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Note on the first fossil remains of a whale from northern Bosnia

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Abstract. Herein, the first find of a fossil whale *Cethotherium* aff. *rathkei* is reported from the Middle Miocene sediments (Badenian) of the West Paratethys (the Štrbci village, east of Banja Luka and Prnjavor, northern Bosnia). Although mostly represented by vertebra, the well preserved remains of the single individual consist also of humeri, tympanicum, and some isolated fragments of the skull. The find is discussed in its paleogeographical context, and the importance of the discovery in an international context is shown.

Key words: Miocene, Badenian, whale, Paratethys, Bosnia.

Апстракт. Први примерак фосилног кита *Cethotherium* aff. *rathkei* пронађен је у средњомиоценским седиментима (баденске старости) Западног Паратетиса у селу Штрбци, источно од Бања Луке и Прњавора у северној Босни. Добро очувани остаци једне индивидуе углавном су представљени пршљеновима, остацима хумеруса, тумпаникума, као и фрагментима костију главе. Налаз је приказан и у палеогеографском контексту и представља други налазак ове врсте.

Кључне речи: миоцен, баден, кит, Паратетис, Босна.

Fossil whales of the Paratethys Sea

Although fossil finds of whales (Cetacea/Cetartiodactyla – depending on which classification is followed) are known from most of the regions of the world, their morphology and evolution is not well known (Fordyce & de Muizion 2001). In Europe, the Pliocene and Miocene species of whales seem to have been the most abundant and they were also present in Central Europe in the region that was once covered by the Paratethys Sea. During the Middle and Late Miocene, tectonics and a decreasing eustatic sea level gradually isolated the Paratethys Sea from the other seas, causing a decrease in salinity (Rögl 1998; Hámor 2001). This process resulted in the extinction of the marine fauna which was once present in the Paratethys. Cetacea became extinct during the final stages of the Miocene, when the Paratethys became a fresh water lacustrine environment. The presence of fossil whales is thus and indicator for higher salinity levels.

The Paratethys Sea was once present in extensive parts of Central Europe and fossil whales are found in Austria, Slovakia, Hungary, Croatia, Bosnia and Serbia. Most of the previously discovered specimens are attributed to the genus *Mesocethus*.

Mesocetus hungaricus Kadić, 1907 is known from several localities. Kadić (1907) based the species on a well-preserved complete skeleton from the Badenian of Borbolya in West Hungary. It is also known from the Middle Miocene (Late Badenian) locality Neudorf-Sandberg (Dvinska Nova Ves) on the border of Slovakia and Austria (Thenius 1952, Stabol & Holec 2001).

Mesocetus agrami van Beneden, 1880 is known from Sarmatian marls from Susjed in Zagreb (Agram was the former name of the city) and it was described by Van Beneden (1880) and Gorjanović-Kramberger (1892). The remains were recovered from the Sarmatian marls close to the border with the Badenian ("Sarmatian marls near to Mediterranean layers"; Gorjanović-Kramberger 1892) at Susjed and Vrbač in Zagreb (Croatia). This species seems to have been the most abundant in the region. Paunović (1993) published a paper on *Mesocetus* aff. *agrami* found in northern Bosnia and stated that it is found in several localities in Bosnia: Knežica, Šargovac, Lužani, Dažnica Ukrina and Kalenderovci. A Middle Miocene

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(Badenian) age was proposed for all these finds. Nevertheless, the remains described by PAUNOVIĆ (1993) consist only of fossil vertebra.

Mesocetus sp. is found in Slovakia in the Middle Miocene (Late Badenian) locality Glavica (SABOL & HOLEC 2002).

STEPANOVIĆ (1938) described lower jaws of a toothless whale found in Belgrade (Serbia). These jaws were atributed to *Cethotherium* sp. without any intention to attribute specimen to the genus *Cethotherium*, but to the Cetacea in general. The age of the sediments that yielded the fossil is Lower Sarmatian *s. str.* (Middle Miocene).

Locality Štrbci in northern Bosnia

The fossil was found in the village Štrbci east of Banja Luka and Prnjavor in northern Bosnia. It was recovered from a well at the depth of 26 m in a coat of marls.

The region of Štrbci was studied by EREMIJA (1970). Marls found in the area include remains of fauna represented by an association of *Vaginella austriaca* KITTL and rare finds of *Amussium* and *Natica milepunctata* LAMARCK with a long list of foraminifera. Eremija stated that the association of pelagic gastropods found in gray marls is characteristic for the region being well-connected to open sea. According to EREMIJA (1970), 214 species of foraminifera are found in strata of the same age in other parts of the basin and most numerous are representatives of the genera *Globigerinoides* and *Globigerina*, Lagenidae (*Robulus*, *Dentalina* and *Lagena*), *Spiroplectamina carinata* (D'ORBIGNY). The association suggests a Badenian age for the marls.

Northern Bosnia is geographically in contact with the Pannonian Lowlands that were the center of the Paratethys Sea, and in the late stages of the Miocene, northern Bosnia was a region of shallow waters.

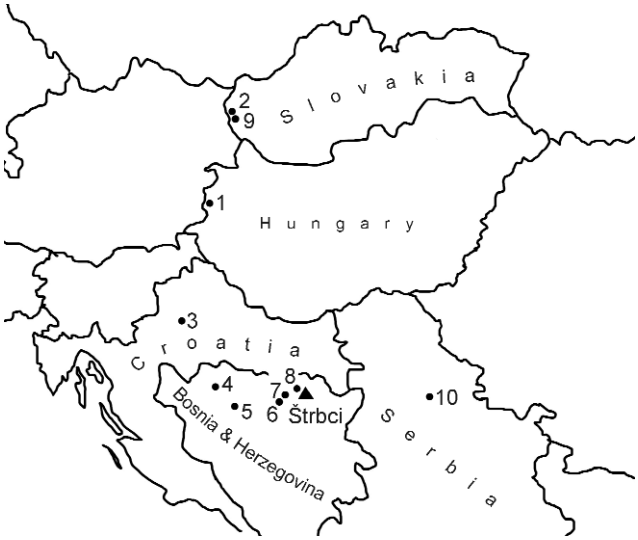

Fig 1. Geographical position of Štrbci (triangle) and other localities of the Paratethys Sea: **1,** Borbolya; **2,** Neudorf-Sandberg; **3,** Zagreb (Susjed); **4,** Knežica; **5,** Šargovac; **6,** Kalenderovci; **7,** Dažnica; **8,** Lužani; **9,** Glavica; **10,** Belgrade.

Fossil remains

Order Cetacea BRISSON, 1762
Suborder Mysticeti FLOWER, 1864
Family Cethotheriidae CAMBERA, 1926
Genus *Cethotherium* VAN BENNEDEN, 1868–1880

Cethotherium aff. *rathkei* VAN BENNEDEN, 1868–1880

Material. *Cethotherium* aff. *rathkei* found in marls of Badenian age in Štrbci (N. Bosnia) represented by left and right tympanicum (RGFC1 and RGFC2), left and right humerus (RGFC6 and RGFC7), 4 well-preserved thoracic vertebra (RGFC11, RGFC12, RGFC13 and RGFC14), 4 well-preserved lumbal vertebra (RGFC15, RGFC16, RGFC17 and RGFC18), one caudal vertebra (RGFC19), 8 fragmented vertebra (RGFC29, RGFC30, RGFC31, RGFC32, RGFC33, RGFC34, RGFC35 and RGFC36), 5 vertebral epiphysis (RGFC25, RGFC26, RGFC27, RGFC28 and RGFC29), 8 skull fragments (RGFC3, RGFC4, RGFC5, RGFC8, RGFC9, RGFC10, RGFC34 and RGFC35) and other unidentified fragments.

The fossil is the property of the Gradiška Museum (Zavičajni muzej Gradiška) and it is kept at the Collection of the Faculty of Mining and Geology (University of Belgrade)

Description. The fossil whale found in Badenian (Middle Miocene) sediments in Štrbci (North Bosnia) east of Prnjavor is represented by a number of well-preserved bones and the skeleton was probably almost complete before it was excavated.

The auditory bulla is one of the most important bones. The auditory bulla was subject to notable changes during the evolution; thus it is important for distinguishing fossil and recent species (FORDYCE & DE MUIZON 2001). The tympanicum (Pl. 1, figs. 1–6, No. RGFC1 and No. RGFC2) show most resemblance to those of the fossil whale *Cethotherium rathkei* found on the Crimean Peninsula (VAN BENEDEN & GERVAIS 1868–1880, fig. 6, fig. 7, Tab VXII and BRANDT 1873, fig. 3b, fig. 4b, Tab XII). Figured here as Fig. 3 and Fig. 4. The size and shape of the tympnicum are almost the same and the dorsal surface of the bulla is without any texture, as in other *C. rathkei* specimens.

Both humeri are well preserved and are about 72.7 and 72.1 mm long (Plate 1, Figs. 13–20; RGFC6 and RGFC7).

Table 1. Measurements of bones given in millimeters.

No.	bone	length	proximal width	distal width		
RGFC6	humerus dex.	72.7	45.7	42.2		
RGFC7	humerus sin.	72.1	66.2	42.8		
No.	**bone**	**length**	**corpus cranial width**	**corpus caudal width**	**corpus cranial width**	**corpus caudal width**
RGFC11	thoratic vertebrata	24.5	46.8	44.1	34.7	36.1
RGFC12	thoratic vertebrata	25.0	47.2	46.6	36.1	37.6
RGFC13	thoratic vertebrata	23.9	47.8	45.2	34.3	40.0
RGFC14	thoratic vertebrata	30.7	47.8	45.7	37.1	37.8
RGFC15	lumbar vertebrata	31.6	50.2	–	41.8	–
RGFC16	lumbar vertebrata	33.1	49.4	–	41.6	–
RGFC17	lumbar vertebrata	27.8	–	–	40.2	–
RGFC18	lumbar vertebrata	33.8	–	–	–	–
RGFC19	caudal vertebrata	19.8	35.1	35.1	–	–
No.	**bone**	**length**				
RGFC1	tympanicum dex.	50.2				
RGFC2	tympanicum sin.	50.1				

A large part of the fossil material is represented by vertebrae (Pl. 1, Figs. 1–12; Pl. 2 and Pl. 3). Most of the vertebrae are incomplete but measurements of the preserved ones are given in Table 1. The manner in which the vertebrae were measured is indicated in Figure 2. The vertebrae of *Mesocetus* found in the region are much larger and the width of the lumbar falls into range of 12–14 cm (PAUNOVIĆ 1993).

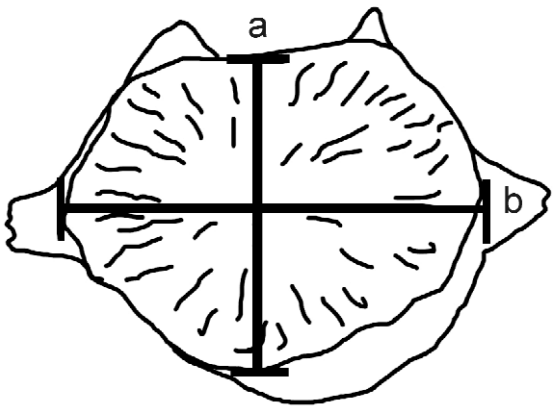

Fig. 2. Measurements of vertebra were restricted to the corpus of vertebra. **a,** height of corpus; **b,** width of corpus.

Among the other bones, some isolated fragments of the skull, and other unidentifiable fragments have to be noted.

Dimensions of the present specimen are in the range of that of *Cethotherium rathkei*. BRANDT (1873) gives an overall length of "6 to 7 feet" for this species. The vertebra of *Mesocetus* found in the region are much larger and width of lumbar falls into the range of 12–14 cm (PAUNOVIĆ 1993). Comparisons of the length of vertebra belonging to *Mesocetus* aff. *agrami* (PAUNOVIĆ 1993) and *Cethotherium* aff. *rathkei* from Štrbci is given on the Table 2. Although the present specimen is juvenile, the individual dimensions of the auditory bulla are identical to the dimensions of the Crimean specimen.

Table 2. Comparison of the length of vertebra belonging to *Mesocetus* aff. *agrami* (PAUNOVIĆ 1993) and *Cethotherium* aff. *rathkei.*

Cethotherium aff. *rathkei*		*Mesocetus* aff. a*grami*	
No.	length in mm	No.	length in mm
lumbar vertebra			
RGFC15	31.6	DAŽ-7	132
RGFC16	33.1	DAŽ-8	134
RGFC17	27.8	DAŽ-11	135
RGFC18	33.8	DAŽ-9	141
		DAŽ-10	148
thoracic vertebra			
RGFC11	24.5	KNEŽ-5	63
RGFC12	25.0		
RGFC13	23.9		
RGFC14	30.7		

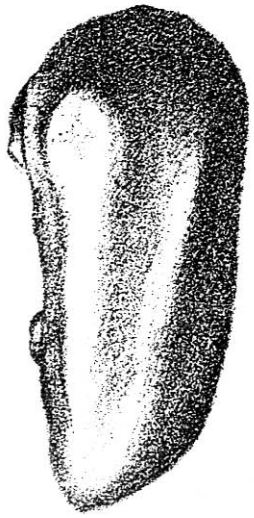

Fig. 3. Tympanicum of *Cethotherium rathkei*, Crimean Peninsula (original drawing from BRANDT 1873, pl. 12, fig. 3b).

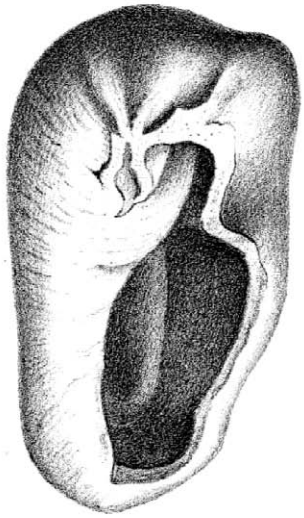

Fig. 4. Tympanicum of *Cethotherium rathkei*, Crimean Peninsula (original drawing from VAN BENEDEN & GERVAIS 1868–80, pl. 17, fig. 7).

Discussion. The genus *Cethotherium* includes only one Miocene species, i.e., *C. rathkei.* The holotype was recovered in the Crimean Peninsula by Prof. RATKE and described by VAN BENNEDEN (1868–1880) and later by BRANDT (1873). Unfortunately, no further details were given about the site and the stratigraphical position of the holotype.

The cethotheres belong to a separate group of Mystecete. The anatomy of mystecete resembles that of balenopterides but differs in the primitive structure of the frontal bone (FORDYCE & MUIZON 2001). Unfortunately, the studied specimen lacks the frontal bone

The geographical localities of the Paratethys Sea where remains of mystecete were found are shown in Fig. 1. They generally follow the borders of the Pannonian Lowlands which were once a part of Paratethys Sea. At the time, there was a connection with eastern provinces and the Black Sea (HÁMOR 2001, appendix VI). It might be concluded that whales belonging to this species were able to migrate through the basin and, hence, it is not surprising to find the representatives of the same species in two, apparently distant localities. According to KORETSKY (2001, fig. 58) and RÖGL (1998, pl. 9), there was a water corridor during the Badenian that allowed this connection. Probably *Cethotherium* migrated through this corridor.

While the Cethotheriidae systematics remain uncertain, they are probably represented by a few species and may be considered as probable ancestors of balaernopterids.

Conclusions

The remains of Middle Miocene whales are abundant in the Paratethys Region. Most of the species are attributed to *Mesocetus*, while a specimen from Štrbci (northern Bosnia) belongs to the genus *Cethotherium*. Bosnian localities numbered by PAUNOVIĆ (1993) yielded exclusively vertebra of fossil whales and it should be presumed that the remains of *Cethotherium* cf. *rathkei* from Štrbci are the best preserved whale fossil in the area.

There is a significant difference in size between *Mesocetus* remains and that of *Cethotherium rathkei*. The *Cethotherium* from Štrbci probably represents the only representative of the species found in this region and the first find of the species in the Western Parathetys. After the Badenian, (Middle Miocene), the salinity started to drop and influenced a general change of the flora and fauna. The climate was also affected during this process. This caused mass extinctions of marine fauna and whales in the area.

Representatives of the *C. rathkei* line are rare and not well-studied. Hopefully, this paper would fill the gap and allow future studies on this species.

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Резиме

Кратак осврт на налаз фосилних остатака кита из северне Босне

Остаци средњомиоценских китова су чести у области Паратетиса. Већина до сада пронађених примерака су остаци *Mesocetus*-а, док остаци примерка из Штрбаца (северна Босна) припадају роду *Cethotherium*. Босански локалитети које наводи Paunović (1993) садрже искључиво остатке пршљенова *Mesocetus*-а, док остаци *Cethotherium* cf. *rathkei* из Штрбаца, описани овом приликом, представљају најбоље сачувани примерак фосилног кита у овој области.

Постоје значајне разлике између остатака представника *Mesocetus*-а и остатака *Cethotherium rathkei*. *Cethotherium* из Шрбаца вероватно представља јединог до сада нађеног представика у овој области и први је налазак врсте у западном Паратетису. По завршетку бадена (средњи миоцен) пад салинитета у Паратетису условио је општу промену флоре и фауне у том мору утицајући и на опште климатске промене. Ови процеси проузроковали су масовна изумирања морске фауне и китова у региону. Представници *C. rathkei* су ретки и недовољно познати. Циљ овог рада је да попуни празнину и омогући даља истраживања.

PLATE 1

Cethotherium aff. *rathkei* VAN BENEDEN, Middle Miocene (Badenian), Štrbci, northern Bosnia.

Fig. 1. Right tympanicum, RGFC1, medial view.
Fig. 2. Right tympanicum, RGFC1, lateral view.
Fig. 3. Right tympanicum, RGFC1, inferior view.
Fig. 4. Left tympanicum, RGFC2, medial view.
Fig. 5. Left tympanicum, RGFC2, lateral view.
Fig. 6. Left tympanicum, RGFC2, inferior view.
Fig. 7. Caudal vertebra, RGFC19, cranial view.
Fig. 8. Caudal vertebra, RGFC19, caudal view.
Fig. 9. Caudal vertebra, RGFC19, dorsal view.
Fig. 10. Caudal vertebra, RGFC19, ventral view.
Fig. 11. Caudal vertebra, RGFC19, view dex.
Fig. 12. Caudal vertebra, RGFC19, view sin.
Fig. 13. Right humerus, RGFC6, lateral view.
Fig. 14. Right humerus, RGFC6, proximal view.
Fig. 15. Right humerus, RGFC6, medial view.
Fig. 16. Right humerus, RGFC6, distal view.
Fig. 17. Left humerus, RGFC7, lateral view.
Fig. 18. Left humerus, RGFC7, proximal view.
Fig. 19. Left humerus, RGFC7, medial view.
Fig. 20. Left humerus, RGFC7, distal view.

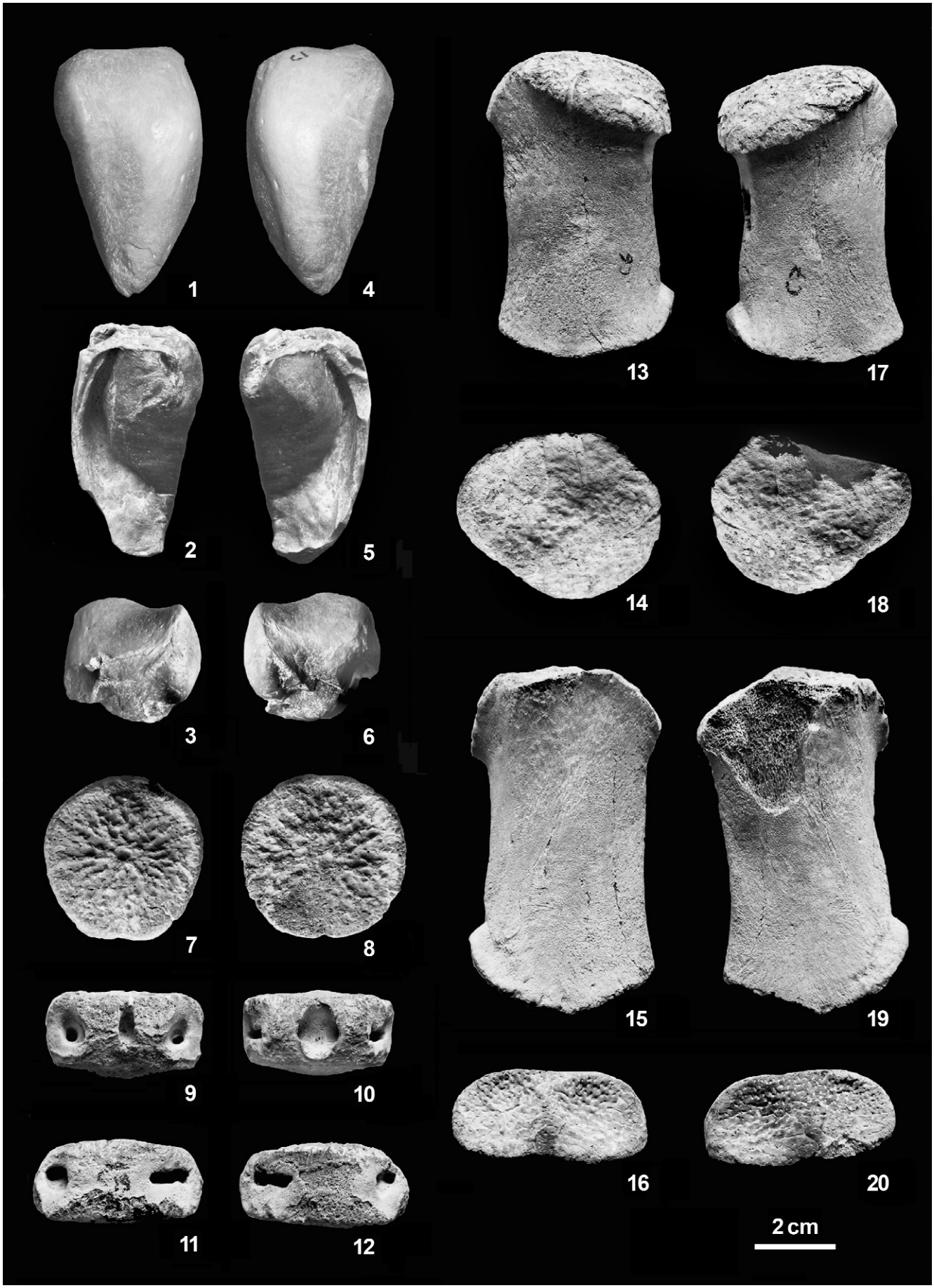
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PLATE 2

Cethotherium aff. *rathkei* VAN BENEDEN, Middle Miocene (Badenian), thoracic vertebrae, Štrbci, northern Bosnia.

Fig. 1. RGFC11, dorsal view.
Fig. 2. RGFC11, caudal view.
Fig. 3. RGFC11, ventral view.
Fig. 4. RGFC11, cranial view.
Fig. 5. RGFC12, dorsal view.
Fig. 6. RGFC12, caudal view (with epiphysis).
Fig. 7. RGFC12, ventral view.
Fig. 8. RGFC12, cranial view.
Fig. 9. RGFC13, dorsal view.
Fig. 10. RGFC13, caudal view (with epiphysis).
Fig. 11. RGFC13, ventral view.
Fig. 12. RGFC13, cranial view.
Fig. 13. RGFC14, dorsal view.
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Fig. 15. RGFC14, ventral view.
Fig. 16. RGFC14, cranial view.

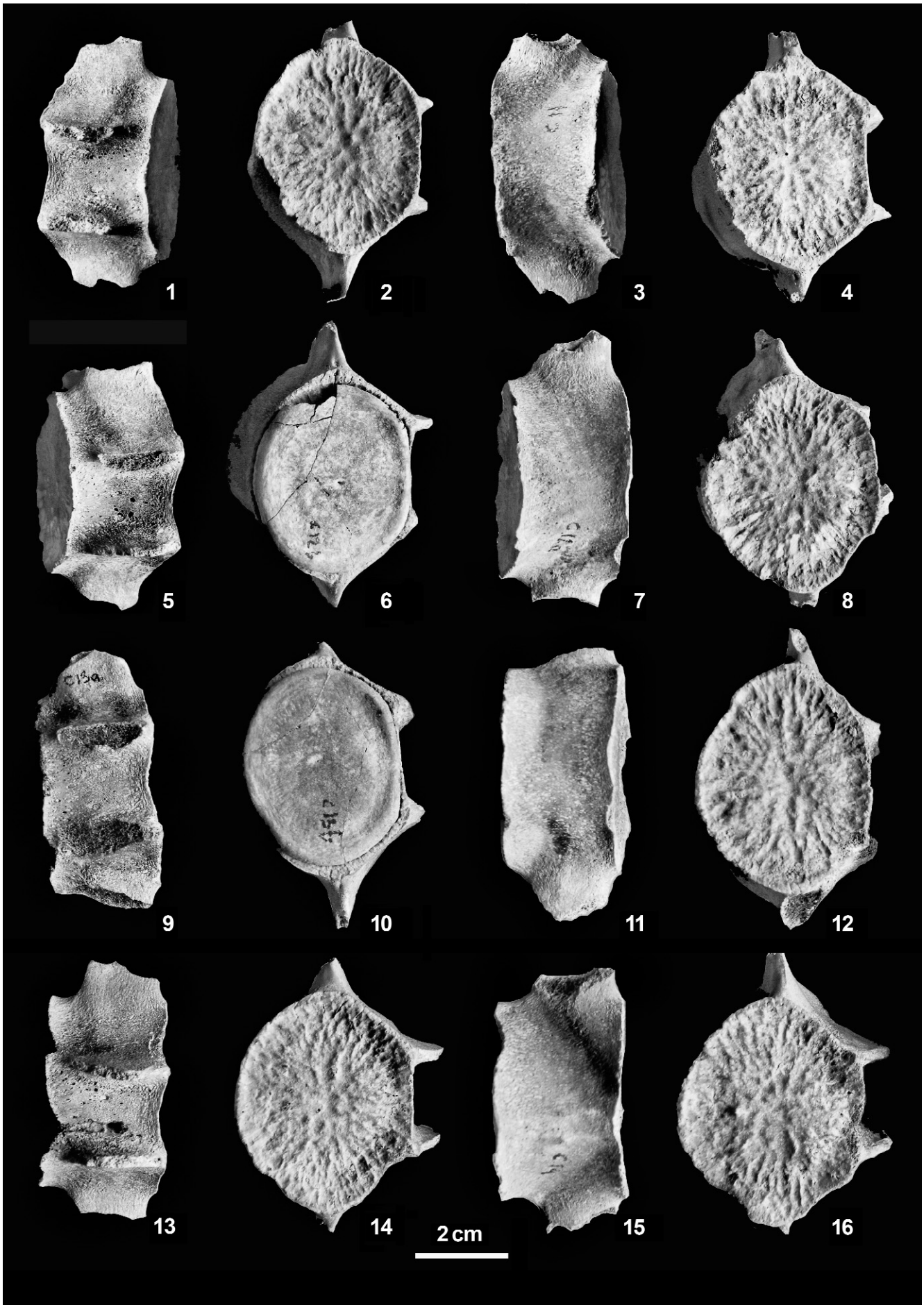
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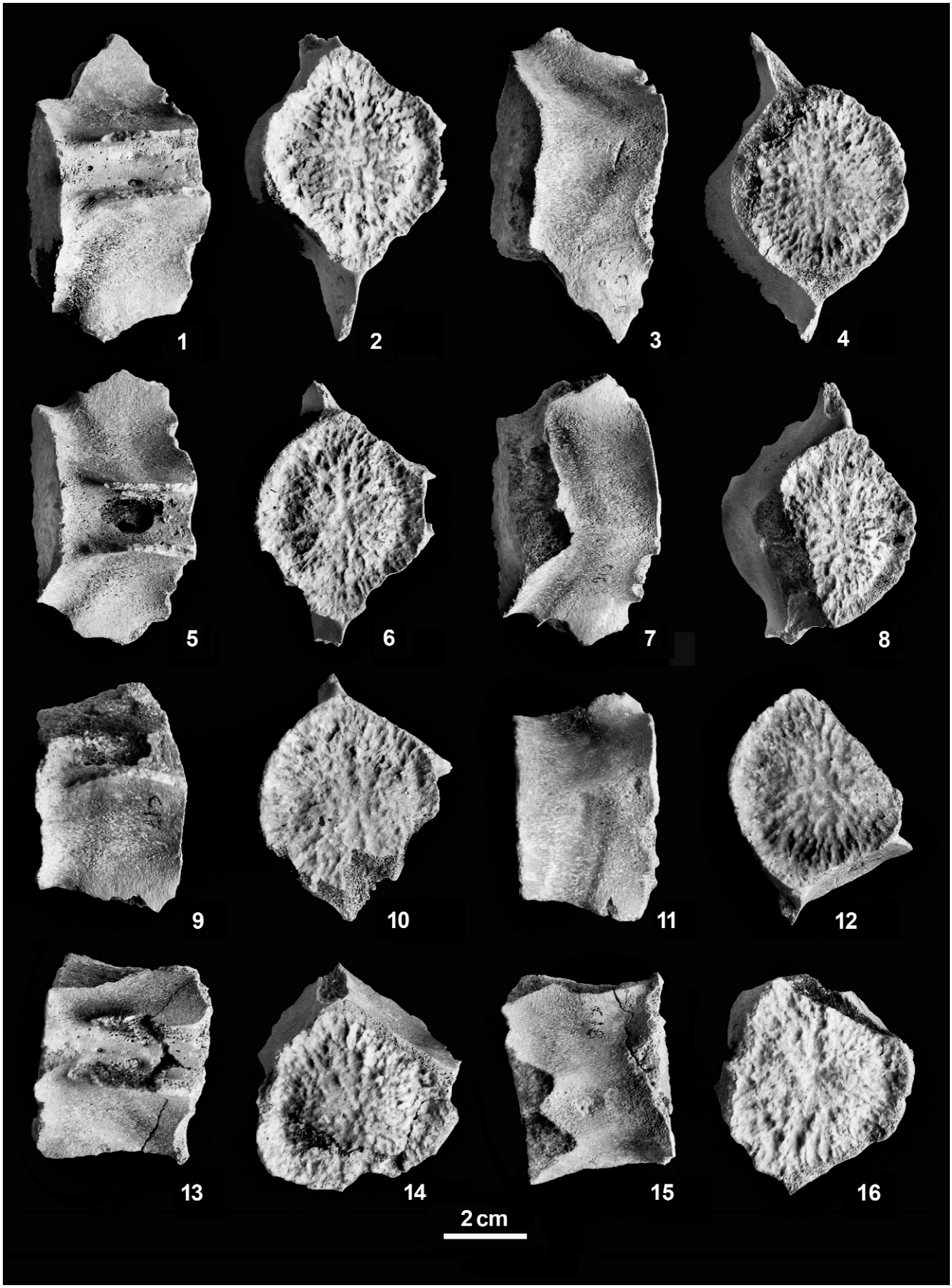
PLATE 3

Cethotherium aff. *rathkei* VAN BENEDEN, Middle Miocene (Badenian), lumbar vertebrae, Štrbci, northern Bosnia.

Fig. 1. RGF C15, dorsal view.
Fig. 2. RGFC15, caudal view.
Fig. 3. RGFC15, ventral view.
Fig. 4. RGFC15, proximal view.
Fig. 5. RGFC16, dorsal view.
Fig. 6. RGFC16, caudal view.
Fig. 7. RGFC16, ventral view.
Fig. 8. RGFC16, proximal view.
Fig. 9. RGFC17, dorsal view.
Fig. 10. RGFC17, caudal view.
Fig. 11. RGFC17, ventral view.
Fig. 12. RGFC17, proximal view.
Fig. 13. RGFC18, dorsal view.
Fig. 14. RGFC18, caudal view.
Fig. 15. RGFC18, ventral view.
Fig. 16. RGFC18, proximal view.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