales by means of the growth-rings of the teeth is not possible. The teeth of bottlenose dolphins, in captivity for a long period, do not form any further growth-rings from the moment of their captivity. The formation of growth-rings depends upon diet or significant events in the life cycle, as confirmed by Albert *et al.* (1988) who studied a captive killer whale.

How does the homodontal set of teeth of the recent whales originate? The multiple crowned teeth of mammals arise from cone-like teeth of reptiles through unification of embronic teeth (Stark, 1982). The ontogeny of the sperm whale teeth shows all transitional stages from reptile to mammal. The ancient archaeocetes possessed a homodontal set of teeth. At times when ichthyosaurians controlled the sea, the ancestors of the archaeocetes went on land, became mammals, and developed smaller jaws. With the reduction of the jaws, the tooth buds united and multiple crown teeth developed; the heterodontal set of teeth of the archaeocetes came into being. After the disappearance of the ichthyosaurians, the archaeocetes returned into the sea. The adaptation to life in the sea and to seafood caused the jaws to lengthen and thus gave room for more embryonic teeth; the homodontal set of teeth appeared again.

When more embryonic teeth were formed, more teeth grew out, but many embryonic teeth remained. As these relics can be restored if teeth find a place, sets developed with more than 280 teeth such as in the common dolphin.

REFERENCES

Albert, C., Myrick, A.K. Jr, Pamela, Y. and Cornell, L.H. 1988. Toward calibrating dental layers in captive killer whales by use of tetracycline labels. In: J. Sigurjónsson and S. Leatherwood (eds.). North Atlantic Killer Whales. *Journal of the Marine Research Institute*, Reykjavik, 11: 285-296.

Boschma, H. 1938a. On the teeth and some other particulars of the sperm whales (*Physeter macrocephalus* L.). *Temminckia Leiden*, 3: 151- 278.

Boschma. H. 1938b. Double teeth in the sperm whale (*Physeter macrocephalus* L.). *Zoologische Mededeelingen Leiden*, 20: 211-221.

Boschma, H. 1951. Remarques sur le Cétacés à dents, et en particulier sur le cachalot. *Bulletin de L´ institut Océanographique, Monaco*, 48, 991: 1-28.

Edmund, A. G., 1969: Sequences and rate of tooth replacement in the *Crocodilia. R. Ont. Mus., Life Sci. Contr.*, 56: 1-42.

Kükenthal, W. 1889. *Vergleichend-anatomische und entwicklungsgeschichtliche Untersuchungen an Walthieren.* Jenaische Denkschrift III: Taf. XXV.

Lockyer, C. 1993: A report on pattern of deposition of dentine and cement in teeth of pilot whales, genus *Globicephala*. Pp. 137-161. In G. P. Donovan (Ed.) *Biology of the Northern Hemisphere Pilot Whales.* Report of the International Whaling Commission, Special Issue 14, Cambridge.

Peyer, B. 1937. Zähne und Gebiß. In Bolk *et al.* (Eds.). *Vergleichende Anatomie der Wirbeltiere*, B 3: 49-90. Verlag Urban & Schwarzenberg, Berlin & Vienna.

Starck, D., 1982: Darmkanal. Pp. 716-748. In *Vergleichende Anatomie der Wirbeltiere* B 3. Springer-Verlag, Berlin, Heidelberg & New York.