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***Diplodus* sp. (Sparidae, Perciformes): a new fossil record of an articulated skeleton from Devínska Nová Ves (Upper Badenian, Vienna Basin, Slovakia)**

By Růžena GREGOROVÁ¹

(With 4 figures and 1 table)

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Abstract

A skeleton of *Diplodus* sp. is described herein from the Upper Badenian locality Devínska Nová Ves (Vienna Basin, Slovakia). This is the first record of articulated sparid remnants at this locality; up to now the sparids there were known only from isolated teeth. The osteology and morphology of the Badenian representative are analyzed. The following characters allow this specimen to be attributed to the genus *Diplodus*: incisiform and molariform teeth, no conical teeth, more than one row of teeth, the cancellose texture on the frontals, D XI + 12.

Keywords: Teleostei, Sparidae, *Diplodus*, Miocene, Vienna Basin.

Zusammenfassung

Der Artikel beschreibt das Skelett eines *Diplodus* sp. von der Fundstelle Devínska Nová Ves (Wiener Becken, Slowakia) aus dem Ober-Badenium. Es ist der erste Fund von Sparidae in anatomischer Lage auf dieser Fundstelle, bisher war dort diese Art nur durch isolierte Zähne vertreten. Die Kenntnisse der Osteologie und Morphologie der Badenum-Funde werden nun ergänzt. Folgende Merkmale erlauben zu Zuordnung des beschriebenen Exemplars zur Gattung *Diplodus*: Schneide- und Backzähne, keine Spitzzähne, mehr als eine Zahnreihe, gitterartige Textur der Stirnbeine, D XI + 12.

Schlüsselwörter: Teleostei, Sparidae, *Diplodus*, Miozän, Wiener Becken

Introduction

Devínska Nová Ves (Miocene, Badenian, Vienna Basin) is a famous paleontological site of fossil vertebrates and invertebrates. The fossils occur in several facies from gravels and sandstones to calcareous and non-calcareous clays (e.g. Sandberg, Bonanza, Vineyard and Brickfield). The geological situation and paleontological contents have been the subject of numerous papers (e.g. HOLEC 2001; HOLEC & SABOL 1996; KOVÁČ et al. 2004). The skeleton described here as *Diplodus* sp. was found in the grey-green clays

¹ Department of Geology and Paleontology, Moravian Museum, Zelný trh 6, 659 37 Brno, Czech Republic;
e-mail: rgregorova@mzm.cz

in the Brickfield (Late Badenian, Nannoplankton Zone NN6). It is the first discovery of an articulated sparid skeleton at this locality.

The Sparidae (BONAPARTE, 1831) comprise 33 nominal genera and approximately 115 species. They occur in a range of shallow marine habitats from tropical to temperate waters, with some species living in brackish waters (NELSON 2006). The fossil records of articulated sparid skeletons in the European Tertiary are sparse compared with the abundant records of isolated teeth and otoliths, which are not summarized here.

DAY (2003) revised articulated sparid remnants from the London Clay (Eocene, Ypresian) determined as *Sciaenurus bowerbanki* (AGASSIZ, 1845); from the Monte Bolca Formation (Eocene, Lutetian), she mentions *Sparnodus vulgaris* (BLAINVILLE, 1818), *Pseudosparnodus microstomus* (AGASSIZ, 1835), *Ellaserrata monksi* (DAY, 2003) and *Abromasta microdon* (AGASSIZ, 1839). *Sparus* ? *cuvieri* (AGASSIZ, 1839) is reported from the Upper Eocene of the Paris Basin (GAUDANT 1980/1981).

An abundant sparid assemblage comes from the Tertiary sediments of former Yugoslavia, where ANDELKOVIC (1989) describes the following taxa: from the Rupelian of Sava Basin (Slovenia): *Sparus hertlei* (KRAMBERGER, 1891), *Sparnodus inflatus* KRAMBERGER, 1891 and ?*Pagrus* sp.; from the Badenian of Celje area and Ugljevik Basin, Sarmatian of Belgrade area *Sparus intermedius* (KRAMBERGER, 1902); from the Badenian of Zagrebačka gora *Sparus* sp. and from the Sarmatian of Zagrebačka gora, Belgrade area, *Sparus brusinai* (KRAMBERGER, 1882) and *Box roulei* ARAMBOURG, 1927. *Sparus brusinai* is also mentioned from the Sarmatian of Turkey (RÜCKERT-ÜLKÜMEN 1965).

From the Eastern Paratethys, DANILTSHENKO (1980) summarized the following sparid taxa: *Sparnodus eotauricus* BOGATSHOV, 1965 from the Upper Eocene of the Crimea; *Sparus brusinai* (KRAMBERGER, 1882) and *Sparus diatomaceus* (BOGATSHOV, 1942) from the Upper Miocene of the Caucasus, and *Sparus brevis* (LEDNEV, 1914) from the Sarmatian of Azerbaijan.

A rich sparid assemblage was described from the Messinian of Algeria by ARAMBOURG (1927) with the taxa: “*Sparus cinctus* (AGASSIZ, 1839-44), *Sparus neogenus* ARAMBOURG, 1927, *Sparus* ? *compactus* ARAMBOURG, 1927, *Pagrus mauritanicus* ARAMBOURG, 1927, *Pagellus leptosomus* ARAMBOURG, 1927, *Diplodus oranensis* WOODWARD, 1901, *Diplodus* sp., *Paracalamus doumergui* ARAMBOURG, 1927, *Box roulei* ARAMBOURG, 1927, *Crenidens intermedius* ARAMBOURG, 1927 and *Dentex barbarus* ARAMBOURG, 1927”. DAY (2003) discussed some specimen assignments to genera such as *Pagellus* (ARAMBOURG 1927, pl. 20, fig. 19, pl. 22, figs 2,3, pl. 25, fig. 2).

Other articulated sparid remnants related to the genus *Boops* come from the Mareschia river deposits of the Pliocene of Italy (SORBINI, 1987). In addition, *Boops* cf. *boops* (LINNAEUS, 1758) and *Boops* sp. were reported from Upper Pliocene of Crete (GAUDANT 2001; GAUDANT et al. 1994).

BRZOBOHATÝ (1979) described the first articulated sparid skeleton from the Badenian of the Silesian part of the Carpathian foreland (Kateřinky locality, Czech Republic). The author assigned the specimen to *Sparus insignis* (PROCHÁZKA, 1893).

From the Late Badenian Devínska Nová Ves locality (Vienna Basin), where the herein-described skeleton was discovered, only isolated remnants were recorded before

(SCHULTZ 1998): *Dentex* sp. and *Pagrus cinctus*; HOLEC (2001) completes the list from this locality by Sparidae gen. et sp. indet., ? *Dentex* sp. and *Diplodus* sp.

This paper describes the first articulated skeleton of the genus *Diplodus* in the Paratethys region, documented before only based on isolated teeth and otoliths. Other representatives of the genus come from the Lower Miocene of the North Alpine Foreland Basin of Austria (unpublished).

Abbreviation:

SL	Standard length
BD	Body depth
PD	Predorsal distance
PA	Preanal distance
HL	Head length
D	Dorsal fin
DS	Dorsal spine

Systematic part

Order Perciformes BLEEKER, 1859

Family Sparidae BONAPARTE, 1831

Genus *Diplodus* RAFINESQUE, 1910

Diplodus sp. (figs 1-4)

Material: 1 specimen (print and counter print), collection of the Moravian Museum Brno, no: Ge 29 818a,b.

Locality: Devínska Nová Ves – brickfield

Stratigraphy: Late Badenian, Nannoplankton Zone NN6 (KOVÁČ et al. 2004)

Description: The body is robust and oval; the dorsal and ventral profiles of the body are equally convex. Maximum body depth is contained 2.3 times in the SL (almost 44 % of SL) and it is situated at the vertical of the beginning of the pelvic girdle and half-way along the spiny dorsal fin, just a little in front of the midline of the body.

Measurements: Length of the preserved part 72 mm and counter part 53 mm, length of the last preserved caudal vertebra 2 mm, Standard length * 80 mm; Body depth (BD) 35 mm; Predorsal distance (PD) 32 mm; Preanal distance (PA) 53 mm; Head length (HL) 24 mm; Head depth 27 mm; Preorbital distance 11 mm; Postorbital distance 9 mm; Orbit diameter 6 mm; Jaw length 9 mm; Length of the Pelvic spine 11 mm; Length of the pelvic bone 11 mm; The longest pelvic ray 14 mm; Dorsal spines



Fig. 1. *Diplodus* sp., Devínska Nová Ves, NN6, Ge 29 818a; length 72 mm, Photo by Kamil JURSA.

(DS): 1st 4.5 mm; 2nd 8 mm; 3rd – 7th 12 mm; 8th-9th 10.5 mm; 11th 9.5 mm; Base of the spiny dorsal fin 24 mm.

* Standard length (from the tip of the snout to the end of the body without caudal fin) is estimated by taking the length of the missing 4 last caudal vertebra into account.

S k u l l : The head is relatively short, a little deeper than long, the round orbit is large, very close to the dorsal profile of the head. The orbit diameter is contained 4 times in the head length. It is difficult to distinguish the exact shape of some skull bones. The frontals bear a cancellose texture typical for the genus *Diplodus*. The triangular occipital crest is greater in height than length, extending anteriorly to the posterior margin of the orbit and posteriorly to the supraneurals but does not touch them. In the otic region a deformed and broken otolith is preserved. The snout is reduced, not prominent. Preopercular posteroventral margin without serration. The jaws are short and do not reach even the anterior margin of the orbit. They represent one third of the head depth. From the upper jaws, both premaxillaries are preserved in their anterior part with the ascending process of the premaxilla. Its length (8 mm) is nearly the same as the length of the toothed part of the jaws (9 mm). There are two anterior incisive teeth preserved in situ – a character typical for the genus *Diplodus*. The crowns of the incisiiform teeth are flattened without a crenellation. The margins seem to be somewhat rounded in one of the anterior teeth, while a second tooth shows a rather rectangular margin (fig. 4). The root is not compressed, but has a rather rounded cross-section. Two or three disarticulated rows of molars are evident; no conical and caniniiform teeth are present.

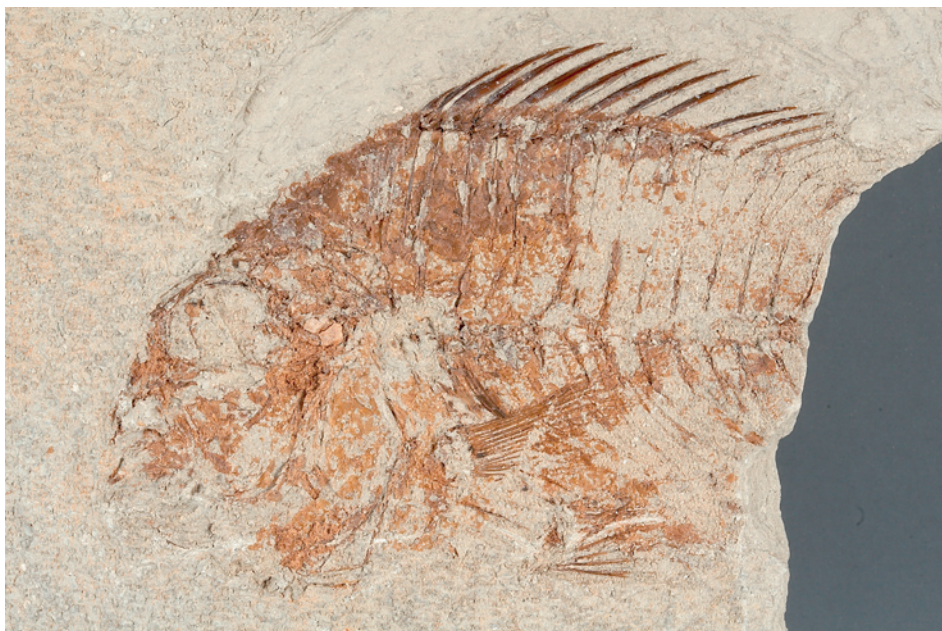


Fig. 2. *Diplodus* sp. Devínska Nová Ves, Ge 29 818b (counter print); length 53 mm, Photo by Kamil JURSA.

On the lower jaw the dentary, articular and angular are distinguishable. The articular and angular form less than one third of the total length of the mandible; the angular forms the posterior margin of the articular. The triangular quadrate is shifted upward from the original position. Posterior to the lower jaw, the disarticulated bones of the hyoid arch are preserved.

Axial skeleton: All 10 abdominal vertebrae and only 10 caudal vertebrae (from a total of 14 caudal vertebrae) are preserved. The abdominal vertebrae bear strong ribs reaching two thirds of the ventral part of the body. The neural spines of all vertebrae and haemal spines of the caudal vertebrae are straight and well developed.

Dorsal fin: There are 11 fin spines and 12 branched soft rays in the dorsal fin. Three supraneurals are close together, parallel to the radials. The supraneurals are expanded anterodorsally and each forms a process that overlies the posteriormost part of the preceding one. The process of the first supraneural does not overhang the occipital crest as observed in some extant sparids, e.g. *Calamus* (DAY 2002).

The dorsal fin originates above the vertical of the second vertebra and the base of the pectoral fin. The first ray is very short and corresponds to one half of the second; the second ray corresponds to two thirds of the third ray. The third and following 6 rays (from 3rd to 7th) are equally long. The preserved soft part of the fin shows that the rays are well developed; the 5th to 10th rays are preserved in their whole length and form a series without distinctive shortening in the spiny part of the fin.



Fig. 3. *Diplodus* sp., detail of the jaws with the incisiform and molariform teeth, Ge 29 818b, Photo by Kamil JURSA.

Anal fin: The anal fin contains three fin-spines. Only the minuscule first spine is completely preserved, the following two only proximally. The first radial is considerably larger, thickened anteriorly, exceeding the length of the haemal arch of the last abdominal vertebra.

Pectoral girdle and fin: The pectoral girdle is only partially preserved. The large scales cover the region of the coracoid and scapula, obscuring the bones. The supracleithrum and cleithrum form the margin of the head; they overlie each other in the middle of the head and form a moderate arch. The rays of the pectoral fins are long and reach the beginning of the anal fin.

Pelvic girdle and fin: The pelvic bone is large at the base and well developed. The posterior margin of the pelvic girdle is level with the sixth vertebra. The fin is large with a posterior margin that extends below the last abdominal vertebra. The length of the pelvic bone corresponds to the length of the pelvic spine. Scales are pronounced, ctenoids, serrated with 6-9 radii.

Discussion: The incomplete character of the herein-described specimen does not allow a detailed comparative study. Nevertheless, some characters are diagnostic and permit attributing the specimen to the genus *Diplodus*: incisiform and molariform teeth, no conical and caniniform teeth, more than one row of teeth, the cancellose texture on the frontals. The incisiform teeth are present in recent representatives of the genera *Diplodus*, *Archosargus* and *Polysteganus* (character 45, p. 283 in DAY 2002). *Archosargus* exhibits conical teeth and *Polysteganus* lacks molariform teeth. Accordingly, only the

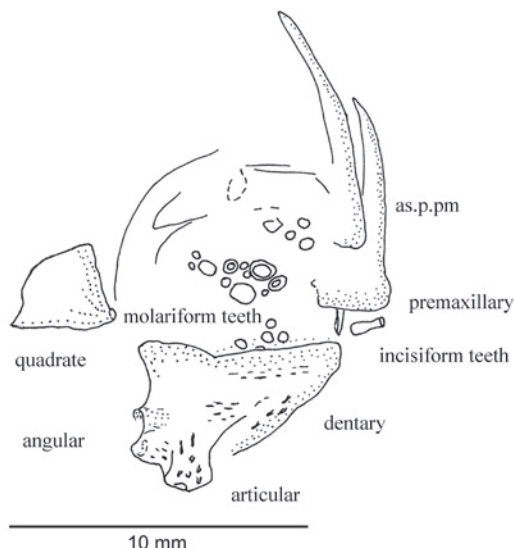


Fig.4. *Diplodus* sp., detail of the jaws with the incisiform and molariform teeth, Ge 29 818b.

genus *Diplodus* possesses the combination of incisiform and molariform teeth. The cancellose texture on the frontals is distinctive in *Diplodus* and present in *Sparus*, *Oblada* and *Evygnis* (character 10 in DAY 2002); these genera, however, have caniniform teeth that exclude them from a relationship with the fossil representative.

Diplodus sp. from Devínska Nová Ves differs from *Diplodus oranensis* WOODWARD, 1901, the only other fossil representative described as a complete skeleton, by 1. the different number of rays in the spiny part of the dorsal fin (XI versus XII in *Diplodus oranensis*), 2. by the different relative lengths of the dorsal spiny rays. While in *Diplodus* sp. the first ray is very short and the third and following 6 rays are equal in length, in *Diplodus oranensis* the dorsal spines increase until the 5th ray and the following rays continually decrease. The teeth apparently differ somewhat from the isolated teeth described by HOLEC (2001) from Sandberg. The teeth from Sandberg are 2 and 4 times larger and their outline is more rectangular. ARAMBOURG (1927) discussed the problem of tooth size. In young specimens the crowns are thinner than in adults. More comparative material could show the relationship among the teeth of *Diplodus* sp. from Sandberg and Devínska Nová Ves – Brickfield.

Regarding a comparison with the extant species of *Diplodus*, we have an insufficient number of characters for a more objective analysis. *Diplodus* sp. from Devínská Nová Ves can be related for instance by the less pointed mouth and head to *Diplodus annularis* (LINNÉ, 1758), *Diplodus bellottii* (STEINDACHNER, 1882) and *Diplodus sargus* (LINNÉ, 1758) versus the more pointed mouth and head in *Diplodus puntazzo* (CETTI, 1777),

Table 1. Morphometric characters (in mm) of the *D. oranensis* Woodward, 1901, (ARAMBOURG 1927) and *Diplodus* sp.; values in the parentheses represent % of the Standard length.

species	SL	BD	PD	PA	HL	LongestDS
<i>D. oranensis</i>	133	58 (43.6)	58 (43.6)	93 (69.9)	43(32.3)	21 (15.8)
<i>Diplodus</i> sp.	80	35 (43.8)	32 (40)	53 (66.25)	24 (30)	12 (15)

Diplodus cervinus (LOWE, 1838) and *Diplodus vulgaris* (GEOFFROY SAINT-HILLAIRE, 1817). Based on the preceding character and the morphology of the dorsal fin, which in *Diplodus* sp. (D XI+12) is completely preserved, we relate the specimen to *Diplodus sargus* (DXI-XII+12-15) or rather to *Diplodus annularis* (D XI+11-13) (QUÉRO 2003). Nonetheless, more comparative material is necessary for a more objective comparison.

The fossil assemblage from Devinská Nova Ves, where *Diplodus* sp. was found, is formed by 23 taxa of isolated shark and ray teeth (Selachii, Batoidea) and bony fishes (Teleostei), indicating a shallow marine environment (HOLEC 2001).

Summary

Articulated remnants of sparids are very rare and are limited to a few regions. The skeleton of *Diplodus* sp. described herein is the first articulated remnant of a sparid at this locality and completes our knowledge about the morphology and anatomy of this Badenian representative. It confirms the presence of the genus previously recorded solely based on isolated teeth and otoliths.

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