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Upper Barremian representatives of *Dzirulina* Nutsubidze, 1945 (Terebratellidina, Brachiopoda) from eastern Serbia

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Abstract: A new Late Barremian terebratellid species of *Dzirulina* Nutsubidze, 1945 of Bežište, Suva Planina Mountain, eastern Serbia, which was earlier described by Petković (1930) was found at the same locality as *Waldheimia* (*Zeilleria*) *zujovici* Antula, 1903. The new species is compared with *Dzirulina pseudojurensis* (Leymerie), and the variability in the external features of this widespread species is shown on specimens from eastern Serbia through their internal structures.

Key words: Cretaceous, Late Barremian, eastern Serbia, new species, brachiopods, Kingenidae, *Dzirulina*.

Introduction

On the basis of only two specimens found in Upper Barremian sediments of Crnoljevica, the Svrljiške Planine Mountains, eastern Serbia, Antula (1903) introduced a new species named *Waldheimia* (*Zeilleria*) *zujovici*. Later, Petković (1930) made the same identification for five small specimens collected from rocks of the same age at Bežište on the Suva Planina Mountain. Among the brachiopods collected by Petković (1930) from this locality was a somewhat larger specimen, which he rightly identified as *Waldheimia* (*Zeilleria*) *pseudojurensis* (Leymerie, 1842). Note that the above mentioned authors dated the rocks containing these brachiopods as Hauterivian.

Jankičević (1978, 1979–1980) and Mitrović-Petrović (1979–1980) later confirmed the Barremian age of the rocks. More recently, Radulović (2000) and Radulović et al. (2002) dated them as Late Barremian.

The two specimens described by Antula (1903: p. 47, pl. 2, figs. 1, 2) are lost and were unavailable for study. A large display of Lower Cretaceous brachiopods from a number of east Serbian localities, collected by Zora Sučić-Protić (1955–1960), has been preserved in the Institute of Regional Geology and Paleontology, Faculty of Mining and Geology in Belgrade. Another set of specimens recently collected during detailed geological field work in both of the above mentioned localities was studied. Specimens from Crnoljevica, the same locality as Antula's two specimens, include an abundance of *D. pseudojurensis*, earlier identified by Antula as *Waldheimia* (*Zeilleria*) *zujovici*. Their external and internal features were studied. Thus it is proposed that the two specimens described by Antula as *Waldheimia* (*Zeilleria*) *zujovici* belong to *Dzirulina pseudojurensis*. The specimens from Bežište, which Petković (1930) mistakenly believed to be *Waldheimia* (*Zeilleria*) *zujovici*, are actually representatives of a new species, which is described herein.

Geological setting

The brachiopods described in this paper originate from two localities, Crnoljevica and Bežište, in the Carpatho-Balkanides of eastern Serbia (Fig. 1). Crnoljevica is located in the Kučaj-Svrljig Zone, and Bežište in the Gornjak-Suva Planina Mountain Zone. Both zones belong to the Geticum (= Srednja Gora in Bulgaria).

The sequence at Crnoljevica consists of bioclastic, marly and argillaceous limestones of Late Barremian

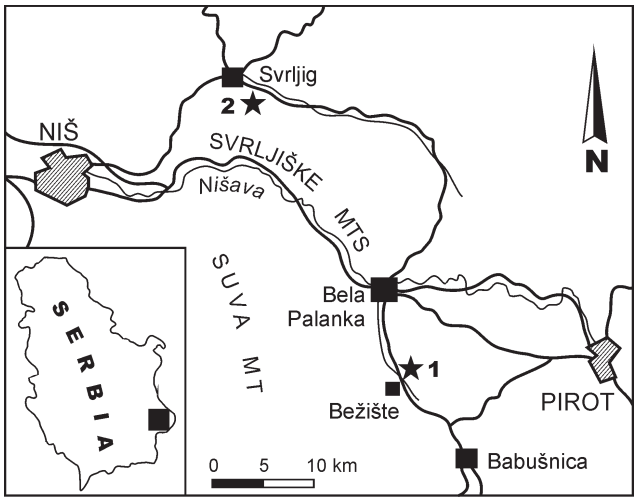

Fig. 1. Location of Upper Barremian brachiopod-bearing sites (asterisks) in east Serbian Carpatho-Balkanides. **1** — Crnoljevica, Svrljiške Planine Mountains; **2** — Bežište, Suva Planina Mountain.

age. In addition to *Dzirulina pseudojurensis*, these rocks contain many other brachiopod species in association with bivalves, echinoids, cephalopods, benthic foraminifers, and algae (Antula 1903; Radulović 2000; Radulović & Radulović 2002).

At Bežište, the locality of the new species, the bioclastic limestones (wackestone and packstone) contain many brachiopods and less abundant bivalves, corals, hydrozoans and benthic foraminifers. Scleractinian corals and hydrozoans from these beds indicate Late Barremian age (Radulović et al. 2002).

The material discussed here is preserved in the first author's collection at the Faculty of Mining and Geology, Belgrade (RGF VR). The synonymy list is presented following the recommendations of Matthews (1973). The superfamily classification follows Williams et al. (1996).

Taxonomic descriptions

Phylum **Brachiopoda** Duméril, 1806
Subphylum **Rhynchonelliformea** Williams et al., 1996
Class **Rhynchonellata** Williams et al., 1996
Order **Terebratulida** Waagen, 1883
Suborder **Terebratellidina** Muir-Wood, 1955
Superfamily **Kingenoidea** Elliott, 1948
Family **Kingenidae** Elliott, 1948
Subfamily **Kingeninae** Elliott, 1948 [emend. Richardson, 1975]

Genus *Dzirulina* Nutsubidze, 1945

Type species: *Terebratula dziroulensis* Antula, 1899; Middle Aptian of Georgia.

Remarks: On the basis of the Aptian species *Terebratula dziroulensis* Antula (1899) from western Georgia, Nutsubidze (1945) introduced a new genus *Dzirulina* and showed a series of transverse sections with spacings from 0.5 to 1 mm, thus missing important elements of the internal structure, such as outer and inner hinge plates, crural bases, and hood.

Without insight into the internal structure of *Dzirulina*, Smirnova (1960) later described a new genus, *Belothyris* from the Early Cretaceous of Beloya, northwestern Caucasus, with *B. plana* Smirnova (1960) as the type species, and also two new species of the same genus.

Kvakhadze (1972) used a series of transverse sections through a specimen of *Dzirulina dziroulensis* from the type locality and proved that the genus *Belothyris* (Smirnova) was a junior synonym of *Dzirulina*. This was also discussed by Owen (1980) and Sandy et al. (1995).

Occurrence: Hitherto, eleven species of *Dzirulina* are known. They have a wide geographical distribution in the Hauterivian and the Barremian, and a narrower one in the Aptian, along the northern Tethyan margin (Morocco, Spain, Sardinia, France, Switzerland, Serbia, western Georgia), and in the Upper Aptian on the southern Tethyan border (Zululand and probably Pakistan). Beyond the limits of the Tethys, representatives of this genus are known from the Hauterivian of the Boreal province (southern England) and from the Lower Albian of the Pacific region (northern California, Sandy et. al. 1995).

Dzirulina pseudojurensis (Leymerie, 1842)
Figs. 2–5, 6.1–4

*	1842	*Terebratula pseudo-jurensis* Leymerie, 12, pl. 15, figs. 5, 6
	1843	*Terebratula pseudo-jurensis* Leym. — Mathéron, 131
.	1847	*Terebratula pseudo-jurensis* Leym. — d'Orbigny, 74, pl. 505, figs. 11–16
.	1861	*Terebratula pseudojurensis* Leymerie — de Loriol, 121, pl. 15, figs. 19–21
.	1868	*Terebratula* (*Waldheimia*) *pseudojurensis* Leymerie — de Loriol, 54, pl. 4, figs. 12–14
.	1872	*Terebratula* (*Waldheimia*) *pseudojurensis* Leymerie — Pictet, 93, pl. 203, figs. 11–15
non	1874	*Terebratula* (*Waldheimia*) *pseudojurensis* Leymerie — Davidson, 48, pl. 7, figs. 10–14
.	1903	*Waldheimia (Zeilleria) Žujovići* Antula, 47, pl. 2, figs. 1, 2
	1907	*Zeilleria pseudojurensis* Leym. — Karakasch, 216
.*v*	1930	*Waldheimia (Zeilleria) pseudojurensis* Leym. — Petković, 107, pl. 3, fig. 1
.*v*	1953	*Waldheimia (Zeilleria) pseudojurensis* Antula — Sučić, 110
.*v*	1953	*Terebratula pseudojurensis* Leymerie — Sučić, 111, pl. 3, figs. 6, 7
.	1970	*Belothyris pseudojurensis* (Leymerie) — Owen, 70, pl. 9, figs. 1–5, 7
.	1975	*Belothyris pseudojurensis* (Leymerie) — Dieni & Middlemiss in Dieni, Middlemiss & Owen, 203, pl. 38, figs. 4–6.
.*v*	1979–80	*Waldheimia* (*Zeilleria*) *pseudojurensis* Leym. — Jankičević, 225
	1980	*Belothyris pseudojurensis* (Leymerie) — Owen, 278
.	1989	*Zeilleria pseudojurensis* (Leymerie) — Gaspard, 84, pl. 1, fig. 3c
	1990	*Belothyris pseudojurensis* (Leymerie) — Smirnova, 134
.	1999	*Belothyris pseudojurensis* (Leymerie) — Sulser, 231 with text-fig.
.	1999	*Belothyris pseudojurensis* (Leymerie) — Gaspard, 313, 319, 322, 324, pl. 2, fig. 6
.*v*	2000	*Dzirulina pseudojurensis* (Leymerie) — Radulović, 122, 124, pl. 2, fig. 9
	2003	*Belothyris pseudojurensis* (Leymerie) — Gaspard, 266, fig. 1A

Neotype: Since the original specimen described by Leymerie (1842) is presumed lost, Owen (1980) proposed another one among the specimens from the Hauterivian type locality of Marolles (Aube), France.

Material: 75 complete specimens from Crnoljevica, the Svrljiške Planine Mountains, 11 specimens from Bežište, Suva Planina Mountain.

Description: ***External features:*** The exterior of this species from France was described by Owen (1970). A description of the morphological characters of specimens from Serbian Carpatho-Balkanides follows.

The shell is of medium size for the genus, reaching 21 mm in length. In one population, the outline may vary from elongate-oval, rounded-pentagonal, pentagonal to almost perfectly circular. The greatest width is situated at the mid-length of the shell or slightly further anteriorly; the greatest thickness is in the posterior third. The valves are nearly equally moderately convex and flattened; the ventral valve is regularly convex, often with a more or less developed sulcus on the anterior half; the dorsal valve is

without a corresponding fold, with a slightly swollen posterior part. The anterior commissure ranges from rectimarginate to slightly uniplicate; the lateral commissure is gently ventrally arched to straight. The indentation of the anterior margin is more or less pronounced. The beak is small, low and wide, erect, in some specimens it is in close contact with the dorsal umbo, with a relatively small circular foramen of the mesothyrid to permesothyrid type. The deltidial plates disjunct. The beak ridges are subangular and short, border small, with a narrow and concave interarea. The shell surface is marked by well-developed growth lines, which become more prominent at the margins.

Internal features: The internal structure of *D. pseudojurensis* of the type material has not hitherto been described. Below is given a detailed description of two specimens from eastern Serbia (Figs. 2, 3). Recently, Gaspard (2003) gave transverse serial sections of this species from the Aptian of Auxerre (Yonne, France).

The dental lamellae are ventrally divergent, very short, nearly reduced before the dorsal valve arises. The hinge teeth are elongated, deeply inserted in dental sockets. No cardinal process is developed. The hinge platform is slightly concave posteriorly, broadening and shallowing anteriorly, supported by a high septal pillar occupying about one-half of the valve length, and rapidly decreasing

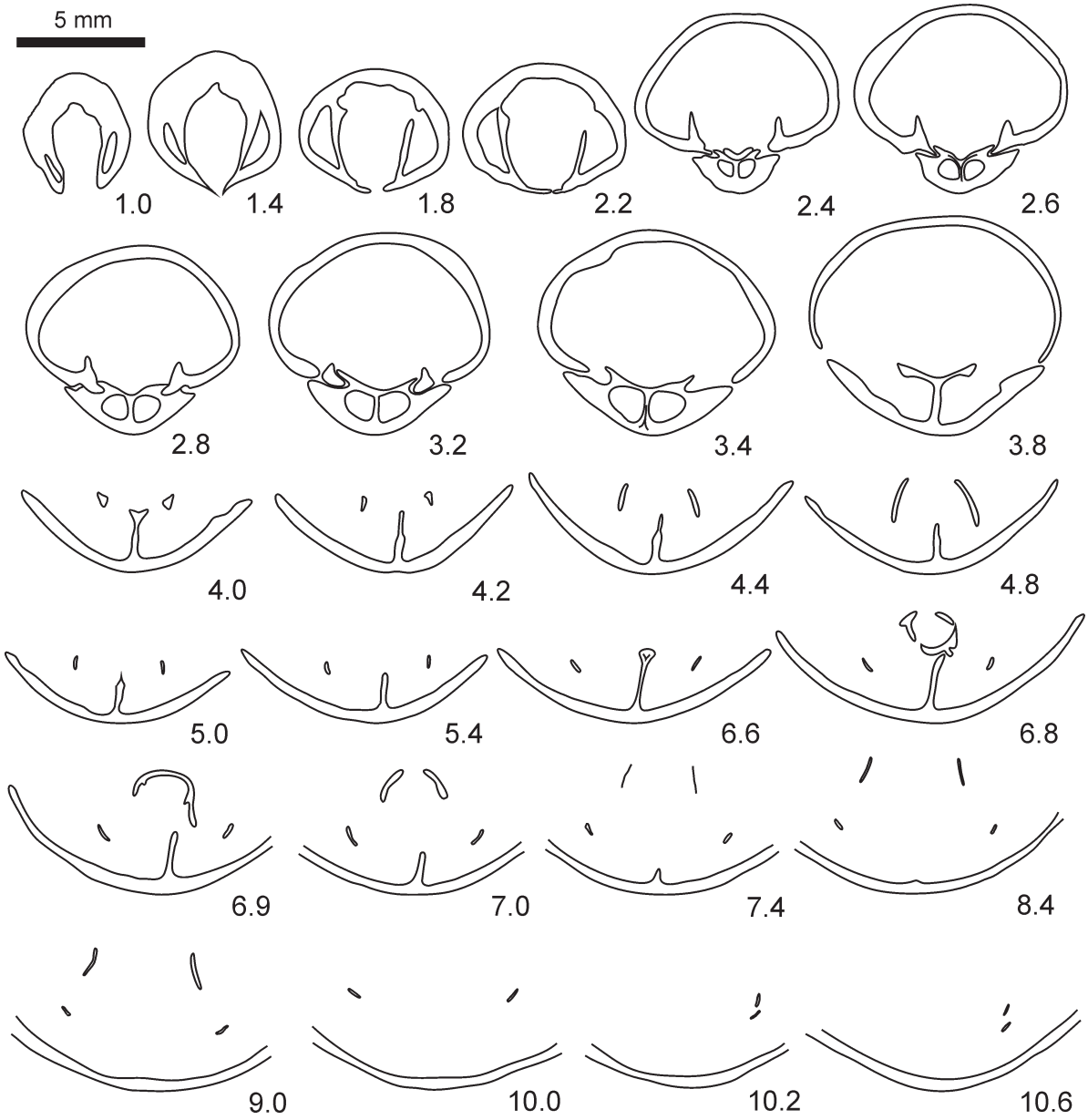

Fig. 2. Transverse serial sections of *Dzirulina pseudojurensis* (Leymerie, 1842) through specimen RGF VR 25/114, collected from Upper Barremian, Crnoljevica, Svrljiške Planine Mountains. Original dimensions of specimens (in mm): L = 16.7, W = 13.2, T = 9.4. Numbers refer to distance in mm from the ventral apex.

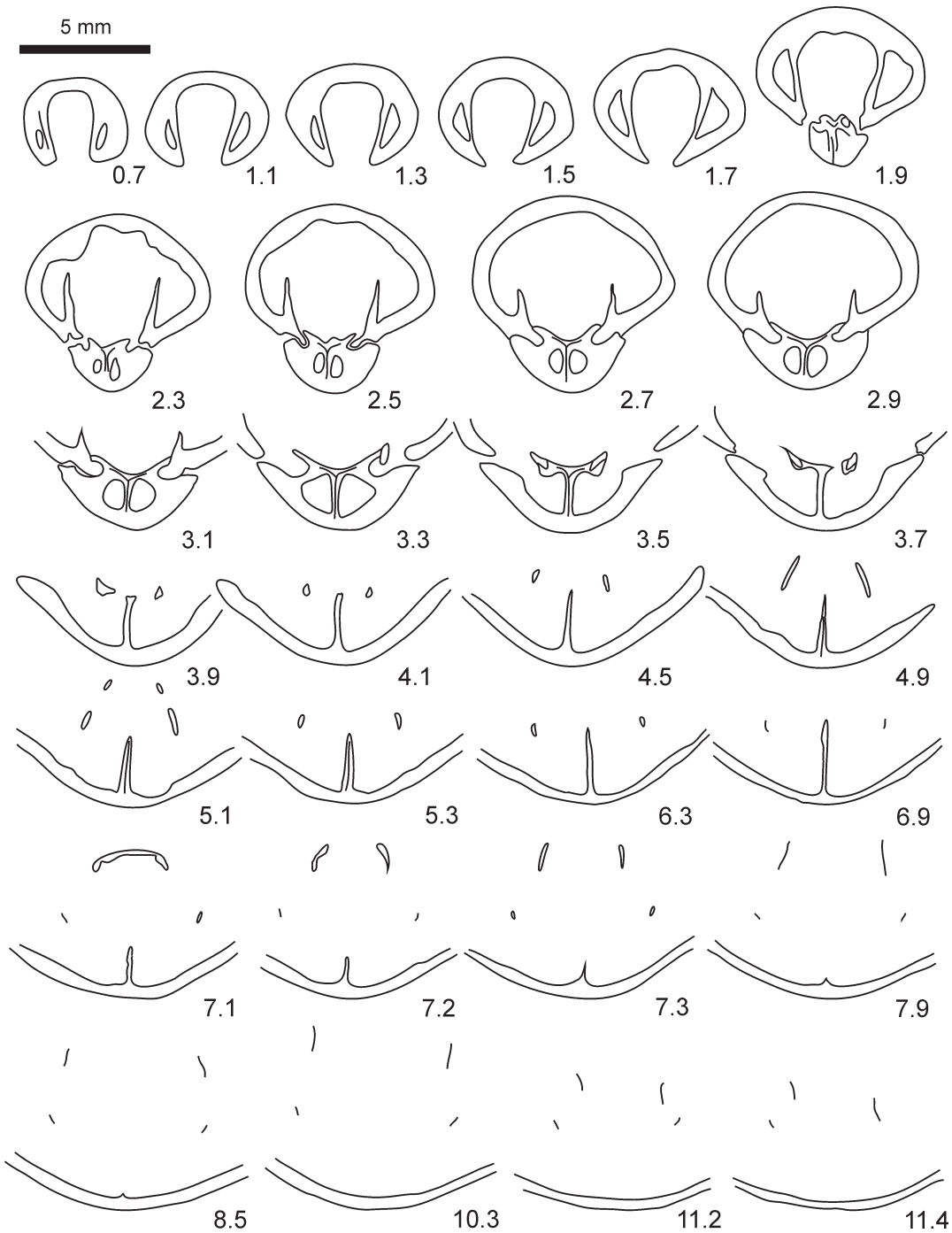

Fig. 3. Transverse serial sections of *Dzirulina pseudojurensis* (Leymerie, 1842) through specimen RGF VR 25/87, collected from Upper Barremian, Crnoljevica, Svrljiške Planine Mountains. Original dimensions of specimens (in mm): L = 15.5, W = 13.8, T = 9.0. Numbers refer to distance in mm from the ventral apex.

in height anteriorly of the hood. The platform is formed by the outer and inner hinge plates, separated by triangular, dorsally directed crural bases. The crural processes are ventrally convergent, slightly inwardly concave and moderate in height. The descending branches are much narrower than the slightly ventrally convergent ascending branches. The transverse band broad, very slightly arched, with two dorsally directed small processes, joins two ascending branches of the loop before it is attached to a septal pillar. The connecting hood is circular and short, at approximately one-third of the dorsal valve length. The loop is kingeniform, thin, extending about three-quarters of the valve length.

Remarks: The species is distinguished externally from *Dzirulina minima* sp. nov. by its much larger dimensions, wide variation in outline, with usually sharp edges. Internal-

ly, it differs in having slightly inclined crural bases, ventrally convergent crural processes, and wide ascending branches, and the septal pillar is without a round structure in the axial part. In five species of genus *Dzirulina*: *D. pseudojurensis* (Leymerie, 1842), *D. ovula* (Anderson, 1938), *D. plana* (Smirnova, 1960), *D. elliptica* (Kvakhadze, 1972), and *D. haughtoni* (Owen, 1980), the interiors of which are known, the septal pillar is without a round structure.

Antula (1903) considered that his new species, *Waldheimia* (*Zeilleria*) *zujovici,* which now belong to *D. pseudojurensis*, to be most similar to Pictet's (1872: pl. 203, figs. 11–15) representatives of *Waldheimia* (*Zeilleria*) *pseudojurensis*. It differs from the latter in having "a sharp beak, much greater thickness, protruded anterior end, and unemarginated lateral edges". He had only two specimens (Fig. 4) and could not have known of the highly varied external morphology of this species.

Dieni & Owen (in: Dieni, Middlemiss & Owen 1975) also described the external morphology of this species from several localities of east-central Sardinia. Unlike the typical form, the specimens mentioned by these authors are much smaller in size, but are proportionally the same as the original specimens of Leymerie (1842). In our opinion, the small size of the shells is most likely the result of unfavourable living conditions. They also wrote that specimens of this species collected from different localities of the Swiss and French Jura could vary widely in size, from small, as the Sardinian specimens, to large, as the type forms. For these authors, the shell size was not of specific importance.

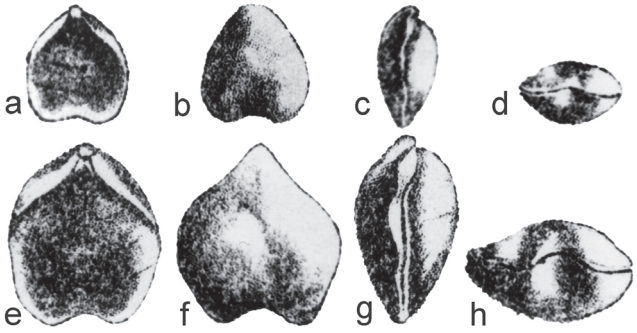

Fig. 4. Antula's (1903: pl. 2, figs. 1, 2) original drawings of two specimens of *Dzirulina pseudojurensis* (Leymerie, 1842), earlier referred to by Antula as *Waldheimia* (*Zeilleria*) *zujovici*, from Upper Barremian, Crnoljevica, Svrljške Planine Mountains. **a–d** — young adult specimen, **e–h** — fully adult specimen. Both specimens are illustrated in dorsal, ventral, lateral and anterior views and natural size.

We also found that the forms of this species from different localities of eastern Serbia vary greatly in size, and in outline. In a study of the external morphology on a large number of specimens from eastern Serbia, the following was noted: — the outline varies greatly, from elongate oval, rounded pentagonal, pentagonal to circular (Fig. 5); — the sulcus is on the anterior half of the shell, and the indentation in the anterior margin is more or less marked; — the shell size varies from small to large; — the valves are flattened, moderately or strongly convex; — very rarely some marginal thickening develops in adult specimens.

Occurrence: The species has been recorded from the Hauterivian of Morocco, eastern Iberides, east-central Sardinia, the South Paris Basin, the French and Swiss Jura, Valanginian and Hauterivian of the Crimea and Caucasus, Late Barremian of eastern Serbia (Fig. 5).

Dzirulina minima sp. nov.
Figs. 6.5–10, 7

non 1903 *Waldheimia (Zeilleria) Žujovići* Antula, 47, pl. 2, figs. 1, 2 (= *Dzirulina pseudojurensis* Leymerie)
.v 1930 *Waldheimia (Zeilleria) Žujovići* Antula — Petković, 107, pl. 3, fig. 4
non v 1953 *Waldheimia (Zeilleria) žujovići* Antula — Sučić, 110 (= *Dzirulina pseudojurensis* Leymerie)
non v 1978 *Waldheimia žujovići* Antula — Jankičević, 129 (= *Dzirulina pseudojurensis* Leymerie)

Derivatio nominis: Latin word "minima" — small, referring to the shell size.

Holotype: Specimen RGF VR 76/8, figured in Fig. 6.7. Dimensions (in mm): length = 10.8, width = 9.3, thickness = 6.8.

Paratypes: The specimens RGF VR 76/6, 7, 9, 10, 11, figured in Figs. 6.5, 6, 8–10.

Stratum typicum: Late Barremian bioclastic limestones.

Locus typicus: Bežište, Suva Planina Mountain, eastern Serbia.

Diagnosis: Small *Dzirulina* species with a pentagonal outline, crowded growth lines along a marginal shell thickening, round structure in the axial part of the septal pillar, strongly dorsally inclined crural bases, and subparallel crural processes.

Description: ***External features:*** Shell small in size for the genus, largest specimen 12.1 mm in length, 11.2 mm in width, 5.7 mm in thickness, always longer than wide, distinctly pentagonal in outline, truncated len-

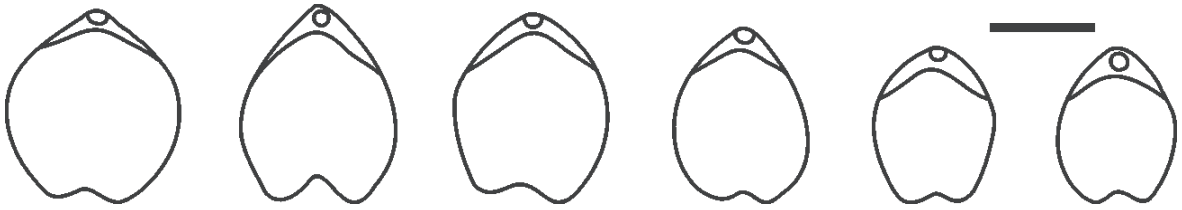

Fig. 5. Shape variability in *Dzirulina pseudojurensis* (Leymerie, 1842) of specimens, collected from Upper Barremian, Crnoljevica, Svrljiške Planine Mountains. Scale bar = 10 mm.

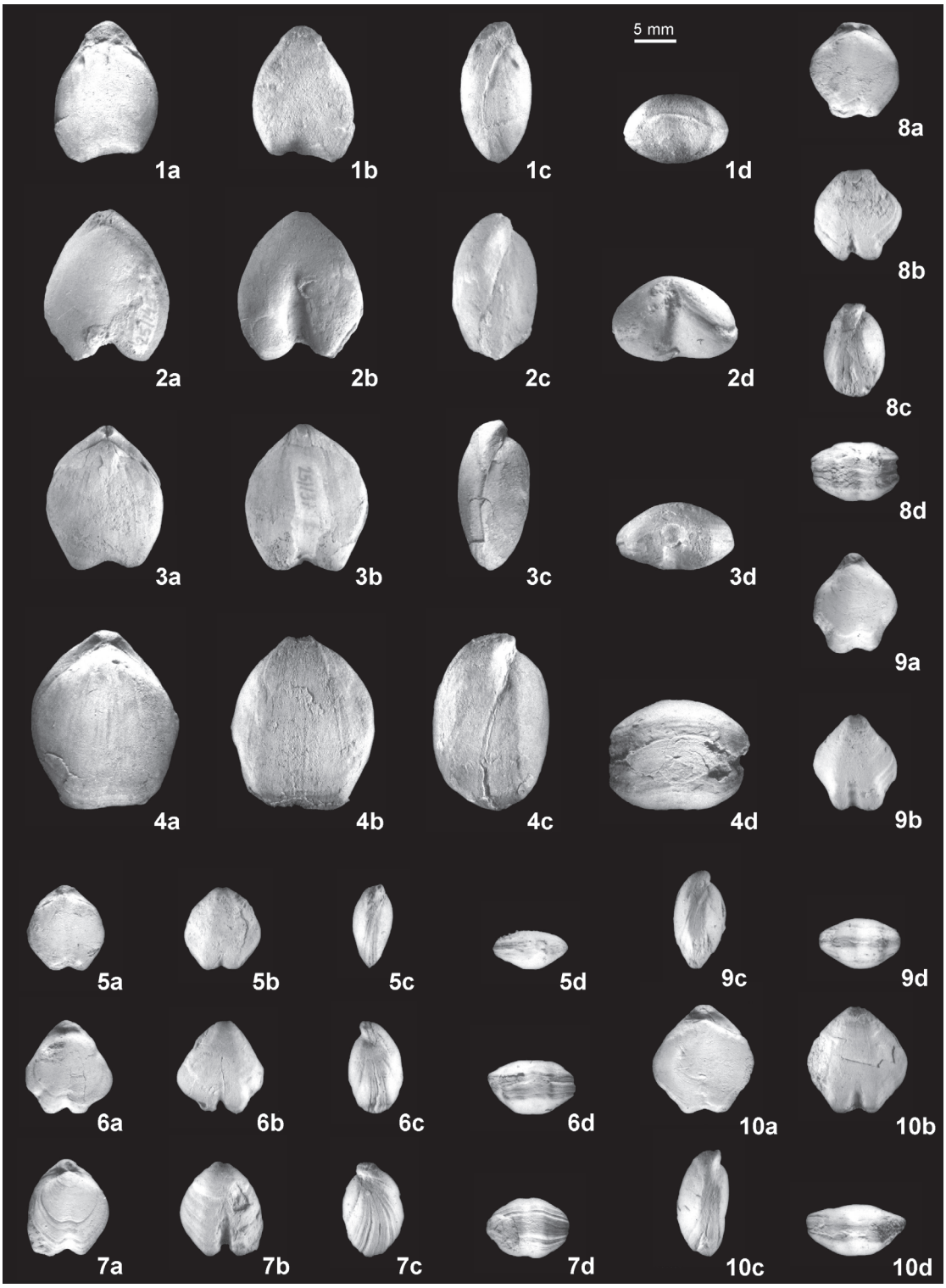

Fig. 6. 1–4 — *Dzirulina pseudojurensis* (Leymerie, 1842). 1 — RGF VR 76/4, Late Barremian, Bežište, Suva Planina Mountain; length of shell 16.3 mm. 2 — RGF VR 25/147, Late Barremian, Crnoljevica, Svrljiške Planine Mountains; length of shell 16.5 mm. 3 — RGF VR 25/137 Late Barremian, Crnoljevica, Svrljiške Planine Mountains; length of shell 17.2 mm. 4 — RGF VR 76/5, Late Barremian, Bežište, Suva Planina Mountain; length of shell 21.0 mm. **5–10** — *Dzirulina minima* sp. nov., Late Barremian, Bežište, Suva Planina Mountain. 5 — RGF VR 76/6, paratype; length of shell 9.6 mm. 6 — RGF VR 76/7, paratype, used for transverse serial sections; length of shell 10.6 mm. 7 — RGF VR 76/8, holotype; length of shell 10.8 mm. 8 — RGF VR 76/9, paratype; length of shell 11.0 mm. 9 — RGF VR 76/10, paratype; length of shell 11.1 mm. 10 — RGF VR 76/11, paratype; length of shell 12.1 mm. All figured specimens were coated with ammonium chloride before being photographed. The letters imply the view: **a** — dorsal, **b** — ventral, **c** — lateral, **d** — anterior. Photographs by V. Radulović.

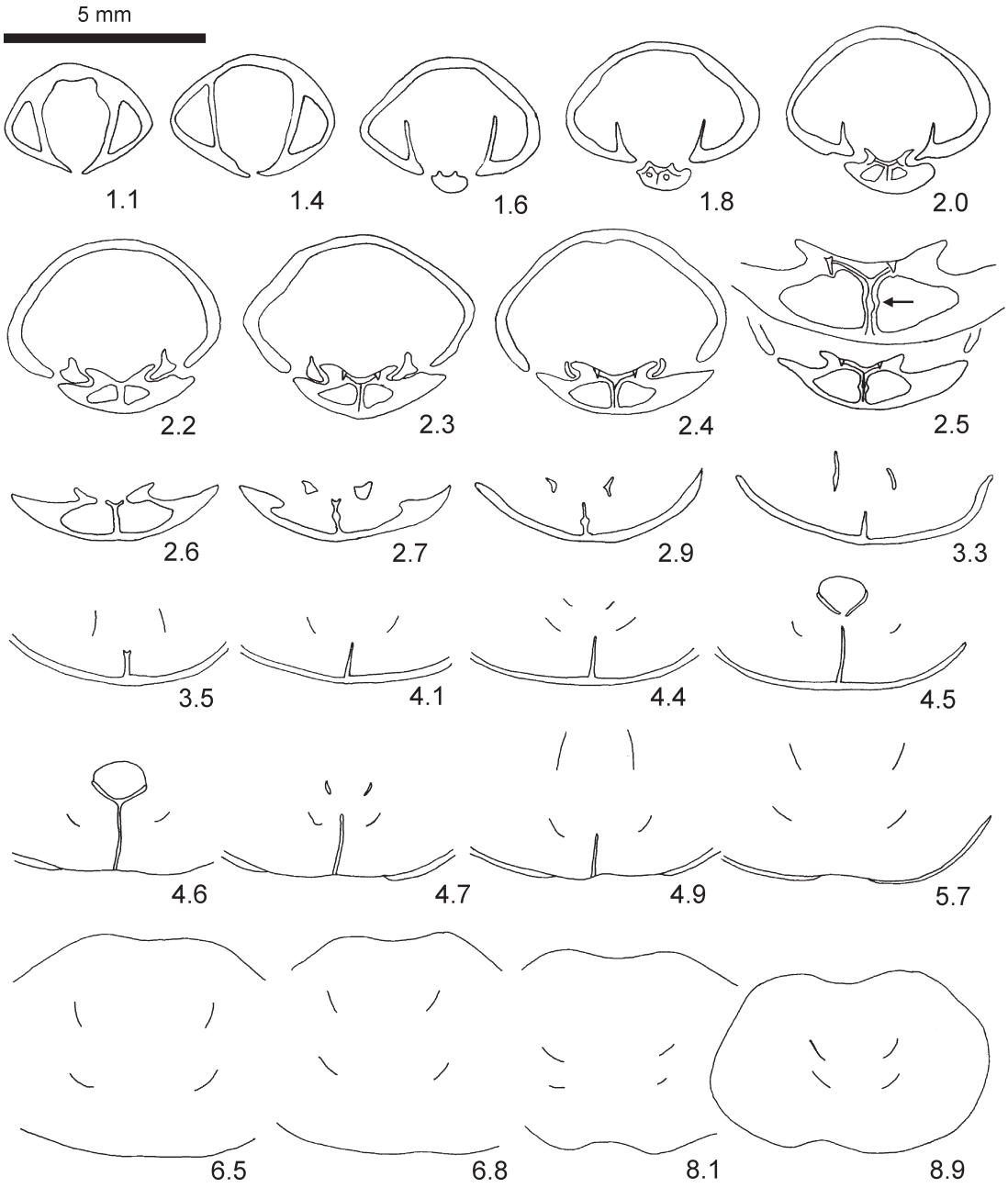

Fig. 7. Transverse serial sections of *Dzirulina minima* sp. nov. through specimen RGF VR 76/7, collected from Upper Barremian, Bežište, Suva Planina Mountain. Original dimensions of specimens (in mm): L = 10.6, W = 9.8, T = 6.1. Figured on Fig. 6.6. Numbers refer to distance in mm from the ventral apex. Enlarged hinge plates, crural bases, and round structure (arrow) in the axial part of the septal pillar are shown above the original structures in section 2.5. Due to the small size of the shell, the transverse band most probably invisible during sectioning.

ticular in the anterior contour, anterior end narrower and indentate. Both valves are moderately, and equally biconvex. Greatest width and thickness at the mid-length of the shell. Beak moderately produced, erect to slightly incurved, in close contact with the dorsal umbo, with short and rather distinct beak ridges, foramen circular, mesothyrid. Interarea in some specimens relatively large, concave. Each valve has two low, barely marked short ridges separated by a more or less developed sulcus on the anterior half. The anterior commissure is rectimarginate to incipiently uniplicate; the lateral commissures are straight or slightly ventrally arched. Marginal thickening develops in the gerontic stage. Numerous fine growth lines concentrated towards the anterior and lateral commissures. Entire surface finely punctated.

Internal features: Two specimens were sectioned. The first specimen revealed a broken loop. The second specimen with a complete loop is figured (Fig. 7).

The dental lamellae are thin and short, ventrally divergent, supporting elongated hinge teeth, which become bracket-like, in cross-section, anteriorly. The sockets are short, but deep. The outer hinge plates are not clearly de-

limited from the inner socket ridges. The inner hinge plates are thin, conjunct, slightly dorsally inclined. They are separated by triangular in cross-section, strongly dorsally inclined crural bases; together forming a broad, concave and shallow hinge platform. The platform is supported by a thin, long, blade-like, septal pillar, reaching about mid-length of the valve, highest at the level where it is linked with the ascending branches. Posteriorly, the septal pillar possess a round structure in the axial part. The crural processes are subparallel, relatively low. The proximal ends of the ascending branches widening, attached to the septal pillar, building a very short and circular hood. The distal ends of the descending and ascending branches are of the same thickness. The loop is long, about three-quarters of the dorsal valve length.

Remarks: Among the species of *Dzirulina,* the new species can only be compared with *D. pseudojurensis* from which it differs in being much smaller, always pentagonal in outline, in having dense and constantly strong growth lines along the lateral and anterior commissures, and marginal shell thickening. On the other hand, it can be distinguished internally from the latter by its round structure in the axial part of the septal pillar, much more inclined crural bases, subparallel crural processes, and a loop consisting of descending and ascending branches of the same thickness. The main external features which connect both species are a more or less developed sulcus on the anterior half and an indentate anterior margin.

All six specimens of the new species possessed small shells. Though small, the shell bears several prominent growth lines on its anterior end, which is, without any doubt, a feature of the adult stage. Hence, the inference is that the forms of the new species are much smaller than other representatives of the same genus. Relatively large specimens of *Dzirulina pseudojurensis* (Fig. 6.4) were found in the same layers of the Bežište locality, from where the small specimens of the new species were recovered. Therefore, the small shells of these new species cannot be attributed to the prevailing ecological conditions and it is clearly a morphogenetic feature.

Radulović (1991) described specimens of three species: *Agerithyris minima*, *Minithyris rhomboidalis*, and *Struvethyris elongata* from the Middle Jurassic of the Laz locality, eastern Serbia, which also had densely-set growth lines near the anterior commissure and possessed small shells, and confirmed they have a gerontic aspect. The size of these adult small shells, found in association with other rhynchonellides and terebratulides of normal size, cannot be attributed to detrimental life conditions.

Conclusions

The Upper Barremian shallow-water limestones of the eastern Serbian Carpatho-Balkanides contain abundant brachiopods. The commonest among them is *Dzirulina pseudojurensis*, which has a wide geographical distribution in the Hauterivian and Barremian along the northern Tethyan margin.

The interior features and variation of the external morphology (size, outline, valve convexity, sulcus and indentation development) of the species are described using a large number of specimens from many localities of eastern Serbia.

Another representative of this genus, *Dziruline minima* sp. n., was identified earlier by Antula (1903) as *Waldheimia* (*Zeilleria*) *pseudojurensis.* The new species distinctly differs from any other *Dzirulina* species in its small shell, dense and strong growth lines along flattened shell edges, and round structure in the axial part of the septal pillar. It is known only from the locality of Bežište, eastern Serbia.

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