

TEREŃA CZYŹEWSKA

Natural endocranial casts of the whales
Pinocetus polonicus Czyżewska & Ryziewicz,
1976, from the Pińczów Limestones (Middle
Miocene; southern slopes of the Holy Cross
Mountains, Central Poland)

ABSTRACT: Presented is a description and interpretation of two natural endocranial casts of the Middle Miocene (Badenian) whale *Pinocetus polonicus* CZYŹEWSKA & RYZIEWICZ, 1976, collected in the Pińczów Limestones (southern slopes of the Holy Cross Mountains, Central Poland). One isolated specimen represents a young individual, the second is preserved in the skull of an older individual, and only a part of the cast is accessible for comparisons in the occipital region of this skull. Some features of the investigated endocranial casts allow to conclude on the anatomy of the brain and life behavior of the whale, the habitats of which were confined primarily to shallow marine basins.

INTRODUCTION

The aim of this paper is to analyze the natural endocranial casts of the Middle Miocene (Badenian) whale, *Pinocetus polonicus* CZYŹEWSKA & RYZIEWICZ, 1976, which belongs to the primitive, extinct family Cetotheriidae CABRERA, 1926. Natural endocranial casts of whales are extremely rare fossils, and those of the Cetotheriidae have never as yet been described.

The investigated endocranial casts were found in the Middle Miocene (Badenian) detrital red-algal and bryozoan limestones exposed at Pińczów, southern slopes of the Holy Cross Mountains, Central Poland. These highly fossiliferous deposits, called the Pińczów Limestones, contain a rich assemblage of marine invertebrates, associated with some vertebrates, especially the elasmobranch and teleost fishes (KOWALEWSKI 1930, pp. 52–56; JERZMAŃSKA 1958; PAWŁOWSKA 1960; RADWAŃSKI 1965, 1977). The whole faunal assemblage is indicative of a warm tropical and/or subtropical sea (PAWŁOWSKA 1960; RADWAŃSKI 1965, 1977).

The unique remains of whales in the Pińczów Limestones have been discovered by the late Professor Z. RYZIEWICZ, who also announced the occurrence of two endocranial casts (RYZIEWICZ 1969), one of which was preserved in an almost complete skeleton described in a separate paper (CZYŻEWSKA & RYZIEWICZ 1976) as a new genus and species, *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ. The endocranial casts are kept in the Museum of the Earth in Warsaw: the first one, analyzed in this paper (see Pls 1–4), is an isolated but almost complete specimen (Catalogue Number *MZ VIII/Vm-751*); the second one, used for comparison in this paper, is that contained in an almost completely preserved skeleton (Catalogue Number *MZ VIII/Vm-750*).

In the whales, especially in the Cetotheriidae and other families of the order Mysticeti, the brain is enveloped with thick meninges and a well-developed tissue featured by a network of blood vessels. This vascular tissue forms the so-called *annexed mass* on the endocranial casts.

The endocranial casts of the whales show therefore the structure of the brain rather poorly, because the proportions of particular regions are changed, boundaries between regions become unclear or completely obscure, and the casts of the brain hemispheres do not exhibit traces of sulci and fissures on the cortex surface. The vascular tissue fills the *fossa olfactoria*, surrounding the *pedunculi olfactorii* and the canal where the 5th cerebral nerve is set up (estimation of its size is thus impossible). Endocranial casts are thus usually distinctly wider than the brain, because the annexed mass is adhered on the both sides of the endocranial cast.

DESCRIPTION OF THE SPECIMENS

The isolated endocranial cast (specimen No. *MZ VIII/Vm-751*), as seen from above (see Pl. 1), is wide posteriorly and narrowing anteriorly. The outline of its caudal region is rounded, and the rostral part is slightly concave. The profile of the cast (see Pl. 2) shows the caudal region considerably convex, falling softly, almost in a straight line towards the rostrum. The angle between the trace of the *fissura longitudinalis cerebri* and the line running from the anterior margin to the outermost, right lateral point on the cast is *ca* 40°. The investigated cast is clearly shorter than its greatest width (see Pl. 3). Its rostral margin of the hemispheres is unclear, while the caudal boundary of the hemispheres can hardly be seen. The cast is slightly asymmetric, as being expressed by a small difference in width and convexity of its right and the left sides (see Pl. 4). The posterior surface of the cast inclines by *ca* 70°. The cast of the cerebellar-spinal region is very indistinctly outlined. Towards the front, from the trace of the rostral margin of the hemispheres, there runs a cast of the caudal part of the *fossa olfactoria*. The whole *fossa olfactoria* is quite wide and low. Below and laterally, there appear casts of the 5th cerebral nerve of great diameter, as well as flat and small casts of the annexed mass. On the ventral surface, visible are impressions of the inner surface of the *basioccipitale* and the *sphenoidale* with well-marked traces of sutures joining the bones of the skull base.

The endocranial cast preserved in the skull (specimen No. *MZ VIII/Vm-750*) is exposed in the vicinity of the *occipital foramen*, posterior parts of the *occipital squama* and in the posterior part of the *temporal fossae*. On its both sides visible are casts of the annexed mass, of large *paraflocculi*, of

the spinal cord, and of a part of the cerebellum. The occipital region of the cast declines very steeply downwards. The profile of the cast, as viewed from the occipital foramen side, is angular. Its size is about one-fourth greater than that of the isolated specimen (No. *MZ VIII/Vm-751*).

ONTOGENIC AGE OF THE INDIVIDUALS

The isolated endocranial cast (specimen No. *MZ VIII/Vm-751*) represents a young individual. This is evidenced by such features as: (i) a rounded shape of the cast, (ii) soft decline of the profile of the frontal region (this region does not bend in the ventral aspect), and by (iii) not overgrown sutures between the bones of the skull base. As regards these features, the cast is similar to that of a young individual of *Balaenoptera physalus* (LINNAEUS) described by DART (1923) and BREATHNACH (1955).

The endocranial cast preserved in the skull (specimen No. *MZ VIII/Vm-750*) represents an older individual, whose endocranium differed from that of the younger individual in the outline and inclination of the caudal part.

The vascular tissue surrounding the *Pinocetus* brain was certainly located the same as in other Mysticeti. It filled a part of the interior of the *fossa olfactoria* (yet this fossa was not very large) and, also partly, the canal of the 5th cerebral nerve. The vascular tissue, occurring on the sides of the brain, left a well-visible impression in the specimen No. *MZ VIII/Vm-750*, while in the specimen No. *MZ VIII/Vm-751* it is small and poorly outlined. In older specimens the vascular tissue probably filled a space of the endocranium greater than in younger specimens. The vascular tissue enveloping the caudal part of the brain hemispheres and the cerebellum was developed so spaciouly that the cerebellal and spinal regions in the two investigated casts are wide and low, and thus very indistinctly separated from the other parts of the casts.

ANATOMY OF THE ANIMAL AND ITS BEHAVIOR

A wide and relatively short form of the investigated endocranial casts of *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ, 1976, is related to the telescoping of the skull.

The degree of telescoping of the skull in the specimen No. *MZ VIII/Vm-750* is characterized by the three features (see CZYŻEWSKA & RYZIEWICZ 1976, pp. 264–265): (i) the presence of the crest, ca 75 mm long, built of parietal bones which are connected in the medial line (the length of the crest is 27.2% of the total length of parietal bones); (ii) the overlapping of the frontal bones by the parietal ones, and formation of a suture, 40 mm long; (iii) location of the apex of the occipital squama, which does not reach the line connecting the anterior ends of the zygomatic processus. The telescoping of this skull was caused by a considerable withdrawal of the rostrum (features i and ii) and by the distinctly weaker moving forwards of the occipital squama (feature iii). This type of telescoping is expressed also by the shape of the

endocranial cast which is wide, and its posterior slope almost vertical. The vertical occipital slope shows that the missing part of the occipital squama was considerably bent ventrally. In younger individuals the inclination of the whole occipital squama must have been greater. In the discussed skull the dimensions and location of the fossa olfactoria cannot be estimated, while the isolated cast (specimen No. *MZ VIII/Vm-751*) shows that it was quite low and wide.

A flattened and narrow frontal region of the isolated cast (specimen No. *MZ VIII/Vm-751*) seems to point out that the rostral part of the brain was low, narrow, and poorly arched. Such a structure could correspond to the poorer withdrawal of the rostrum in the younger individual, while flattening and narrowness of the frontal region may show poor expansion of the frontal region of the brain hemispheres.

Only tentative conclusions may be drawn as to the development of sense organs in the investigated specimens of *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ, 1976. The olfactory part of the brain could be better developed in this *Pinocetus* species than it was in the contemporaneous Mysticeti, because in *Pinocetus* the parietal bones were connected in the middle of the skull, the nasal bones were elongate and the meatus relatively long (see CZYŻEWSKA & RYZIEWICZ 1976), yet these arguments do not concern the endocranial structure. The wide and low cast of the fossa olfactoria, which contained vascular tissue and the pedunculi olfactorii cannot be regarded as decisive. The investigated *Pinocetus* endocranial casts do not also contribute any argument to an assessment of the function of the auditory sense in the biology of this whale.

The *Pinocetus* musculature was quite well-developed in the posterior part of the thorax and in the tail, and it could be used predominantly for flexing the body when submerging or surfacing (see CZYŻEWSKA & RYZIEWICZ 1976). The blood system in whales has probably some importance in diving (JABLOKOV & al. 1972), yet its functioning in submersion is not quite clear (MATTHEWS 1978). In the investigated *Pinocetus* endocrania the vascular tissue, especially in the young individual, was relatively poorly developed in comparison to the modern whales. The *Pinocetus* specimens were not as adapted to efficient submersion as modern whales and, on the other hand, older individuals probably were able to dive better than younger ones. It is therefore thought that the life habitats of this whale have primarily been confined to shallow parts of marine basins, in which they could realize well their life strategy (see CZYŻEWSKA & RYZIEWICZ 1976).

Acknowledgements

The author offers her most sincere thanks to Z. STANIEWSKI who took carefully photos of the investigated specimen.

*Paleozoological Laboratory
of the Institute of Zoology,
University of Wrocław,
ul. Sienkiewicza 21,
50-335 Wrocław, Poland*

REFERENCES

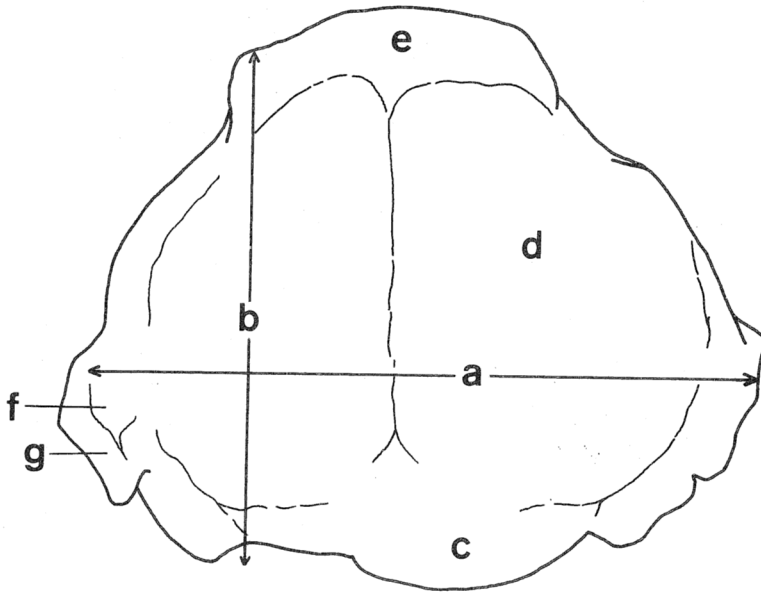
- BREATHNACH, A. S. 1955. Observations on endocranial casts of recent and fossil Cetaceans. *J. Anat.*, **89** (4), 532–546. London.
- CZYŻEWSKA, T. & RYZIEWICZ, Z. 1976. *Pinocetus polonicus*, gen. n., sp. n. (Cetacea) from the Miocene limestones of Pińczów, Poland. *Acta Palaeont. Polon.*, **21** (3), 259–291. Warszawa.
- DART, R. A. 1923. The brain of the Zeuglodontidae. *Proc. Zool. Soc. London*, **2**, 600–615. London.
- DECHASEAU, C. 1961. Cetacea. In: J. PIVETEAU, *Traité de Paléontologie*, **6** (1), pp. 831–886. Paris.
- JABLOKOV, A. V., BELKOVICH, V. M. & BORISOV, V. J. 1978. Kity i del'fany, pp. 1–472. Nauka; Moskva.
- JERZMAŃSKA, A. 1958. *Scorpaena ensiger* (Jordan & Gilbert) from the Miocene of Pińczów (Poland). *Acta Palaeont. Polon.*, **3** (2), 151–159. Warszawa.
- KOWALEWSKI, K. 1930. Stratigraphie du Miocène des environs de Korytnica en comparaison avec le Tertiaire des autres territoires du Massif de S-te Croix. *Spraw. Pol. Inst. Geol. (Bull. Serv. Géol. Pol.)*, **6** (1), 1–211. Warszawa.
- MATTHEWS, L. H. 1978. The natural history of the whale, pp. 1–213. *Columbia University Press*; New York.
- PAWŁOWSKA, K. 1960. Les restes de poissons des calcaires miocènes à *Lithothamnium* de Pińczów. *Acta Palaeont. Polon.*, **5** (4), 421–434. Warszawa.
- RADWAŃSKI, A. 1965. A contribution to the knowledge of Miocene Elasmobranchii from Pińczów (Poland). *Acta Palaeont. Polon.*, **10** (2), 267–279. Warszawa.
- 1977. Neogene. In: H. MAKOWSKI (Ed.), *Historical Geology [In Polish]*, pp. 731–770. *Wyd. Geol.*; Warszawa.
- RYZIEWICZ, Z. 1969. Miocene walę remains from Pińczów. *Przeegl. Zool.*, **13** (2), 225–226. Wrocław.

T. CZYŻEWSKA

NATURALNE ODLEWY ENDOKRANIUM WALENI *Pinocetus polonicus*
Czyżewska & Ryziewicz Z WAPIENI PIŃCZOWSKICH

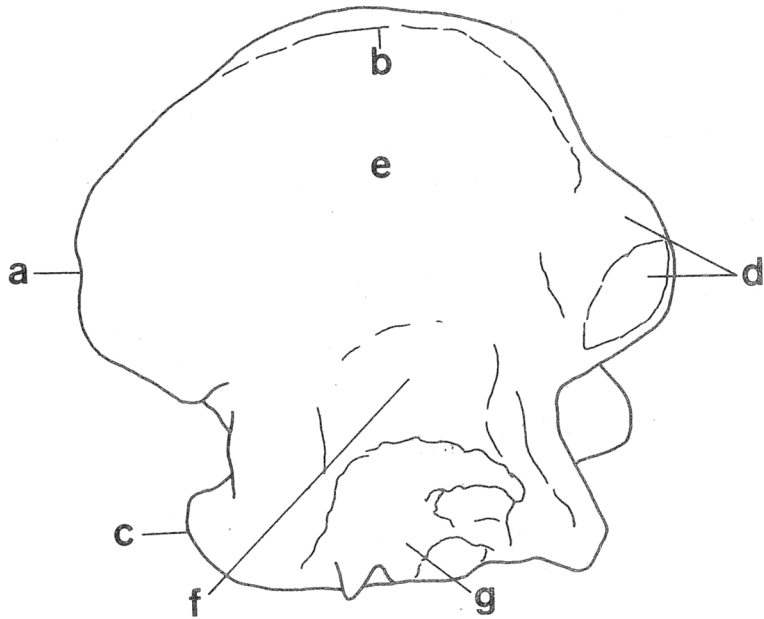
(Streszczenie)

Przedmiotem pracy jest analiza anatomiczna dwóch naturalnych odlewów endokranium walenii *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ, 1976, napotkanych w obrębie wapieni pińczowskich. Przedmiotem szczegółowej analizy jest jeden okaz znaleziony luźno, a należący do osobnika młodocianego (patrz pl. 1–4). Drugi odlew, omawiany porównawczo, znajduje się w obrębie prawie całkowicie zachowanego szkieletu osobnika dorosłego, który był przedmiotem osobnego opracowania (CZYŻEWSKA & RYZIEWICZ 1976). Analiza tego szkieletu, jak również wnioski dotyczące stopnia organizacji mózgu, a wynikające z budowy omawianych odlewów endokranium, zezwalają na odtworzenie trybu życia osobników badanego gatunku. Sądzić należy, iż te miocenijskie walenie należały do form stosunkowo prymitywnych, o małej stabilności ciała i stąd zapewne o niezbyt wydajnej zdolności do pływania, a zwłaszcza nurkowania, co powodowało konieczność zasiedlania się ich w strefach przybrzeżnych ówczesnych mórz.

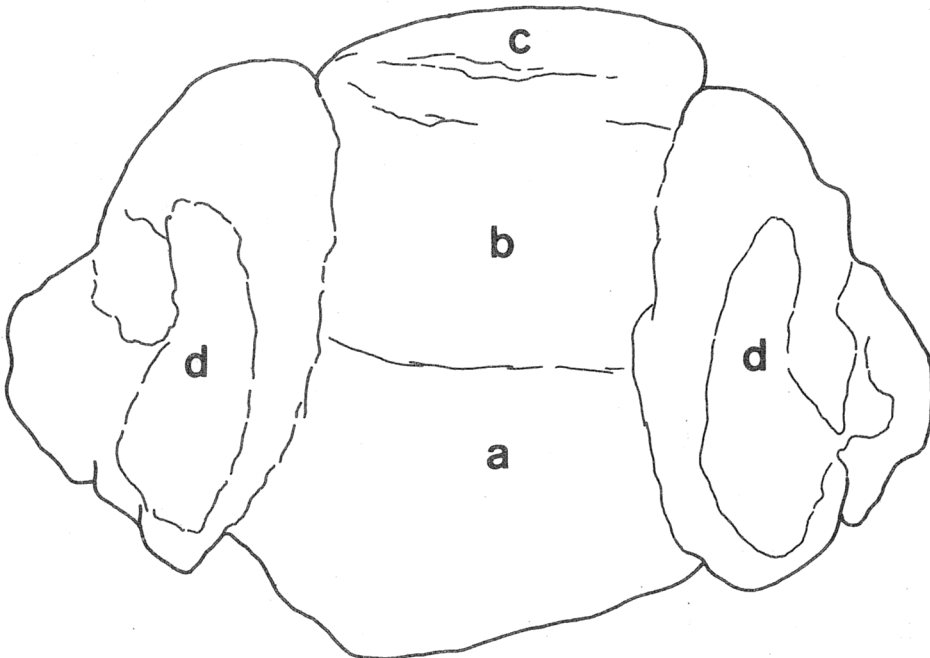
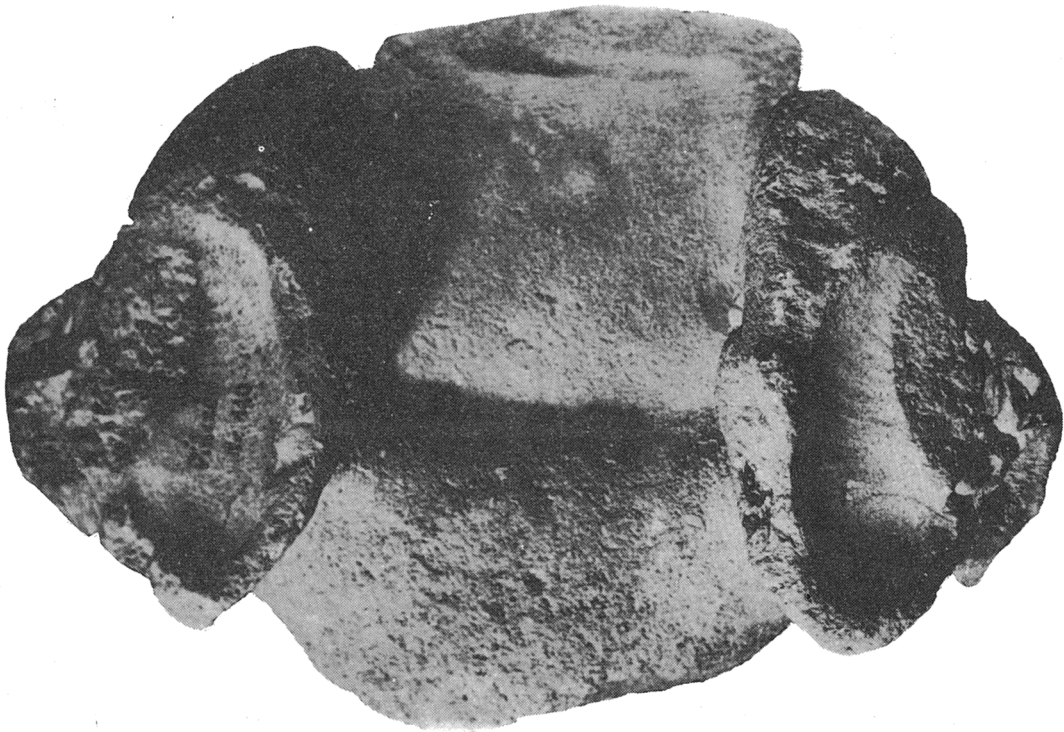


Pinocetus polonicus CZYŻEWSKA & RYZIEWICZ, 1976; natural endocranial cast (specimen No. MZ VIII/Vm-751); dorsal view, $ca \times 1.4$

a – maximum width, b – lateral length, c – cerebellal-spinal region, d – right hemisphere of cerebrum, e – fossa olfactoria, f – annexed mass, g – part of skull bone



Pinocetus polonicus CZYŻEWSKA & RYZIEWICZ, 1976; natural endocranial cast (specimen No. MZ VIII/Vm-751); left-side view, *ca* \times 1.4
a – fossa olfactoria, **b** – fissura longitudinalis cerebri, **c** – 5th nerve canal, **d** – cerebellal-spinal region, **e** – left hemisphere of cerebrum, **f** – annexed mass, **g** – part of skull bone



Pinocetus polonicus CZYŻEWSKA & RYZIEWICZ, 1976; natural endocranial cast (specimen No. MZ VIII/Vm-751); ventral view, $ca \times 1.2$

a – basioccipitale, b – sphenoidium and fragment of skull base, c – rostral region, d – dorsal surface of bulla tympani



Pinocetus polonicus CZYŻEWSKA & RYZIEWICZ, 1976; natural endocranial cast (specimen No. MZ VIII/Vm-751); caudal (*above*) and rostral (*below*) views, to show asymmetry of the cast; both taken $\times 1.2$