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Middle Miocene (Badenian) delphinid and phocoenid remains from the Fore-Carpathian Depression in southern Poland

ABSTRACT: A small assemblage of remains of the toothed whales (Mammalia: order Cetacea, suborder Odontoceti) from the Middle Miocene (Badenian) deposits of the Fore-Carpathian Depression in Poland is analyzed. Their typical occurrence site within the Pińczów Limestones on the southern slopes of the Holy Cross Mountains (Central Poland) has yielded the teeth belonging probably to the delphinid genus *Lagenorhynchus*, the vertebrae and a fragment of bulla tympani of indeterminable delphinids, and the teeth of the porpoises *Phocoena* sp. All these delphinid and phocoenid remains were buried in deposits which formed under very shallow marine conditions, close to the shore.

Commented in this report are also occurrences of the delphinid remains in deposits of the Fore-Carpathian Depression slightly younger (localities Leszcze near Pińczów, and Dzierzysław in the Upper Silesia region) than the Pińczów Limestones and which are underlying the Gypsum Member, still of Middle Miocene (Badenian) age.

INTRODUCTION

The Tertiary toothed whales are rather very rare fossils in Europe. Their occurrence in Poland is confined to the marine Middle Miocene (Badenian) deposits of the Fore-Carpathian Depression which is situated between the mountain range of the Carpathians to the south and the Central Polish Uplands to the north (*see* Text-fig. 1; *and* BAŁUK & RADWAŃSKI 1977, Fig. 1A).

Within the frames of the Fore-Carpathian Depression the toothed whales have first been recorded by ROEMER (1865; *and* 1870, pp. 390-391) who reported from Dzierzysław near Głubczyce (= *Dirschel bei Leobschütz*) in Upper Silesia, westernmost part of the Fore-Carpathian Depression (*see* Text-fig. 1; *and* BAŁUK & RADWAŃSKI 1977, Fig. 1B), the presence of a scapula and vertebrae, some of which were illustrated (ROEMER 1870, Pl. 49, Figs 1-3 and Pl. 50, Fig. 1).

The second site of the toothed whales occurrence is in the Pińczów Limestones exposed on the southern slopes of the Holy Cross Mountains which border the Fore-Carpathian Depression from the north in the middle part of the Central Polish Uplands (*see* BAŁUK & RADWAŃSKI 1977, Fig. 1B). This is the locality from where all the illustrated specimens come (*see* Pls 1-2).

The studied material has been collected by the junior author of the present paper (A. RADWAŃSKI) in large quarries numbered 2 (now abandoned) and 3 situated in the village Nowa Wieś near Pińczów throughout the time interval since 1968 up to 1991. This material is housed in the collection of the Institute of Geology, University of Warsaw, and kept under the Catalogue Numbers PL 101—PL 111.

THE LITHOTOPE OF THE INVESTIGATED MATERIAL

The Middle Miocene (Badenian) fossiliferous limestones typical of the Pińczów area, and thus commonly called the Pińczów Limestones, are one of the lithofacies locally developed in the Fore-Carpathian Depression. These are soft, white-colored, detrital, red-algal (lithothamnian) and/or bryozoan limestones similar to the Leitha Mountains type (*Leithakalk*) in the Vienna Basin (see RADWAŃSKI 1977b, p. 228). Their paleontological content comprises much differentiated faunal remains of almost all the animal phyla (see KOWALEWSKI 1930; RADWAŃSKI 1977a, b). A peculiar feature of the Pińczów Limestones is the presence of vertebrates, the most important of which are the elasmobranch and teleost fishes (see JERZMAŃSKA 1958; PAWŁOWSKA 1960; RADWAŃSKI 1965, 1977a; SCHULTZ 1977, 1979), the aberrant crocodiles of the genus *Tomistoma* (see RADWAŃSKI 1977a, ANTUNES 1984), the sirenians (see RADWAŃSKI 1977a), and the whales (see RYZIEWICZ 1969, CZYŻEWSKA & RYZIEWICZ 1976, CZYŻEWSKA 1988). The delphinid remains complete that list, and their occurrence was first stated by KOWALEWSKI (1930, p. 55) who noted the presence of vertebrae, *ossa periotica* and *tympanica* of *Delphinus* sp. These records were supplemented by RADWAŃSKI (1977a, p. 749) who reported on the occurrence of teeth which are now demonstrated in this paper.



Fig. 1

Paleogeographic map of southern Poland, to show the extent of the Middle Miocene (Badenian) transgression in the Fore-Carpathian Depression (*stippled*); besides the localities yielding the investigated remains of the delphinids and phocoenids, indicated are also the most important fossil-bearing sections (*adopted from: RADWAŃSKI 1977a, Fig. 169*)

A very rich invertebrate assemblage of the Pińczów Limestones is briefly discussed by KOWALEWSKI (1930), RADWAŃSKI (1977a, pp. 747-749), and BAŁUK & RADWAŃSKI (1977, p. 115). The systematic studies of particular organic phyla from the Pińczów Limestones have recently been promoted by the junior author (A. RADWAŃSKI) and these resulted in monographic descriptions of decapod crustaceans (FÖRSTER 1979), bivalves (STUDENCKA & STUDENCKI 1988), brachiopods (POPIEL-BARCZYK & BARCZYK 1990), and echinoids (MACZYŃSKA 1992). This series of recent publications contains also a comprehensive study of the red algae and their ecological significance (STUDENCKI 1988). On the other hand, the paleontological content of the Pińczów Limestones is also pronounced by the presence of timber logs densely bored by the terebinthid bivalves (*see* RADWAŃSKI 1977b, Plate 6a).

A general conclusion on the environmental conditions under which the Pińczów Limestones were formed should easily be indicated as shallow marine with a distinct contribution of features typical of the shallow subtidal and /or intertidal zone.

The shallow marine environment is also apparent from analysis of the baleen whale remains, and performed by RYZIEWICZ & CZYŻEWSKA (1976) and CZYŻEWSKA (1988). A study of the natural endocranial casts (CZYŻEWSKA 1988) shows that the structure of the brain in the Pińczów endemic whales, *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ, 1976, is typical of the primitive forms which could not dive too long and thus had to live at smaller depths, near the shores.

Such very life habitat was also required by the sirenians ("sea cows") of the genus *Thalattosiren* (= *Metaxytherium*), allied to the present-day dugongs, whose biotope was confined to the seagrass beds thriving along the shallow offshores, and upon which they grazed (*see* RADWAŃSKI 1977b, p. 749; and DOMNING 1981).

The climatic conditions under which the Pińczów cetaceans and associated sea mammals have lived is recognized, after analysis of the life requirements of the benthic invertebrates and the other vertebrates, as tropical and/or subtropical (*see* JERZMAŃSKA 1958; PAWŁOWSKA 1960; RADWAŃSKI 1965, 1977a), what conforms well with the data concluded from the study of coeval communities of the nearby Korytnica Basin (*see* BAŁUK & RADWAŃSKI 1977).

SYSTEMATIC ACCOUNT

Order **Cetacea** BRISSON, 1762

Suborder **Odontoceti** FLOWER, 1867

Family **Delphinidae** GRAY, 1821

Genus *Lagenorhynchus* GRAY, 1821

? *Lagenorhynchus* sp.

(Pl. 1, Figs 1-2)

DIMENSIONS (*in mm*):

	Specimens	
	No. 101 (Pl. 1, Figs 1a-1b)	No. 102 (Pl. 1, Figs 2a-2b)
Crown diameter	4.2 × 4.2	4.6 × 5.5
Height of the preserved fragment	14.7	8.5

DESCRIPTION: The crowns are of conical shape, slightly curved. The smaller tooth (Pl. 1, Figs 2a-2b) is curved more distinctly than the larger one (Pl. 1, Figs 1a-1b) which is almost straight. The enamel is smooth.

REMARKS: A poor material does not permit for its precise determination. The size and shape of the studied teeth correspond to those of the present-day genus *Lagenorhynchus* GRAY, for instance of the species *L. acutus* (GRAY) living in the northern Atlantic. The present-day forms of this genus feed on epibenthic and pelagic fish (see TOMLIN 1957).

The genus *Lagenorhynchus* GRAY is regarded by THENIUS (1969) as one of the delphinids the most advanced evolutionary, although its stratigraphic record, as appears from the herein presented data, is one of the earliest. The fossil remains attributable to the genus are known insofar from the Pleistocene solely, and they do not differ from the modern forms.

Delphinidae, gen. et sp. indet.
(Pl. 1, Figs 3-4 and Pl. 2, Figs 1-4)

MATERIAL: Two lumbar vertebrae (Specimens No. 103-104), one last lumbar or first caudal vertebra (Specimen No. 105) and three caudal vertebrae (Specimens No. 106-108); one fragment of bulla tympani (Specimen No. 109).

DIMENSIONS (*in mm*):

Lumbar vertebrae:	Specimens		
	No. 103 (Pl. 1, Figs 3a-3b)	No. 104	(?No. 105) (Pl. 2, Figs 1a-1b)
Length of centrum	+55.0	55.0	50.8
Width of centrum	55.5	51.6	38.3
Height of centrum	50.0	55.0	38.0

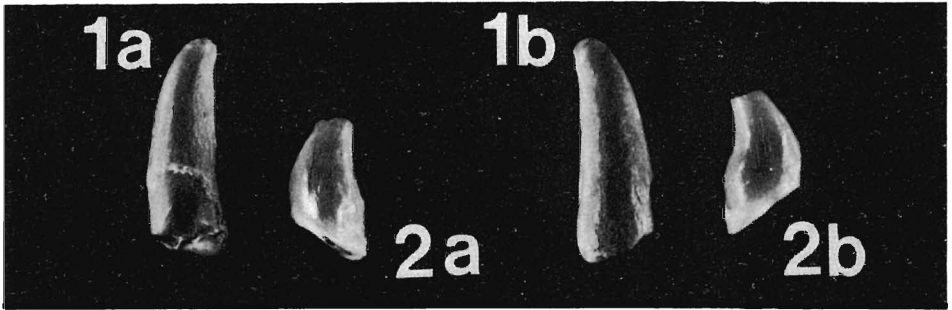
Caudal vertebrae:	Specimens		
	No. 106 (Pl. 2, Fig. 2)	No. 107 (Pl. 1, Figs 4a-4c)	No. 108 (Pl. 2, Fig. 3)
Length of centrum	40.5	34.0	28.0
Width of centrum	29.5	32.8	25.4
Height of centrum	34.5	35.5	28.4

DESCRIPTION: The **lumbar vertebrae** (Specimens No. 103-104) have their neural and hemal arches, as well as the *processus transversi* broken off. The centrum of these vertebrae is furnished with *arteria intervertebralis*. The neural foramina and impress of bloodvessels are large (see Pl. 1, Fig. 3).

The Specimen No. 105 (see Pl. 2, Figs 1a-1b) is the centrum furnished with the pedicle of the neural arch and the base of *processus transversus*. In the anterior part of the centrum, there appears an impress of *arteria intervertebralis*. The left side of the centrum is provided with the foramen of *nervus sympaticus*. A characteristic feature of the specimen is displayed by a relatively narrow spreading of pedicles of the neural arch. The transverse processes are inferred to have been rather small; the artery and the neural foramen are situated near each other. All the latter features in the delphinids are typical of the last lumbar and/or the first caudal vertebra.

The **caudal vertebrae** (Specimens No. 106-108; see Pl. 1, Fig. 4 and Pl. 2, Figs 2-3) are preserved as the centrum with the pedicle of the neural arch. The foramina of *arteria intervertebralis* are distinct.

A fragment of **bulla tympani** (Specimen No. 109; see Pl. 2, Fig. 4) is a rather small part (25 mm long, 10 mm wide), precisely the innerside of the dorsal part. Its *processus posterius* was directed backwardly and outwardly, like in modern representatives of the genus *Delphinus*. The dimensions of the fragment correspond to those of bulla tympani in present-day species *Delphinus delphis* LINNAEUS, 1758, or *D. bairdi* DALL, 1873.

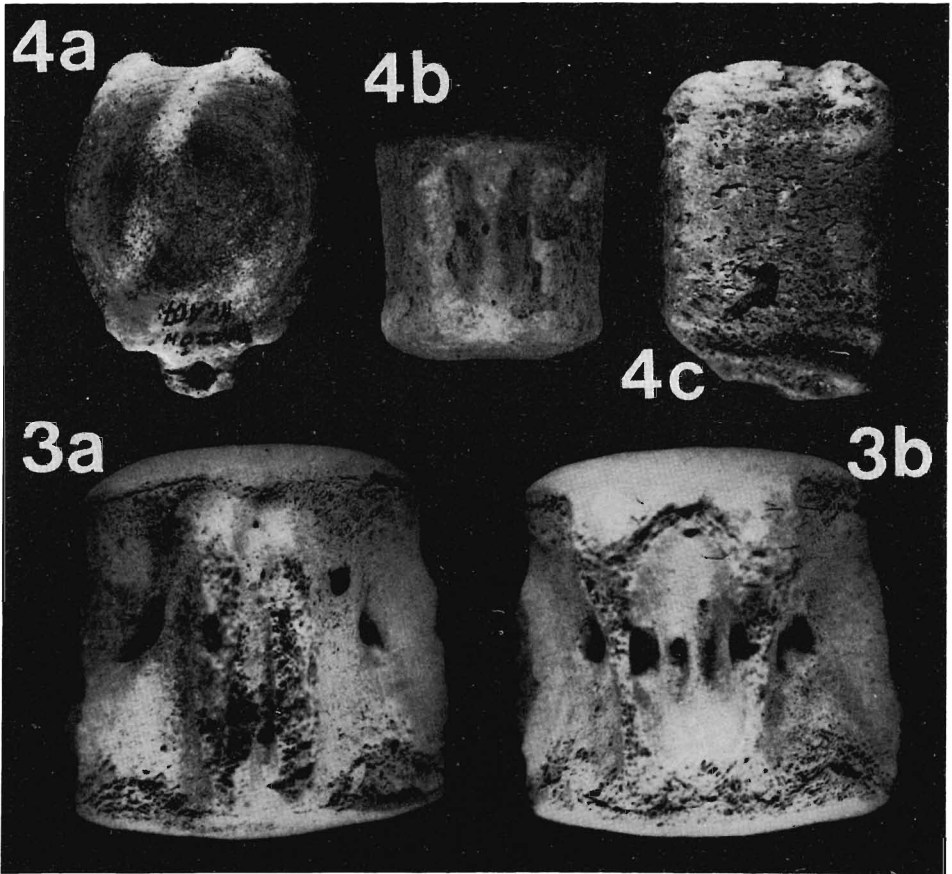


? *Legenorhynchus* sp.

1a-1b — Fragmented tooth (Specimen No. 101); taken from both sides, ×2

2a-2b — Another fragmented tooth (Specimen No. 102); taken from both sides, ×2

Photos by Dr. R. ADAMSKI

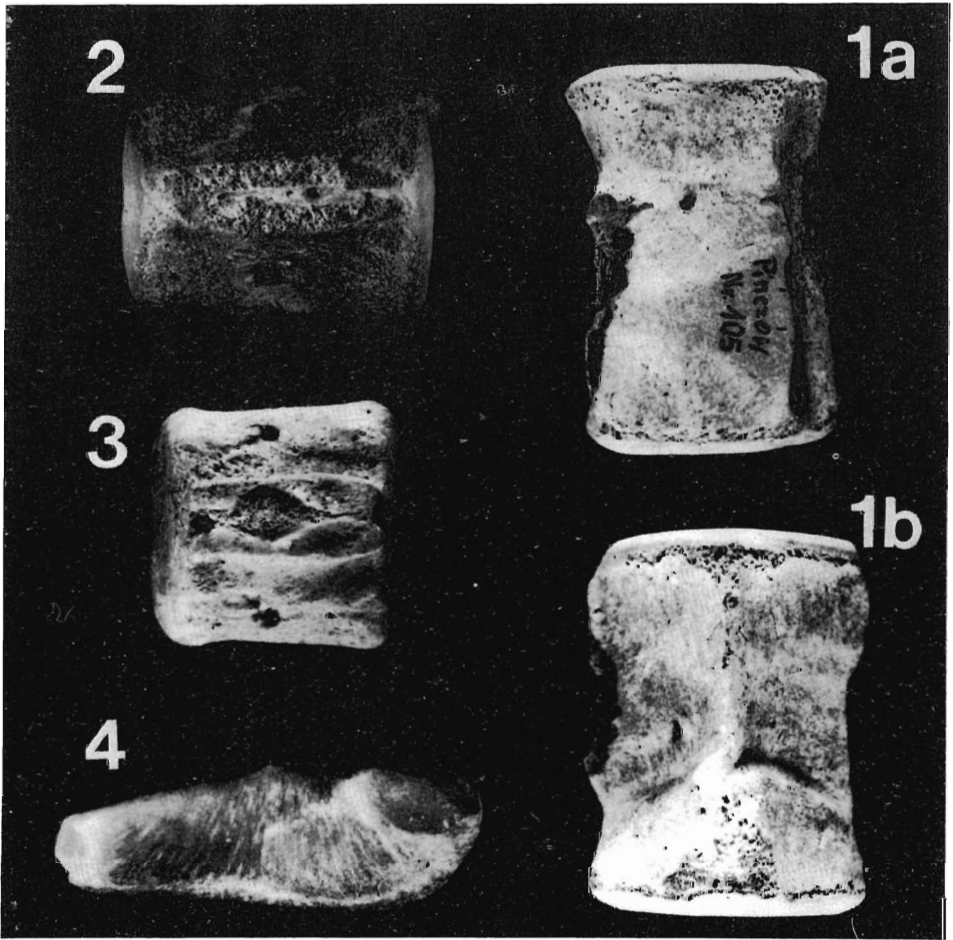


Delphinidae, gen. et sp. indet.

3a-3b — Lumbar vertebra: 3a — underside view, 3b — top view; Specimen No. 103, nat. size

4a-4c — Caudal vertebra: 4a — front view, 4b — top view, 4c — left side view; Specimen No. 107, nat. size

Photos by Dr. R. ADAMSKI



Family *Phocoenidae* CUVIER, 1817

The family of porpoises, the *Phocoenidae* CUVIER, 1817, in recent systematical classifications is usually treated as a separate one (e.g., BARNES 1976). Formerly, it was commonly included into the family *Delphinidae* GRAY, 1821. The history of these small toothed whales is still poorly known, primarily due to very scanty materials so far recovered and their fragmentary preservation. The oldest remains of the *Phocoenidae* are seemingly those of the genus *Loxolithax* KELLOGG, 1931, reported from the Middle Miocene deposits (Temblor Formation) of Palos Verdes Hills near Los Angeles in California (see WILSON 1973, BARNES 1976).

Genus *Phocoena* CUVIER, 1817*Phocoena* sp.

(Pl. 2, Figs 5-6)

MATERIAL: Two, almost well preserved teeth, with the tops of the crowns broken off and the base of the roots damaged.

DIMENSIONS (in mm):

	Specimens	
	No. 110 (Pl. 2, Figs 5a-5b)	No. 111 (Pl. 2, Figs 6a-6b)
Crown diameter (l-l)	3.5	3.6
Crown diameter (a-p)	4.1	4.0
Crown height	6.9	7.4
Root length	11.4	9.6
Root diameter below the crown	3.6 × 4.2	3.4 × 4.0
Maximum diameter of the root	4.8 × 4.8	3.8 × 4.0

DESCRIPTION: The crowns of teeth are curved and laterally flattened. The enamel is indistinctly wrinkled. The roots taper at their base, whilst the higher parts are thicker. In its lower part, the root of the larger tooth (Pl. 2, Figs 5a-5b) is folded medially (see Pl. 2, Fig. 5b).

REMARKS: The size of the studied teeth, and their shape, the tapering of the roots at their base particularly, are the features indicative of their belonging to the porpoises. The studied teeth do not differ from those of the present-day porpoises, and thus they are assigned generally as *Phocoena* sp.

The both of the studied teeth display their roots having been closed what results from their loss by live specimens.

The only ancient material to which the studied specimens could bear a relation is that reported by KUDRIN & TATARINOV (1965) from the Upper Miocene ("Sarmatian") of Podolia in the Ukraine, formerly the Soviet Union (locality Brykovo near Tarnopol; easternmost part of the Fore-Carpathian Depression). It was a posterior fragment of the skull referred to as a new genus and

PLATE 2

Delphinidae, gen. et sp. indet.

- 1a-1b — Last lumbar or the first caudal vertebra: 1a — left side view, 1b — underside view; Specimen No. 105, nat. size
 2 — Caudal vertebra, underside view; Specimen No. 106, nat. size
 3 — Another caudal vertebra, top view; Specimen No. 108, nat. size
 4 — Fragment of bulla tympani; Specimen No. 109, taken × 2

Photos by Dr. R. ADAMSKI

Phocoena sp.

- 5a-5b — Tooth (Specimen No. 110); taken from both sides, × 2
 6a-6b — Another tooth (Specimen No. 111); taken from both sides, × 2

Photos by Dr. R. ADAMSKI

species, *Microphocoena podolica* KUDRIN & TATARINOV, 1965. This was a small porpoise, as the fragment of its skull was of 75.7–81.2% measurement value of that average for the present-day porpoise living in the Black Sea, *Phocoena relicta* ABEL, 1905, to which the Podolian species might have been an ancestor. The teeth of that Podolian species are therefore thought to have been much smaller than those of the species living in the Middle Miocene of the Pińczów area in Poland. Anyway, it is to note that according to BARNES (1978), most of the Miocene findings of remains attributed to small toothed whales, *Microphocoena podolica* including, need a revision and should thoroughly be reexamined.

PRESERVATION OF THE REMAINS — A TAPHONOMICAL INQUEST

The heretofore studied cetaceans from the Pińczów Limestones belonged primarily to the baleen whales of the family Cetotheriidae, the remains of which are represented by an almost complete skeleton of the newly established species, *Pinocetus polonicus* CZYŻEWSKA & RYZIEWICZ, 1976 (see RYZIEWICZ 1969, CZYŻEWSKA & RYZIEWICZ 1976, CZYŻEWSKA 1988). To this species ascribed was also an isolated endocranial cast (CZYŻEWSKA 1988). The mode of preservation of the discussed skeleton shows (see CZYŻEWSKA & RYZIEWICZ 1976) that the carcass has been buried under shallow marine conditions, in a zone of low-energy regime where quiet waters did not cause a disarticulation of the skeleton and a bursting of its bones. On the other hand, the sedimentation rate was rather high there, and thus the burial of the skeleton was relatively fast. The same may be said about the teleost fish, *Scorpaena ensiger* (JORDAN & GILBERT), whose skeleton has been preserved perfectly (see JERZMAŃSKA 1958).

The investigated remains of the toothed whales have all been found isolated. Both the vertebrae and teeth were scattered throughout the successive layers of the sedimentary sequence exposed in the Pińczów quarries. Thus, it cannot be stated whether they could belong to one or more individuals. The teeth display their enamel unworn, and thus they were certainly embedded in the sediment soon after their freeing from the jaws of either live or dead specimens (see remarks on the teeth of *Phocoena* sp.). Contrary to that, all the delphinid vertebrae studied are damaged to various extent, and this likely results from their longer being on the seafloor. In other words, it was a much longer timespan between the death of the animals and the burial of their disarticulated bones. Presumably, the delphinid carcasses have been floating at the surface. Under such circumstances, it is known that the caudal fin and the neighboring vertebrae of the backbone are the first to be broken off and freed, and — when isolated — to settle successively on the seafloor where they may undergo further transportation and/or abrasion. A similar set of events may also be inferred for all the isolated teeth of sharks, the teeth and caudal spines of rays (see RADWAŃSKI 1965, 1977a), the teeth of the crocodile *Tomistoma*, and the skeleton fragments of the sirenians (see RADWAŃSKI 1977a).

The presented data show that mode of burial of remains of particular vertebrates in the Pińczów sedimentary area was variable. This depended upon the environmental conditions and accumulation rate which were temporarily changing during deposition of the Pińczów Limestones sequence.

OTHER OCCURRENCES OF DELPHINIDS
IN THE FORE-CARPATHIAN DEPRESSION

The investigated toothed whales from the Pińczów Limestones were not the only ones which lived in the Miocene sea of the Fore-Carpathian Depression in Poland. Within the transgressive sequence of that area, the Pińczów Limestones are one of the oldest lithofacies in the stratigraphic succession of Middle Miocene (Badenian) age (see RADWAŃSKI 1969, p. 36 and p. 52: Fig. 22; and 1977a, p. 750: Table 50). The younger are the members preceding the evaporation event of the basin and formation of the Gypsum Member. The delphinid remains reported by ROEMER (1865; and 1870, pp. 390–391) from Upper Silesia were coming just from these members which are underlying the Gypsum Member. From the coeval deposits exposed in the gypsum quarry Leszcze at Gacki near Pińczów (see Text-fig. 1), an undeterminable delphinid vertebra has recently (July 1991) been recovered within the grayish clays bearing commonly the oyster *Neopycnodonte cochlear* (POLI).

The illustrated vertebrae, designated by ROEMER (1870) as “? *Delphinus*”, when taking into account their size, should be ascribed to any large, toothed whales of a family other than the Delphinidae. Unfortunately, the original specimens have been lost during the winds of this century.

The discussed two occurrences demonstrate that the delphinids and/or other toothed whales have survived a rapid change of environmental conditions and could live at the time when almost all organic phyla typical of the Pińczów Limestones disappeared, and clay sedimentation was in progress until a hypersaline regime and evaporation were established in the Fore-Carpathian Depression.

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**SZCZĄTKI DELFINÓW I MORŚWINÓW Z WAPIENI PIŃCZOWSKICH ORAZ INNYCH
STANÓWK MIOCENU ZAPADLIKA PRZEDKARPACKIEGO**

(Streszczenie)

Przedmiotem pracy jest analiza szczątków mioceńskich waleni uzębionych — delfinów i morświnów — znalezionych w obrębie wapieni pińczowskich w okolicach Pińczowa. Wśród szczątków tych zwierząt, których obecność tutaj notowana była już dawniej (KOWALEWSKI 1930, p. 55; RADWAŃSKI 1977a, p. 749) znajdują się zęby delfinów należących przypuszczalnie do znanego dotychczas tylko z czwartorzędu rodzaju *Lagenorhynchus* GRAY (patrz pl. 1, fig. 1–2), rozmaite kręgi (łędźwiowe i ogonowe) oraz fragment puszki słuchowej bliżej nieoznaczalnych delfinów (patrz pl. 1, fig. 3–4 oraz pl. 2, fig. 1–4), a także zęby morświnów *Phocoena* sp. (patrz pl. 2, fig. 5–6).

Obecność szczątków morświnów, które współcześnie trzymają się wybrzeży morskich, a nieraz zapuszczają się także w głąb rzek, wskazuje na bardzo płytkomorskie środowisko powstawania wapieni pińczowskich. Zwrócić należy uwagę, iż wniosek ten jest zaskakująco zbieżny z wynikami analizy szczątków waleni bezzębnych — wielorybów fiszbinowych (patrz RYZIEWICZ 1969, CZYŻEWSKA & RYZIEWICZ 1976, CZYŻEWSKA 1988), a także szczątków krów morskich („syren”) pokrewnych dzisiejszemu dugoniowi (patrz RADWAŃSKI 1977a, p. 749).

W pracy omówiono także występowanie szczątków waleni uzębionych w osadach podgipsowych Zapadlika Przedkarpackiego, podając nowe stanowisko z kamieniołomu Leszcze w Gąckach koło Pińczowa, oraz komentując dawniejsze znaleziska (ROEMER 1865, 1870) z Dierzysławia koło Głubczyc na Górnym Śląsku.
