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A NEW SHORT-ROSTRUM ODONTOCETE (MAMMALIA: CETACEA) FROM THE MIDDLE MIOCENE OF THE EASTERN NETHERLANDS

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ABSTRACT

An incomplete odontocete (Mammalia, Cetacea) skull from Middle Miocene Miste Bed (near Winterswijk in the eastern part of The Netherlands) is described as *Vanbreenia trigonia*, a new genus and species. The skull exhibits a short rostrum with only two maxillary teeth for each toothrow and with narrow and toothless apical portion exclusively formed by the premaxilla. Considering this last character, the specimen could belong to the Eurhinodelphinidae even if a certain attribution is not possible because of the incompleteness of the specimen. *Vanbreenia* n. gen. could represent a specialized adaptation to bottom suction feeding among the eurhinodelphinids.

Key words: Cetacea, Odontocete, systematics, feeding, Miocene, The Netherlands

INTRODUCTION

Different trophic patterns caused a wide variation in the skull architecture of the extant and fossil odontocetes (Mammalia, Cetacea). Particularly, the shape of the rostrum and mandible and the number of teeth are the characters more closely related to the trophic adaptation of these marine mammals. Some genera, as the extant *Platanista*, *Inia* and *Lipotes* and the fossil *Zarhachis* and *Eoplatanista* show a very elongated and slender gavial-like rostrum with a large number of teeth utilised, at least in the extant species, for raptorial feeding near the bottom in river or neritic waters (Werth, 2000). A peculiar longirostral adaptation, probably for raptorial feeding, is that of the fossil swordfish-like eurhinodelphinids that exhibit a rostrum more elongated than the mandible.

On the contrary some odontocetes are characterised by a very short rostrum sometimes associated with a drastical reduction of the teeth number. Some of these, like the extant *Feresa* and *Orcinus* and perhaps the fossil *Prosqualodon*, are shark-like predators. Others, with also a reduced number of teeth, like the extant *Kogia* and *Grampus*, are specialised for capturing octopus and squids using suction feeding mechanisms (Heyning & Mead, 1996; Werth, 2000).

Extreme elongation or shortening of the rostrum seem adaptative characters subject to fast evolution judging from some cases as the short-rostrum Miocene *Brachydelphis* in respect to the other longirostral pontoporiids (De Muizon,

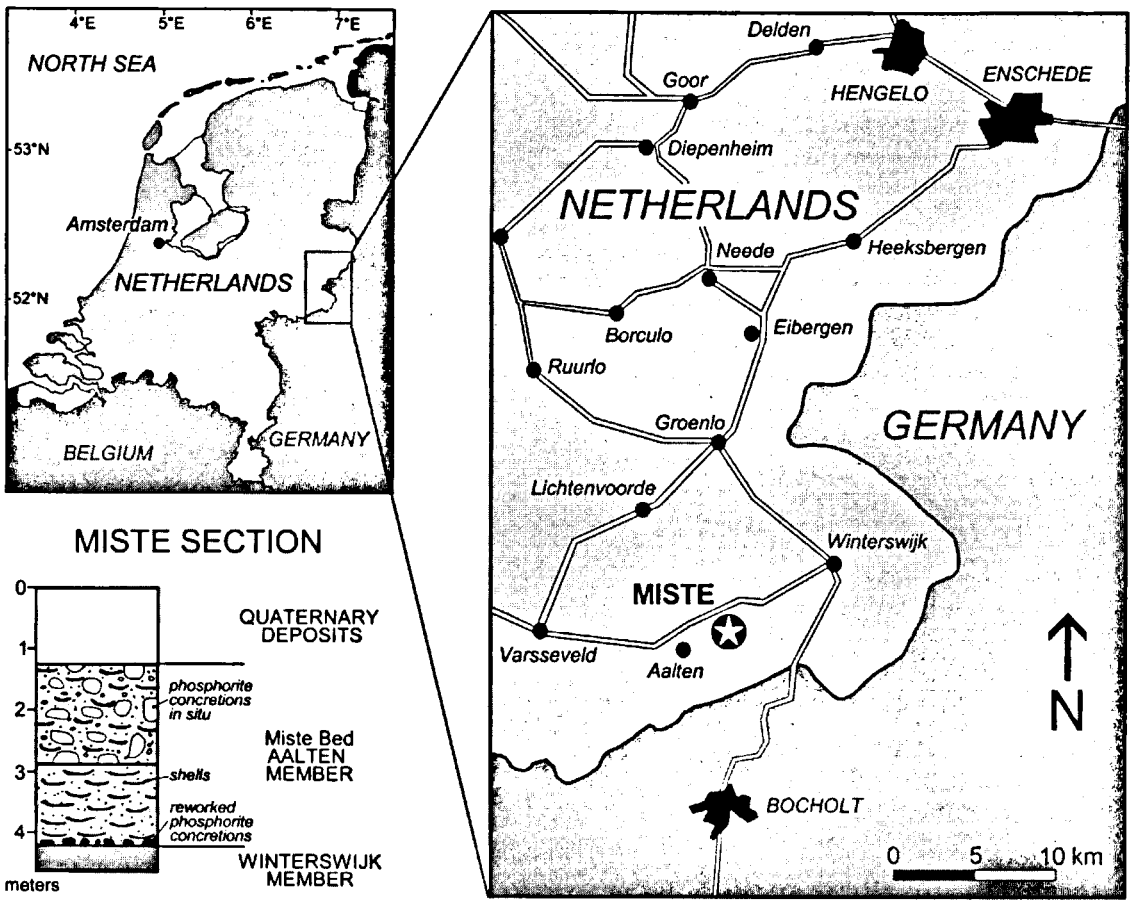

Fig. 1. Geographic location (circled star) of the examined odontocete specimen and stratigraphic section based on Bosch et al. (1975).

1988a) or the early Miocene *Prosqualodon* in respect to other squalodontid-like odontocetes (Kellogg, 1928). The fossil skull from Miocene Miste Bed (Fig. 1) here described could represent a new peculiar case of shortening of the rostrum in a longirostral odontocete group. In fact, the skull is very short and exhibits only two maxillary teeth, but it has also some eurhinodelphinids characters, particularly a narrow and toothless apical portion of the rostrum that probably was longer than the mandible.

The skull described below was collected by Mr D.J. Mol and Mr Von der Hocht in August 1975 and is kept in the Zoological Museum Amsterdam (ZMA).

SYSTEMATIC PALEONTOLOGY

Class Mammalia Linnaeus, 1758

Order Cetacea Brisson, 1762
Suborder Odontoceti Flower, 1867
Family ?Eurhinodelphinidae Abel, 1901

Vanbreenia n. gen.

TYPE AND ONLY INCLUDED SPECIES. - *Vanbreenia trigonia* n. sp.

DIAGNOSIS. - A small-sized and short-rostrum odontocete genus that differs from all other odontocete genera, except those referred to Eurhinodelphinidae and to *Messapicetus*, by having a narrow and cylindrical apical portion of the rostrum formed exclusively by the premaxilla and lacking alveolar teeth. It differs from all eurhinodelphinid genera by smaller size, shorter rostrum, rostrum broader at the base, absence of longitudinal sulci on the dorsal surface of the rostrum, reduced

Table 1. *Vanbreenia trigonia* n. gen., n. sp., measurements (in mm). Asterisk indicates estimated measurements.

Length of rostrum	>90
Width of rostrum at base	95
Height of rostrum at base	47
Width of premaxillae at base of rostrum	47
Width of rostrum 60 mm anteriorly to its base	35*
Greatest preorbital width	145*
Greatest supraorbital width	140

number of maxillary teeth and absence of a sharp ventral keel at the base of rostrum. It differs from *Messapicetus* by the smaller size, shorter rostrum and reduced number of maxillary teeth. It also differs from *Messapicetus* and all other Ziphiidae by not having a large and anteriorly extended hamular process of the pterygoid. It differs from all Squalodontidae and Platanistidae by not having the palatine covered in the middle by maxilla and pterygoids; the short-rostrum *Kogia* and from all Physeteroidea for lesser cranial asymmetry, the presence of spiracular plate on the premaxillae and the absence of dorsal concavity of the skull; from the short-rostrum *Brachydelphis* for lacking constriction of the premaxilla at the basis of the rostrum, not having deep antorbital notch and not having the pterygoid sinus fossa extended anteriorly to the base of the rostrum; from the short-rostrum phocoenids for lacking thickening portion of premaxilla anteriorly the external nares; and from the short-rostrum *Prosqualodon* for smaller size, reduction of number of teeth, and for not having deep antorbital notch and strong preorbital process.

ETYMOLOGY. - The genus name is in honour of Dr P.J.H. van Bree of the Zoological Museum (University of Amsterdam) for his distinguished research activity and outstanding contribution to the knowledge of extant and fossil marine mammals. Gender feminine.

Vanbreenia trigonia n. gen., n. sp.
Figs. 2-4

MATERIAL. - Holotype: ZMA 17.943, incomplete skull lacking the most anterior portion of the rostrum and the posterior half portion of the neurocranium. The postcranial skeleton is not preserved.

TYPE LOCALITY. - Miste, a locality between Aalten and Winterswijk towns in the eastern part of The Netherlands (51°58' N 6°44'E).

HORIZON AND AGE. - Miste Bed, a sand with a variable silt and clay content that represents the lower part of the Aalten Member (Bosch et al., 1975). In the stratotype section, where the specimen examined was collected, the Miste Bed is represented by about three meters of dark green glauconite sand very rich in quartz and with shells and phosphorite concretions. The inferior half portion of the Miste Bed stratotype section was designed as the typical reference section of the *Hiatella arctica* Acme Zone. On the basis of correlations with other deposits in the North Sea Basin, the Miste Bed was referred to Middle Miocene (Bosch et al., 1975, encl. 2).

DESCRIPTION AND COMPARISON. - Small skull size due not only to the shortening of the rostrum but also to the small cerebral skull whose width at the orbit is140 mm (see also Table 1).

The anterior portion of the rostrum, as in the eurhinodelphinids and in the ziphiid *Messapicetus* (Bianucci et al., 1994b), is very narrow, cylindrical and formed exclusively by the premaxilla. The apex of the rostrum is missing so it is not possible to evaluate the total length of this cylindrical portion. However, considering that the section of the preserved anterior portion is very small, we can suppose that a not long portion of the rostrum is missing. The base of rostrum is very broad and consequently the short rostrum exhibits a triangular outline in dorsal view.

The antorbital notch, as observed in many eurhinodelphinid skulls (Myrick, 1979; De Muizon, 1988b; Bianucci et al., 1994a), is wide and not deep. In this character *Vanbreenia* n. gen.

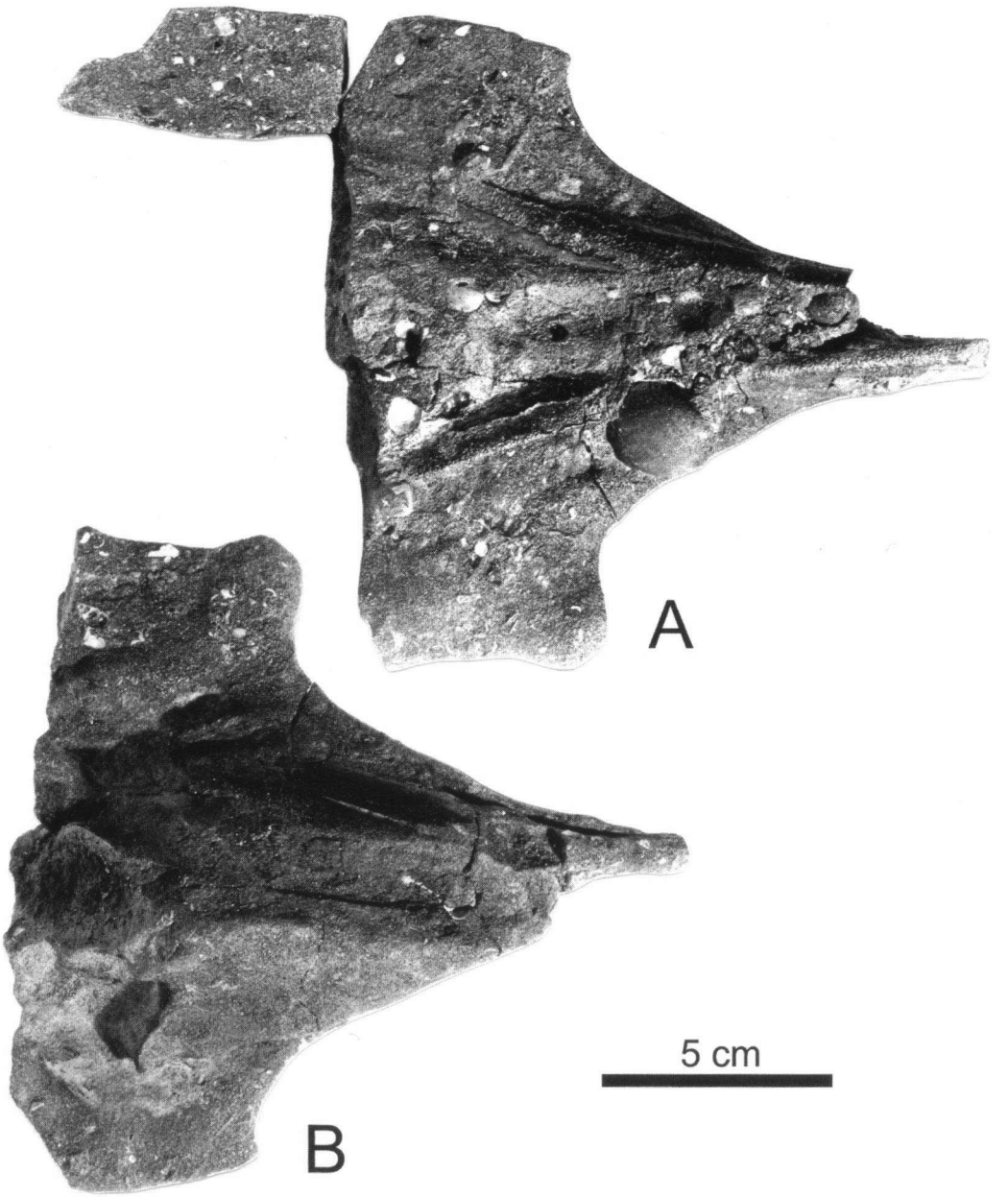

Fig. 2. Holotype incomplete skull of *Vanbreenia trigonia* n. gen., n. sp. (ZMA 17.943) in dorsal view (A) and ventral view (B).

differs from the short-rostrum *Brachydelphis* and *Prosqualodon* that have very deep antorbital notches. This character, however, could have been emphasised by mechanical abrasion.

The premaxillae are separated medially by a wide mesorostral groove that reaches its maximum width just anteriorly to the rostrum base and that seems to be open also in the anterior preserved portion. In this context *Vanbreenia* n. gen. could differ from the eurhinodelphinids which have a mesorostral gutter closed anteriorly. Nevertheless the specimen may have suffered possible deformations and, moreover, the closure of the mesorostral groove could have been in the missing anterior portion of the rostrum. Laterally, the dorsal surface of the premaxillae is in continuity to the maxillae, without the longitudinal sulci observed in the eurhinodelphinids and in

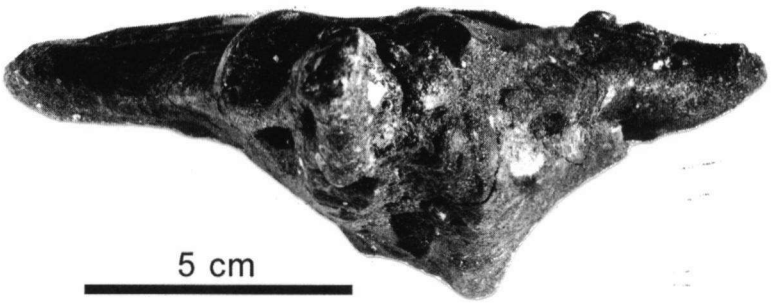

Fig. 3. Holotype incomplete skull of *Vanbreenia trigonia* n. gen., n. sp. (ZMA 17.943) in anterior view.

the eoplatanistids (De Muizon, 1988b). In correspondance with the widening of the preserved posterior portion of the premaxilla, the spiracular plates for the premaxillary sac fossa are visible, even if abraded. Due to the bad preservation, the premaxillary foramina are not visible. The premaxillae lack the constriction at the basis of the rostrum that is instead observed in many other odontocetes and that is very accentuated in the short-rostrum *Brachydelphis*. Moreover the thickening portion of premaxilla anteriorly the external nares that characterizes the phocoenids is not present.

The dorsal surface of the maxilla is flat, except in the anterior portion of the rostrum that is a little bent laterally. The right maxilla is strongly broader than the left, on the basis of the rostrum which evidences the asymmetry of the skull; however this may have been accentuated by deformation during fossilization. In the right side of the rostrum base a small circular depression is visible that could represent a maxillary foramen. The maxilla seems to completely cover the orbit dorsally. Consequently, the frontal is not dorsolaterally exposed as, instead, in some primitive odontocetes like the squalodontids.

In lateral view, the flat dorsal surface of the skull, with the preserved portion of the spiracular plate not sloping posteriorly is evident. Nevertheless an isolated portion of skull, that could represent a lateral left postorbital fragment of the neurocranium, seems to show a slight posterior elevation of the skull. In all cases no evidence of a prenarial basin, as in all physeterids and in some ziphiids, is observed. The strongly abraded antorbital process is apparently very small.

In ventral view the preserved right margin of the rostrum shows two rudimentary maxillary alveoli. The most posterior alveolum is a narrow and not deep incisure about 10 mm anteroposteriorly elongated and it is 10 mm far from the anterior one which is narrower and smaller. Anteriorly to this structures, the rostrum, even if not well preserved, does not show other incisures but only a feeble longitudinal sulcus that extends on the premaxilla. The preserved posterior rostral portion of the left margin shows an incisure similar to that of the posterior one in the right margin. Probably *Vanbreenia* n. gen. had only two rudimentary small maxillary teeth for each toothrow. Moreover, in accordance with what observed in the eurhinodelphinids, it is probable that the mandible of *Vanbreenia* n. gen. was shorter than the rostrum, leaving free the anterior premaxillary toothless portion.

Medially the palate exhibits a large fissure among the maxillae, filled by sediment, that probably originally uncovered the vomer. Posteriorly this groove is closed by the medial conjunction of maxillae. In the right side of the palate there is a thin and very anteriorly extended lamina that covers, almost completely, the maxilla and that may be referred to the palatine bone. It is triangular in shape with a pointed angle in its anterior extremity and with a wide extension in its posterior portion. The posterolaterally preserved portion of the palatine delimits medially the infraorbital foramen. Medially the palatine does not cover completely the maxilla and so the two

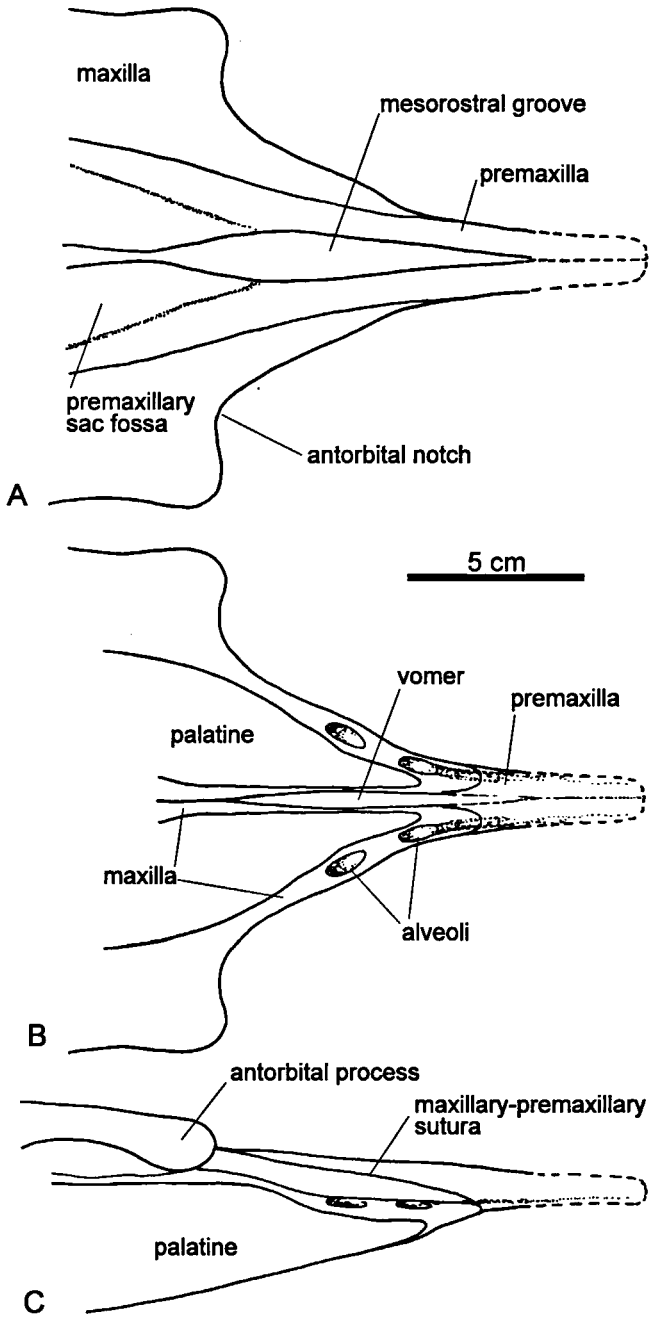

Fig. 4. Reconstruction of the preserved portion of skull of *Vanbreenia trigonia* n. gen., n. sp. (ZMA 17.943) in dorsal view (A), ventral view (B), and lateral view (C).

palatines were not in contact each other. The lateral palatine-maxillary sutura forms a regular arch, differing from that of Platanistidae and Squalodontidae whose maxilla covers partially the palatine (De Muizon, 1991); consequently the sutura shows an evident posterior excavation. An intermediate condition seems to be present in *Waipatia* which, judging from the picture by Fordyce (1994, fig. 7a), shows a posterior concavity in the left palatine-maxillary sutura.

Posteriorly the palatine is broken and so it is not possible to evaluate its complete extension. In the preserved portion there is no trace of the pterygoid sutura and pterygoid sinus fossa and so their anterior margins finished at least 25 mm before the base of the rostrum. This condition excludes that *Vanbreenia* n. gen. may belong to ziphiids, which have a large and anterior extension of the pterygoid sinus, to platanistids and squalodontids which have pterygoids covering the palatine in the middle (De Muizon, 1994), and to many delphinida which have the pterygoid sinus fossa extended more anteriorly than the rostrum base. The right side of the palatus lacks the large palatine lamina present on the left side and consequently the whole ventral surface of the right maxilla is visible. On this surface are visible some longitudinal striations that probably represent the maxillary-palatine sutura. On the whole, the palate is convex with a triangular transverse section but without the sharp ventral keel that characterizes the Eurhinodelphinoidea (De Muizon, 1991).

The ventrolateral surface of the preserved portion of the neurocranium is abraded and consequently it is not possible to evaluate the extension of lachrymal, frontal and maxilla and the possible presence of an antorbital lobe of the pterygoid sinus.

ETYMOLOGY. - The species name is from the Latin adjective *trigonius* = triangular, referred to the shape of the rostrum in dorsal view.

DISCUSSION

We consider probable that *Vanbreenia* n. gen. belongs to Eurhindelphinidae, even if the preserved rostrum of this new genus lacks some characteristic eurhinodelphinid features as the extreme elongation, the polydonty, the ventral keel at the base of the rostrum and the lateral longitudinal sulci on the dorsal surface of the rostrum. Nevertheless we do not exclude that a future discovery of a more complete skull (and particularly of the ear bones) might allow to refer *Vanbreenia* n. gen. to a different or even to a new family, but we also think that the not eurhinodelphinid features of this skull may be considered all as consequences of the shortening of the rostrum, a character that realises for homoplasy with some frequency in different odontocete groups. Some examples are *Prosqualodon* in contrast to other squalodontids, *Brachydelphis* in contrast to the other pontoporiids (Fig. 5), all extant phocoenids in contrast to some fossil phocoenid genera (e.g. *Lomacetus*). Among the short-rostrum odontocetes there are some taxa (e.g. *Kogia* and *Grampus*) which suffered also an almost complete or total lacking of maxillary teeth, like *Vanbreenia* n. gen. In the Dutch skull the secondary shortening of the rostrum could have made useless the extreme elevation of the palate that is observed in the other eurhinodelphinids. In fact, in these odontocetes this structure could function as a support to the long rostrum and/or, as hypothesized by Fordyce & Barnes (1994), for insertion to large muscles. A similar structure is also observed in longirostral odontocetes belonging of other families (e.g. the ziphiid *Messapicetus*). The secondary shortening of the rostrum in *Vanbreenia* n. gen. would have caused a considerable decrease of the rostrum height in respect that of the other eurinodelphinids, even if it remains relatively high. Also the lacking of longitudinal sulci on the rostrum may be related to its shortening; in fact the very elongated and slender rostrum of the other eurhinodelphinids present longitudinal deep sulci which make the section similar to an upside-down 'T', a shape that confers a greater rigidity and a greater resistence of the flexion. The rostrum of the skull here examined being shorter did not need the T-shaped structure to be have a sufficient rigidity and therefore it lost the longitudinal sulci.

Considering the small size and short rostrum, it would be possible to refer this skull to a young specimen of *Eurhinodelphis* or *Schizodelphis* whose finds are relatively frequent in the North Atlantic area. In fact the length of the rostrum in the eurhinodelphinids increases with the age of the animal (Myrick, 1979) as in the extant species (e.g. *Stenella*, see Perrin, 1975). However, the ontogenetical elongation of the rostrum is a character not related to an increase of the number of teeth and so, in all cases, the skull examined, even if belonging to a young animal, would have mantained two single teeth also as adult. This character contrasts with the poliodont state of all known eurhinodelphinid genera. Finally, Myrick (1979)

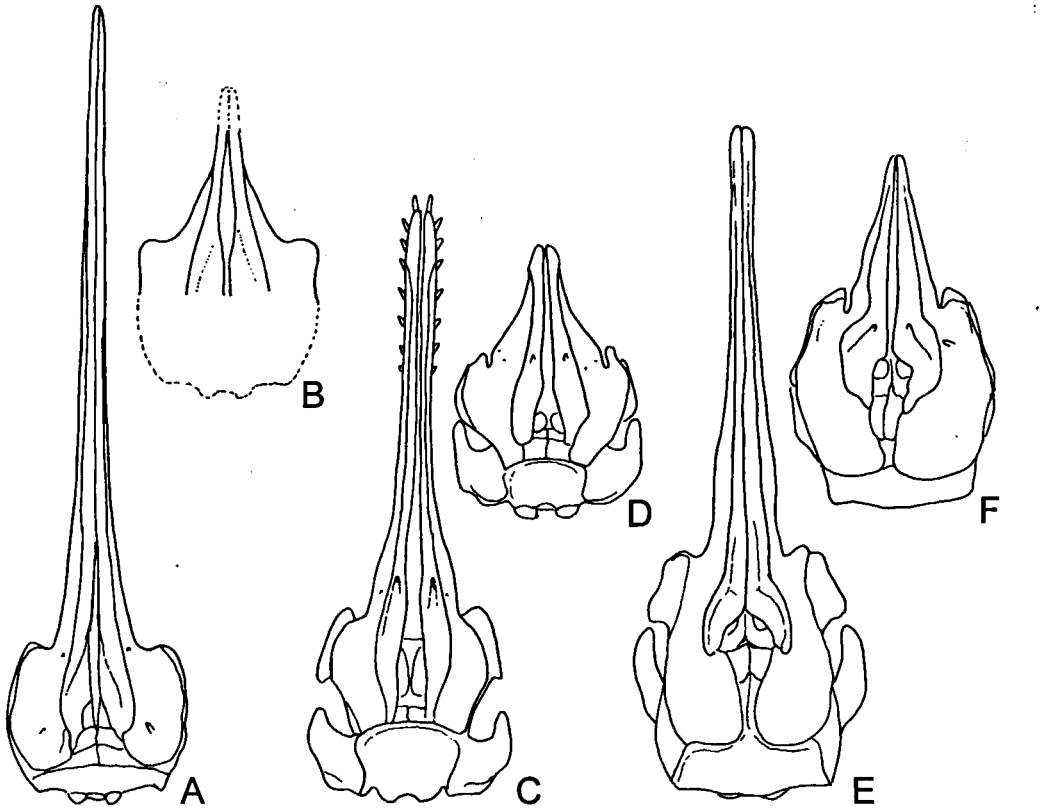

Fig. 5. Comparison of skull in dorsal view of *Eurhinodelphis* (A), *Vanbreenia* n. gen. (B), *Squalodon* (C), *Prosqualodon* (D), *Pontoporia* (E), and *Brachydelphis* (F). Reduced at the same supraorbital width.

observed that in the young *Eurhinodelphis* and *Rhabdosteid* (=*Schizodelphis*) skulls the rostrum is less broad at the base than in the adult, and this is in contrast with the rostrum very broad at base of the *Vanbreenia* skull.

A speculative interpretation on the trophic adaptation of the new small odontocete here described may be made on the basis of a comparison with extant trophic patterns. Particularly, we hypothesise that *Vanbreenia* n. gen. utilised its pointed rostrum to search preys near the bottom mantaining the probable adaptation (for analogy with the extant longirostral odontocetes) of bottom feeding of other eurhinodelphinids. Moreover, we assume that the Duch odontocete had more specialised features in respect to the eurhinodelphinds and particularly that it was prevalently teuthophagus and that it used sunction to catch the prey (Fig. 6). This is in accordance with what is observed in all short-rostrum extant odontocetes with reduced dentition and with the modern hypothesis which considers the reduction in dentition in the extant odontocete as a character favorably selected for the evolution of suction feeding (Heyning & Mead, 1996).

CONCLUSION

The Middle Miocene small skull here examined belongs to a new odontocete genus probably related to eurhinodelphinds in having a very narrow and toothless anterior portion of the rostrum but lacking some peculiar eurhinodelphinid features, as possible consequence of the shortening of the rostrum. The shortening of the rostrum is considered a derived character probably due to the sunction feeding adaptation of this odontocete. The hypothesis of sunction feeding is corroborated also by the extreme reduction of maxillary teeth. Both *Vanbreenia* n. gen. and the eurhinodelphinids were probably sympatric, living in neritic and/or river waters but perhaps this

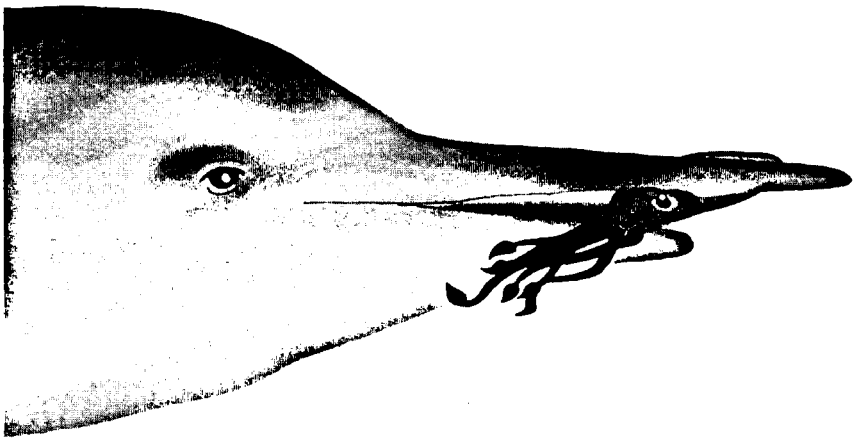

Fig. 6. Hypothetical reconstruction of the external morphology of the head and of feeding of *Vanbreenia trigonia* n. gen., n. sp.

odontocete realised a more specialised diet based on small squids. The shortening of the rostrum surely gave advantage to *Vanbreenia* n. gen. in respect to the eurhinodelphinids in the swimming manoeuvrability for capturing the prey and to escape the attack of possible predators.

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