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A JUVENILE *TRACHINUS MINUTUS* (PISCES, PERCIFORMES, TRACHINIDAE) FROM THE MIDDLE OLIGOCENE OF LITENČICE (MORAVIA, CZECH REPUBLIC)

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Abstract. The paper presents information about the first find of Trachinus minutus (Jonet, 1958) in the Šitbořice Beds (Middle Oligocene) in the Czech Republic. The exemplar is relatively well ossified, however the total length is only 16.5mm. A comparison of preserved morphologic and meristic characters with features in exemplars from other Europian localities shows its similarity to the specimens from Poland. Slightly different praeoperculare morphology is probably caused by ontogeny. The taphonomic information is combined with information about finds of terrestrial elements in Menilitic shale and selected bathymetric and paleoecological data are discussed as possible evidences of coastal upwelling.

■ Fossil fish, Trachinidae, Middle Oligocene, Western Carpathians

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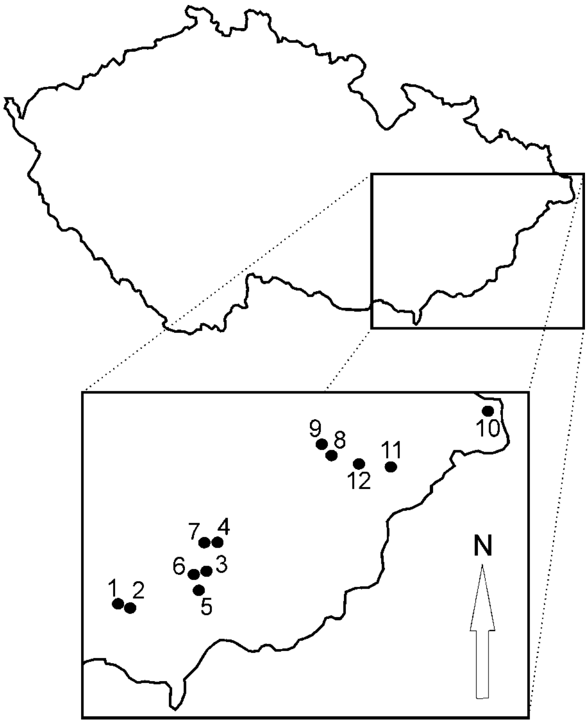
Introduction

The existence of fish remains in the Menilitic Formation has been well known since the 1830s (see Kalabis 1981) and fossil fishes have been collected from many localities in Moravia. The fish material is well documented from many localities (Text-fig. 1) although has not been published fully until today.

The fossil fish fauna found at the Litenčice locality were first described by Gregorová (1988) and then published by same author (e.g. 1989, 1997). The fossils from this locaty are perfectly preserved and it allows study of their fine structures. The material described here was collected in the year 2006. During the examination of material in 2007, *Trachinus minutus* (family Trachinidae) was discovered among the unidentified material. The single specimen represents a small, almost complete, articulated skeleton with a large skull and remarkably developed praeopercular spines.

Trachinus minutus is known from Oligocene sediments in Europe (Jonet 1958, Jerzmańska 1968, Pharisat 1991). The recent fishes from the family Trachinidae () are demersal, neritic predators living at depths of up to 150 m (Froese and Pauly 2008). The recent form, *Trachinus draco,* differs from *Trachinus minutus* only in its lower number of vertebrae (Jerzmańska 1968).

The earliest doubtless fossil evidence (isolated operculare) of the family Trachinidae was found in Sables de Forest, Forestlez-Bruxelles in Belgium, dated as Eocene, Ypresian Stage (Patterson 1993). Trachinidae otoliths are quite frequent in Oligocene and Miocene deposits in Europe (Nolf 1985).



Text-fig. 1. Geographic position of fish localities in Moravia. Ždánice Unit: 1 – Křepice; 2 – Nikolčice; 3 – Mouchnice; 4 – Litenčice; 5 – Bohuslavice; 6 – Jestřabice; 7 – Nítkovice. Subsilesian Unit: 8 – Kelč; 9 – Špičky; 10 – Bystřice nad Olší. Silesian Unit: 11 – Rožnov pod Radhoštěm; 12 – Valašské Meziříčí.

Geological setting

The studied material was collected from an outcrop on the periphery of the village of Litenčice, about 500m southwest of the village square. A detailed description of the outcrop was given by Gregorová (1988). The deposits belong to the Ždánice Unit of the Menilitic Formation. The *Trachinus* discovery came from the Šitbořice Beds of calcareous clay shales.

The calcareous nannofossil association in the underlying Dynow Marlstones indicated zone NP 23 at the locality (Gregorová 1988).

Material and methods

The specimens numbered Lit2006/16a and Lit2006/16b (counterpart) are housed in the collection of the Institute of Geology and Palaeontology, Charles University in Prague, Faculty of Sciences. The fossil specimens were left unprepared. All measurements are in millimeters.

Anatomical abbreviations: A – anal fin; BD – body depth; C – caudal fin; CPD – caudal panducle depth; D I – first dorsal fin; D II – second dorsal fin; HD – head depth; HL – head length; P – pectoral fin; PAL – preanal length; PDL I – length in front of first dorsal length; PDL II – length in front of second dorsal length; PPL – prepectoral length; PVL – preventral length; SL – standard length; TL – total length; V – ventral fin; Vert – vertebrae.

Systematic Paleontology

Suborder **Trachinoidei Bertin et Arambourg, 1958**

Family **Trachinidae Risso, 1826**

Genus ***Trachinus* Linnaeus, 1758**

***Trachinus minutus* (Jonet, 1958)**

Figs 2, 3A

1958 *Megalolepis minutus* Jonet, Pl. 8, Fig. 5
1968 *Trachinus minutus* (Jonet) Jerzmańska, Pl. 6, Fig. 1; Text fig. 20
1991 *Trachinus minutus* (Jonet) Pharisat, Figs 44, 45

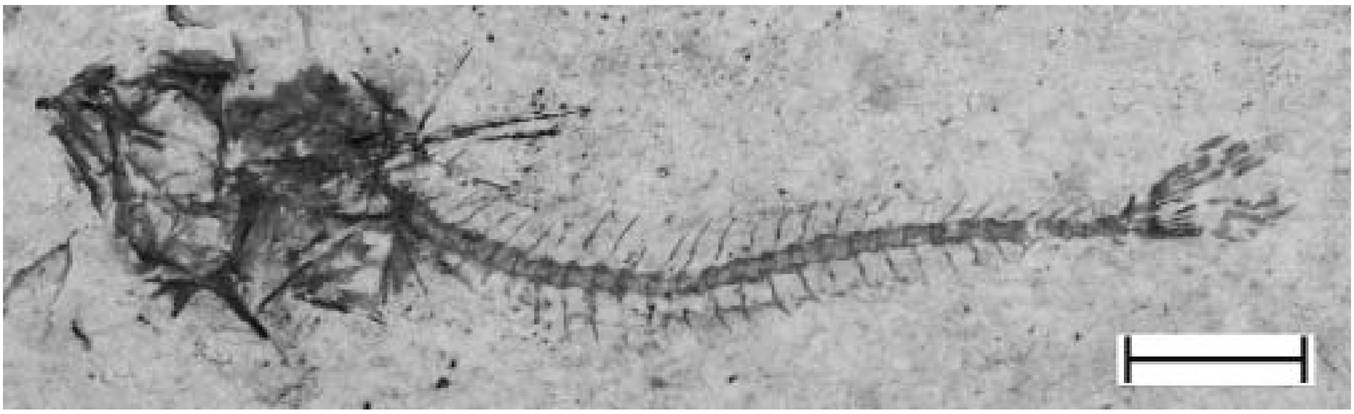
The body is elongated, with a large head. Although the total length is only 16.5mm, most of the bones are well ossified. The caudal penducle depth is about 28 % of the body depth. The head is almost triangular in shape and its length exceeds the depth of the body. The head length is 29.3 % of standard length (SL). The maximal body depth was 6.4 times the SL. Measurements of the specimen and percentages of the standard length and head length are given in Table 1.

S k u l l : The ratio of the head length to the head depth equals 1.09. The eye is quite large and it is placed in the anterior part of the head (preorbital length is 27.4 % of the head length). The diameter of the orbit is about 25 % of the head length. The mouth is moderately large and elevated. The neurocranium is relatively deep (34.7 % of head depth). The parasphenoid is exposed in the middle part of the orbit as a slender shaft. Infraorbital bones are poorly preserved. The praemaxilla has an ascending process probably fused with the processus articularis. The praemaxilla bears small conical teeth which are arranged in several rows. The maxilla is relatively narrow and has a distinct articular head. The attachment between dentary and angulo-articular is not obvious. The teeth preserved in the dentary are small, sharp and conical. The lower jaw articulation is under the anteriormost part of the orbit. The quadrate has a triangular corpus quadrati and along its anterodorsal edge the corpus quadrati articulates with the ectopterygoid. The praeoperculare (Text-fig. 3A) is sickle shaped. The anterior part of the ramus horizontalis is not preserved. The outer margin of the praeoperculare has 5 spiny projections. The operculare is a thin broad plate. The posterior part of the operculare is not preserved. There are 5 branchiostegal rays preserved.

A x i a l s k e l e t o n : There are 23 caudal vertebrae (including urostyle) and most probably 7 abdominal vertebrae. The first two abdominal vertebrae are covered by the dorsal part of the operculare. The ribs are not preserved. The vertebral column is S bent and slightly elevated dorsally in the anterior part of the body. The ratio of vertebra length to its maximum depth is 1.34 (measured at the first caudal vertebra). The neural spines are long and slender in the first half of the body, in the second half of body they are shorter than the haemal spines. The haemal spines are relatively long and slenderand slightly curved (straight in the posterior half of the caudal part of the body).

The dorsal fin is preserved directly behind the head. There are 5 spines preserved in the anterior dorsal fin. Other rays and spines are not preserved.

The anal fin is poorly preserved and it is impossible to determine the number of fin rays.



Text-fig. 2. *Trachinus minutus*, Lit2006/16a, right side. Oligocene, Litenčice. Scale bar represents 2mm.

Table 1. Measurements of fossil (in mm).

	mm	% of SL	% of HL
TL	16,5	-	-
SL	14,8	-	-
HL	4,3	29,3	-
BD	2,3	15,7	-
CPD	0,6	4,4	-
PDL I	4,2	28,6	-
PAL	6,1	41,4	-
PPL	4,5	30,2	-
PVL	3,8	26	-
HD	3,1	-	72,4
preorbital length	1,2	-	27,4
diameter of the orbit	1,1	-	24,7
postorbital	1,6	-	37,1
maxilla length	1,3	-	30,0
jowl length	1,3	-	28,8

The pectoral fin has 13 rays. The fin base is positioned under the third abdominal vertebra. The ventral fin has one spine and probably six rays. Its base is situated directly behind the head in the ventral part of body.

The caudal fin has 16 preserved rays .

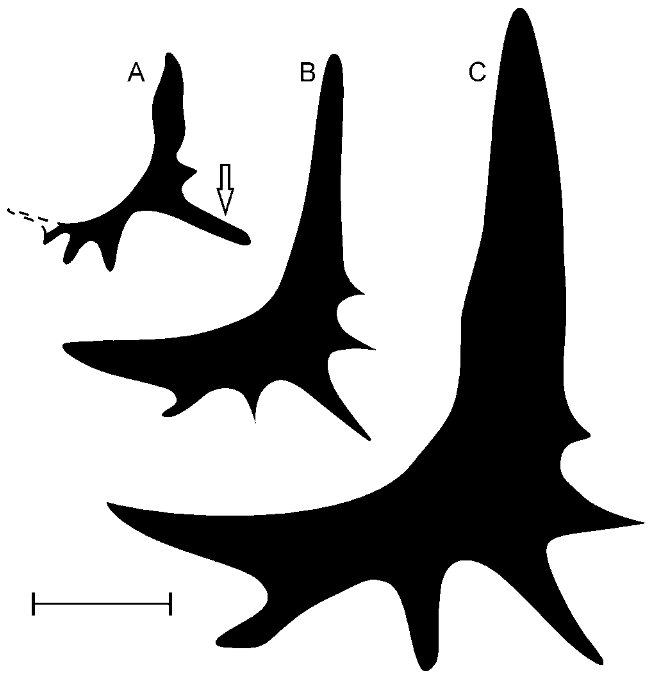
Scales are absent.

Discussion of morphology

All morphological facts show direct affinity of this specimen to the Oligocene species *Trachinus minutus*.

The most peculiar feature is the sickle shape of the praeoperculare. The shape is more triangular in specimens from localities in France and Poland (see Text-fig. 3). Additionally, in the specimen from the Litenčice locality, the most prominent praeopercular spine is the second one (from dorsum; labelled by an arrow in Text-fig. 3A) contrary to specimens from France and Poland (whose largest is the middle one). For the following reasons these aberrations of shape may be considered to be caused by ontogeny:

The development of the preoperculare of the recent *Trachinus* has not been described, but generally, dermal bones associated with lateral line systems (including preoperculare) are developed early in ontogeny (Schultze 1993). For example in *Salmo gairdneri* the first ossification of the praeoperculare appears 12 days after hatching (fig. 1 in Verraes 1977). Although the development of the praeoperculare was not directly described by this author, the figure sequence in his work allows us to study part of the praeopercular ontogeny. The development starts in the tiny triangular ossification centre which probably represents the middle unflexed part of the preoperculare. The ramus verticalis grows during other stages and at this time the preoperculare is sickle shaped (fig. 2 in Verraes 1977). The ramus horizontalis appears at the end of development of the preoperculare. The same scheme of preopercular development could be expected in *Trachinus minutus*. It is probable that the anterior part of the ramus horizontalis had not been well ossified or constituted at the time when the exemplar died.



Text-fig. 3. *Trachinus minutus*, praeopercular shape, lateral view. A – Litenčice specimen (Czech Republic). B – Froidefontaine specimen (France). C – Specimen from Jamna Dolna (Poland). Scale bar represents 1mm. According Pharisat (1991) and Jerzmańska (1968), modified.

It is not possible to comment on the significance of the most prominent second praeoperculare spine due to the lack of other specimens from the Litenčice locality. It is possible to suggest that this spine (the second one) had developed first in an earlier ontogenetic stage as tiny juveniles of *T. minutus* have been found in the Błażova locality (unnumbered material housed in the Rzeszów University, Poland) and the smallest exemplar (HL is 3.5mm only) has a preserved praeoperculare with only the ramus verticalis (without ramus horizontalis) and with one long praeopercular spine (Přikryl, personal observations). All slightly bigger specimens from same locality have a full count of praeopercular spines (five) and the biggest is the third one.

On the basis of the number of vertebrae and anterior dorsal fin spines, the Litenčice fossil is similar to the individuals from Poland (see Table 2).

Paleoecology and taphonomy

Trachinus minutus fossils were found at the Froidefontaine locality in France (Pharisat 1991), Homoraciú in Romania (Jonet 1958) and at localities in Poland (e.g. Jerzmańska 1968).

The occurrence of *Trachinus minutus* is limited to the lower part of the IPM2 zone, which has been delineated within the frame of the biostratigraphic fish zonation in the Polish Oligo-Miocene sediments by Kotlarczyk and Jerz-

Table 2. Comparison of meristic and plastic features of Trachinus minutus from different localities (according to Pharisat 1991, modified).

	Froidefontaine	Carpathes				
	Pharisat 1991	**Jerzmańska 1968**		**Jonet 1958**	**Přikryl**	
SL	17	25	27,5	15-16?	14,8	mm
BD	3,5	5	5,2	3	2,3	
CPD	1,5	2,4	2,1	-	0,6	
HL	5	7,8	8,8	5	4,3	
PDL I	5	9	9,9	-	4,2	
PDL II	8	13,5	13,9	-	-	
PAL	8,5	12,3	14,2	-	6,1	
Vert.	(31-33):(7-8)+(24-25)	(30-31):7+(23-24)		32:8+24	30:7+23	
D I	6.VIII	6		6.VIII	5	
D II	22-24	19-20		22-24	-	
A	24	21-22		23-24	-	
C	(3-5)(8-(7-8))(3-5)	3?(16)3?		3(14)3	16	
P	15-16	16		12?	13	
V	I+5	I+5		I+6	I+6?	

mańska (1976) (for details see Kotlarczyk and Jerzmańska 1976 and Kotlarczyk et al. 2006). Here *T. minutus* is the index taxon of the so called "Trachinus event" in the Menilite-Krosno Series of the Polish Carpathians (Kotlarczyk et al. 2006). Throughout the entire IPM2 zone, shallow-water fishes are quite frequent (24 % according to Kotlarczyk et al. 2006) in comparison with deep-water fishes. This is a marked difference to the other IPM zones which were assumed to be bathypelagic on the basis of the major occurrence of deep-water fishes (Kotlarczyk and Jerzmańska 1976, Kotlarczyk et al. 2006). The presence of shallow-water fish fauna (e.g. *Hipposyngnathus neriticus*, *Syngnathus incompletus* and *Trachinus minutus*) in the IPM2 biozone indicates a presumably neritic to sublitoral enviroment (Kotlarczyk and Jerzmańska 1976, Kotlarczyk et al. 2006).

The Šitbořice Beds at the Litenčice locality were paleobathymetrically evaluated by Gregorová (1997) from the view of the fish fauna and on the basis of the heterogeneous fish fauna, she suggested a mesopelagic environment with interferences from litoral, epipelagic and terrestrial surroundings. The co-occurrence of the neritic and deep-water ecological types of fishes in Menilitic Formations has been interpreted as the result of the combined influence of vertical migration and silting up to the litoral part of the basin by Kalabis (1975a, 1938-40, 1948). The necessity to consider the effect of vertical migration was also mentioned by Gregorová (1997).

Another possible interpretation and the one I am in favour of, is that the presence of both, deep and shallow water fishes is related to coastal upwelling. The co-occurrence of the deep and shallow water fishes was also observed in the late Miocene to early Pliocene Cubagua formation in northeastern Venezuela (Aguilera and Aguilera 2001) and in the Messinian diatomites of the Mediterranean (Gaudant 1989, Gaudant et al. 2006). This conception supposed the existence of a nearby trench. The abyss of this structure was the source area of the deep water types of fish, which were admixed to the neritic (autochthonic) assemblage.

The fish fauna at the Litenčice locality is heterogeneous (Gregorová 1997) and very well preserved with details which are commonly destroyed in long-distance transport. Additionally, at the Litenčice locality, the articulated remains of a bird were discovered (Gregorová 2006) and it can be suggested that the presence of the well preserved terrestrial elements and shallow-water fishes in menilitic formation are not rare.

In the menilitic shales finds of terrestrial flora from Bystřice nad Olší were described (Bubík 1987), Špičky (Kalabis 1975a) and Kelč (Kalabis 1975b, Knobloch 1969); insects from Kelč (Štys and Říha 1973, Kalabis 1975b, Prokop et al. 2007) and Bystřice nad Olší (Bubík 1987); and birds from Litenčice (Gregorová 2006 – articulated skeleton), Bystřice nad Olší (Bubík 1987 – isolated feathers), Kelč (Kalabis 1975b – isolated feathers) and Winnica (Bochenski and Bochenski 2008 – articulated skeleton).

According to Jerzmańska (in Kotlarczyk et al. 2006), the fish fauna of IPM2 is not autochthonous, but a deep-water thanathocoenosis to which the shallow-water fishes were transported over a long distance of a few hundred kilometers. Unfortunately, this conception does not consider the preservation of fragile parts of fish bodies (e.g. spines of the praeoperculare of *Trachinus*). Also fossils such as insect relics can be expected in the more shallow water sediments rather than in the deep water sediments. Although many snags were dredged from the abysses in recent seas, finely preserved fossils, such as coniferous needles, leaves or articulated birds, could not endure intact such a long journey to the bottom of the abyss.

Conclusion

The morphology of the first find of *Trachinus minutus* from the Czech part of the Western Carpathians was described.

On the basis of the selected determinable plastic data (mainly vertebrae number and relatively low number of fine spines in the anterior dorsal fin), it is possible to state that the Litenčice specimen is similar to Polish specimens. The differences in the shape of the praeoperculare are probably caused by ontogeny (on the basis of comparison with ontogeny of praeoperculare in recent *Salmo gairdneri*). It is not possible to appreciate the real taxonomical significance of the most prominent second praeopercular spine (counted from the dorsum) due to the lack of other specimens from the studied area.

Due to the common occurrence of both terrestrial fauna and flora remains and the type of preservation of fossil fishes, an autochthonic character of the litoral fish fauna was postulated.

The effect of coastal upwelling was mentioned as another possible process for the admixture of deep-water fishes to the litoral fish fauna assemblages (especially in IPM2 zone).

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