geodiversitas

2020 • 42 • 21

Ostracods from the ‘Raibl Beds’ (Carnian, Late Triassic) of Belca section in Karavanke Mountains, northwestern Slovenia

Marie-Béatrice FOREL,
Tea KOLAR-JURKOVŠEK &
Bogdan JURKOVŠEK

art. 42 (21) — Published on 10 September 2020
www.geodiversitas.com

PUBLICATIONS SCIENTIFIQUES
MUSÉUM NAL HIST NATURELLE

Directeur de la publication / *Publication director* : Bruno David,
Président du Muséum national d'Histoire naturelle

Rédacteur en chef / *Editor-in-chief* : Didier Merle

Assistant de rédaction / *Assistant editor* : Emmanuel Côtez (geodiv@mnhn.fr)

Mise en page / *Page layout* : Emmanuel Côtez

Couverture / *Cover* :
Réalisée à partir des Figures de l'article/*Made from the Figures of the article*.

Geodiversitas est indexé dans / Geodiversitas *is indexed in:*
- Science Citation Index Expanded (SciSearch®)
- ISI Alerting Services®
- Current Contents® / Physical, Chemical, and Earth Sciences®
- Scopus®

Geodiversitas est distribué en version électronique par / Geodiversitas *is distributed electronically by:*
- BioOne® (http://www.bioone.org)

Les articles ainsi que les nouveautés nomenclaturales publiés dans *Geodiversitas* sont référencés par /
Articles and nomenclatural novelties published in Geodiversitas *are referenced by:*
- ZooBank® (http://zoobank.org)

Geodiversitas est une revue en flux continu publiée par les Publications scientifiques du Muséum, Paris
Geodiversitas *is a fast track journal published by the Museum Science Press, Paris*

Les Publications scientifiques du Muséum publient aussi / *The Museum Science Press also publish:* ***Adansonia***, ***Zoosystema***, ***Anthropozoologica***, ***European Journal of Taxonomy***, ***Naturae***, ***Cryptogamie*** **sous-sections** ***Algologie***, ***Bryologie***, ***Mycologie, Comptes Rendus Palevol***

Diffusion – Publications scientifiques Muséum national d'Histoire naturelle
CP 41 – 57 rue Cuvier F-75231 Paris cedex 05 (France)
Tél. : 33 (0)1 40 79 48 05 / Fax : 33 (0)1 40 79 38 40
diff.pub@mnhn.fr / http://sciencepress.mnhn.fr

ISSN (imprimé / *print*) : 1280-9659/ ISSN (électronique / *electronic*) : 1638-9395

Ostracods from the ‘Raibl Beds’ (Carnian, Late Triassic) of Belca section in Karavanke Mountains, northwestern Slovenia

Marie-Béatrice FOREL
CR2P (CNRS, MNHN, Sorbonne Université),
Département Origines et Évolution, Muséum national d’Histoire naturelle,
case postale 38, 57 rue Cuvier, F-75231 Paris cedex 05 (France)
marie-beatrice.forel@mnhn.fr (corresponding author)

Tea KOLAR-JURKOVŠEK
Geološki zavod Slovenije, Dimičeva ulica 14, 1000 Ljubljana (Slovenija)
tea.kolar-jurkovsek@geo-zs.si

Bogdan JURKOVŠEK
Kamnica 27, 1262 Dol pri Ljubljani (Slovenija)
geolog.bj@gmail.com

Submitted on 13 February 2019 | accepted on 25 September 2019 | published on 10 September 2020

urn:lsid:zoobank.org:pub:7EC0E4FA-D538-4CE2-91B8-D7F549C32985

Forel M.-B., Kolar-Jurkovšek T. & Jurkovšek B. 2020. — Ostracods from the ‘Raibl Beds’ (Carnian, Late Triassic) of Belca section in Karavanke Mountains, northwestern Slovenia. *Geodiversitas* 42 (21): 377-407. https://doi.org/10.5252/geodiversitas2020v42a21. http://geodiversitas.com/42/21

ABSTRACT
The taxonomy of marine ostracod assemblages from Belca section in the Karavanke Mountains, northwestern Slovenia, is discussed, adding to the scientific understanding of marine ostracods during the Carnian stage, Late Triassic. In Belca, the ostracod assemblages include 39 species, among which two are newly described: *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp. The recovery of abundant juvenile and adult specimens facilitated the illustration and discussion of the ontogenetic series of several typically Triassic species including *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973, *Leviella bogschi* Kozur, 1972 and *Leviella veghae* Kozur, 1972. The occurrence of sexual dimorphism is furthermore confirmed for *Renngartenella sanctaecrucis*. Ostracods in Belca record a major shift from low diversity and high dominance assemblages at the base of the section to higher diversity and lower dominance with diversification of stable open-marine taxa in the upper part. This pattern might illustrate low salinity levels related to high land-derived input at the base of the section and a return to relatively normal marine salinity in the intermediate sublittoral zone in the upper portion of Belca section.

KEY WORDS
Ostracods,
Carnian,
‘Raibl Beds’,
Karavanke Mountains,
Košuta Nappe,
Slovenia.

RÉSUMÉ
Ostracodes des « Couches Raibl » (Carnien, Trias supérieur) de la coupe de Belca dans les Montagnes Karavanke, nord-ouest de la Slovénie.
La taxinomie des assemblages d'ostracodes marins de la coupe de Belca dans les Montagnes Karavanke, nord-ouest de la Slovénie, est discutée et apporte à la compréhension scientifique des ostracodes marins du Carnien, Trias supérieur. À Belca, les assemblages d'ostracodes incluent 39 espèces, parmi lesquelles deux sont nouvelles : *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp. La présence d'abondats spécimens juvéniles et adultes a facilité l'illustration et la discussion des séries ontogénétiques de plusieurs espèces typiquement triasiques, notamment *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973, *Leviella bogschi* Kozur, 1972 and *Leviella veghae* Kozur, 1972. L'existence de dimorphisme sexuel est par ailleurs confirmée pour *Renngartenella sanctaecrucis*. Les ostracodes à Belca enregistrent un changement majeur d'assemblages peu diversifiés à forte dominance à la base de la coupe, à des assemblages plus diversifiés, à plus faible dominance voyant la diversification des taxons de milieux marins stables et ouverts dans la partie supérieure. Cette tendance pourrait indiquer une salinité réduite reliée à un influx d'eau douce à la base de la coupe et un retour à une salinité marine normale dans la zone sublittoral intermédiaire dans la partie supérieure de la coupe de Belca.

MOTS CLÉS
Ostracodes,
Carnien,
« Couches Raibl »,
Montagnes Karavanke,
Nappe de Košuta,
Slovénie.

INTRODUCTION

Following the end-Permian extinction that deeply affected marine organisms, the Carnian stage is one of the most scrutinized interval of the Triassic as it witnessed the most distinctive climate change within the Triassic about 230 Ma (Preto *et al.* 2010). In shallow marine areas of the western Tethys, this episode is characterized by the demise of early Carnian carbonate platforms and the sudden deposition of coarse siliciclastics (e.g., Simms & Ruffell 1989). It is recognized from deltaic to shallow marine successions of the Dolomites (e.g., Krystyn 1978; Breda *et al.* 2009) to deep-water settings of the Himalayas and Lagonegro Basin (Hornung *et al.* 2007a; Rigo *et al.* 2007). It has been termed 'Carnian Wet Intermezzo' in the Germanic Basin, 'Carnian Pluvial Event' in northern Europe, "Reingraben turnover" in the Northern Calcareous Alps, or 'Raibl Event' in the Italian Dolomites (e.g., Schlager & Schöelnberger 1974; Simms & Ruffell 1989, 1990; Hornung & Brandner 2005; Hornung *et al.* 2007a, b; Kozur & Bachmann 2010; Dal Corso *et al.* 2012; Ogg 2015). This event has been attributed to an increase in rainfall and is associated with extinction and biotic turnover (e.g., Simms & Ruffell 1989, 1990; Roghi *et al.* 2010).

Ostracods are crustaceans of millimeter size, which today inhabit oceans, seas, estuaries, lagoons, lakes, rivers, ponds and springs. They have been entirely marine during the Early Palaeozoic (e.g., Salas *et al.* 2007; Siveter 2008) and colonized non-marine water bodies during the Carboniferous (e.g., Williams *et al.* 2006; Bennett 2008; Bennett *et al.* 2012). The fossil record of ostracods' carapaces provides information on their evolution, as well as on climatic changes throughout the Phanerozoic. Marine ostracods greatly suffered from the end-Permian crisis about 252 Ma and their recovery is considered complete during the Anisian, Middle Triassic (Crasquin & Forel 2014). However, increasing evidence of the residual presence of Palaeozoic taxa up to the Carnian challenges our current knowledge on the survival and recovery mechanisms following this major event and revives discussion on the existence of refuge zones and oxygenation levels through this interval (e.g., Forel *et al.* 2019a).

Carnian marine ostracods have been reported worldwide since the end of the 19th century, from Alaska (Sohn 1964, 1987), Austria (Bunza & Kozur 1971; Kristan-Tollmann & Hamedani 1973), Hungary (Méhes 1911; Monostori 1994; Bunza & Kozur 1971; Kristan-Tollmann *et al.* 1991b; Kozur 1972; Széles 1965; Monostori & Tóth 2014), Iran (Crasquin-Soleau & Teherani 1995), Israel (Sohn 1968; Gerry *et al.* 1990), Italy (Reuss 1869; Gümbel 1869; Kollmann 1963; Urlichs 1970; Kristan-Tollmann & Hamedani 1973); Kristan-Tollmann 1972, 1978; Liebermann 1979; Keim *et al.* 2001; Kustatscher *et al.* 2011; Haussmann & Nützel 2015; Crasquin *et al.* 2018), Jordan (Basha 1982), Slovenia (Kolar-Jurkovšek 1990, 1991), South China (Ye *et al.* 1977; Forel *et al.* 2019b) and Turkey (Forel *et al.* 2018, 2019a). Some of these recent works document the survival of Palaeozoic lineages (Palaeocopida, Beecherellidae, Rectonariidae) in deep-waters (Forel *et al.* 2019a). In parallel, Mesozoic features are also firstly recorded during the Carnian with the earliest occurrence of some typical Jurassic taxa (Schulerideidae) on the easternmost margin of the Tethys (Forel *et al.* 2019b) and the oldest evidence of drilling predation on ostracods (Forel *et al.* 2018). Although several ostracod assemblages witness the degradation of environmental conditions related to the Carnian Humid Episode (e.g., Keim *et al.* 2001), the influence of the Carnian Pluvial event on marine ostracods is still poorly studied. Furthermore, global- and sub- global-scale Carnian shallow-marine palaeobiogeography is relatively poorly understood, mainly because of the paucity of in-depth modern syntheses.

Ostracods have already been reported and illustrated from the Triassic succession of Slovenia but we provide here the first in-depth taxonomic analysis of Slovenian assemblages during the Carnian. Abundant ostracods are described from five pro-

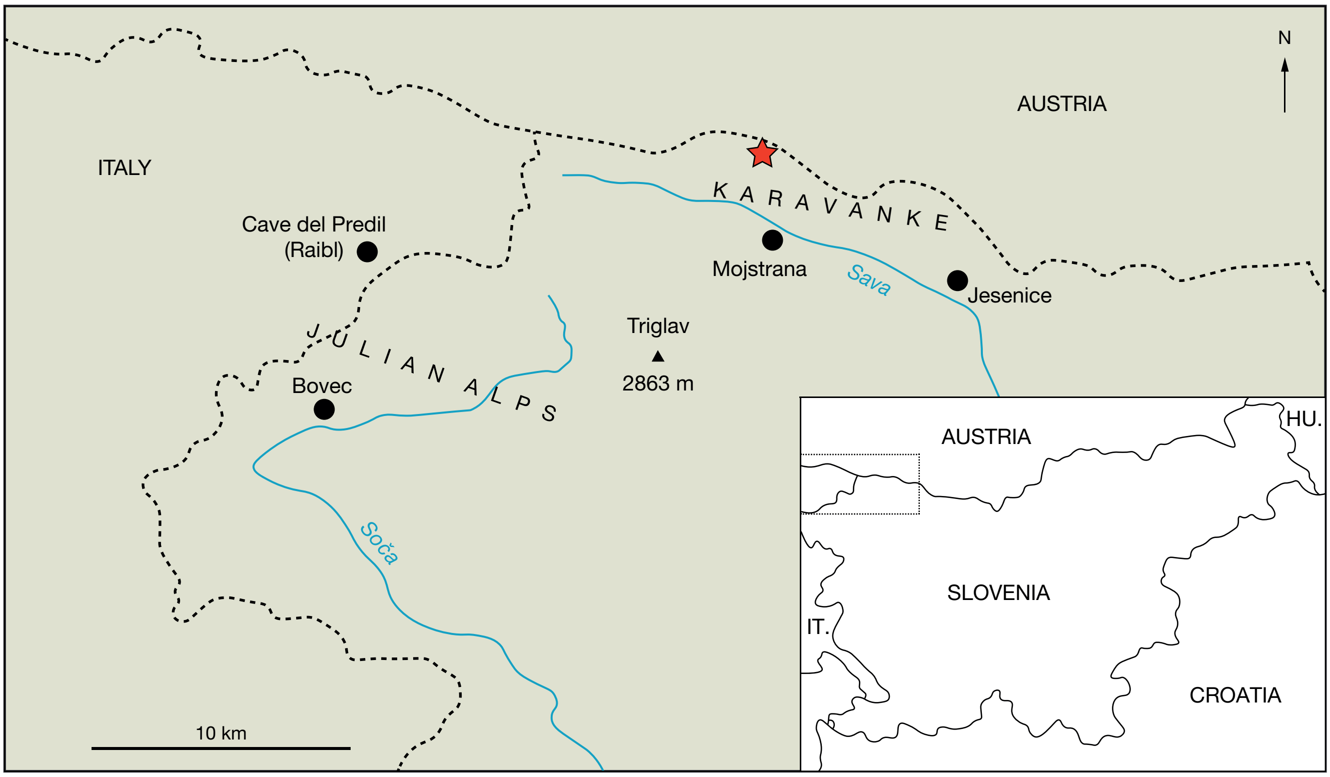


FIG. 1. — Geographical map of the studied area in the southern Karavanke Mountains, northwestern Slovenia. The star shows the position of the Belca section.

ductive samples spanning the Belca section in northwestern Slovenia, which exposes an 85-m thick succession of Carnian age (Kolar-Jurkovšek *et al.* 2005). These assemblages include 39 species (two of which are new: *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp.) distributed into 21 genera. We describe the ontogenetic development of *Issacharella bisulcata, Leviella bogschi, L. veghae, Renngartenella sanctaecrucis*, for which sexual dimorphism hypothesized by Monostori (1994) is confirmed. In order to evaluate the representativeness of species richness in assemblages of different sizes and to discuss their palaeoenvironmental implications, we performed a rarefaction analysis as well as calculation of diversity indices (Shannon-Wiener and Simpson). These ostracod assemblages record a major diversity and environmental shift through the Belca section. The low diversity, high dominance (*Renngartenella sanctaecrucis* and *Issacharella bisulcata*) as well as sedimentary features might indicate high land-derived inputs associated with low salinity levels in the lower part of the Beca section. The upper portion of the section sees the increase of diversity, reduction of dominance, associated with the increase of the abundance and diversity of stable open marine taxa.

GEOLOGICAL SETTING AND STUDIED SECTION

Thick Carnian successions are exposed on the southern flank of the Karavanke Mountains in northern Slovenia (Fig. 1). In this area, the 'Raibl Beds' are considered as part of the Košuta Nappe (Budkovič 1983, 1999; Buser 1980; Jurkovšek 1987; Ogorelec *et al.* 1999) or of the Hahnkogel Unit (Krystyn *et al.* 1994; Lein *et al.* 1995), which should be a part of the Košuta Nappe (Fig. 2). The Carnian layers are exposed in the upper part of the Belca valley in the north of Mojstrana close to the Slovenian-Austrian state boundary (Fig. 1).

The Belca section is an 85 m-thick succession of Carnian age which was sampled by the last two authors of this work in 1994 for conodont investigation is positioned in the upper part of the 'Raibl Beds' (the coordinates of the section are 46°30'42"N, 13°55'29"E). In the Belca valley, the studied 'Raibl Beds' develop above the Schlern Dolomite, and are overlain by the dolomite and limestone of the Dachstein Formation in unclear tecotnic contact. The 'Raibl Beds' principally consist of platy limestone with lenses and cherty nodules. Frequent layers and sheets of marly limestone and marl as well as breccia beds occur between the limestone beds. At the Belca section, an alternation of dark gray limestone and marly limestone with marlstone intercalations occur; thicker marl beds are rare. The limestone is platy to medium bedded and generally has an internally laminated biomicrite texture or is rarely calcarenitic or brecciated. Breccia beds occur and are 30 to 40 cm in thickness (Fig. 3).

The most frequent macrofossils are thin valves of the bivalve *Posidonia*, which occur both in marlstone and limestone layers. The valves are generally articulated with the convex side oriented downward, indicative of a relatively quiet sedimentary environment. Plant fossils, dominated by *Voltzia* (Dobruskina *et al.* 2001), and fish remains only occur in the more marl beds of the lower part of the section. Conodont elements of

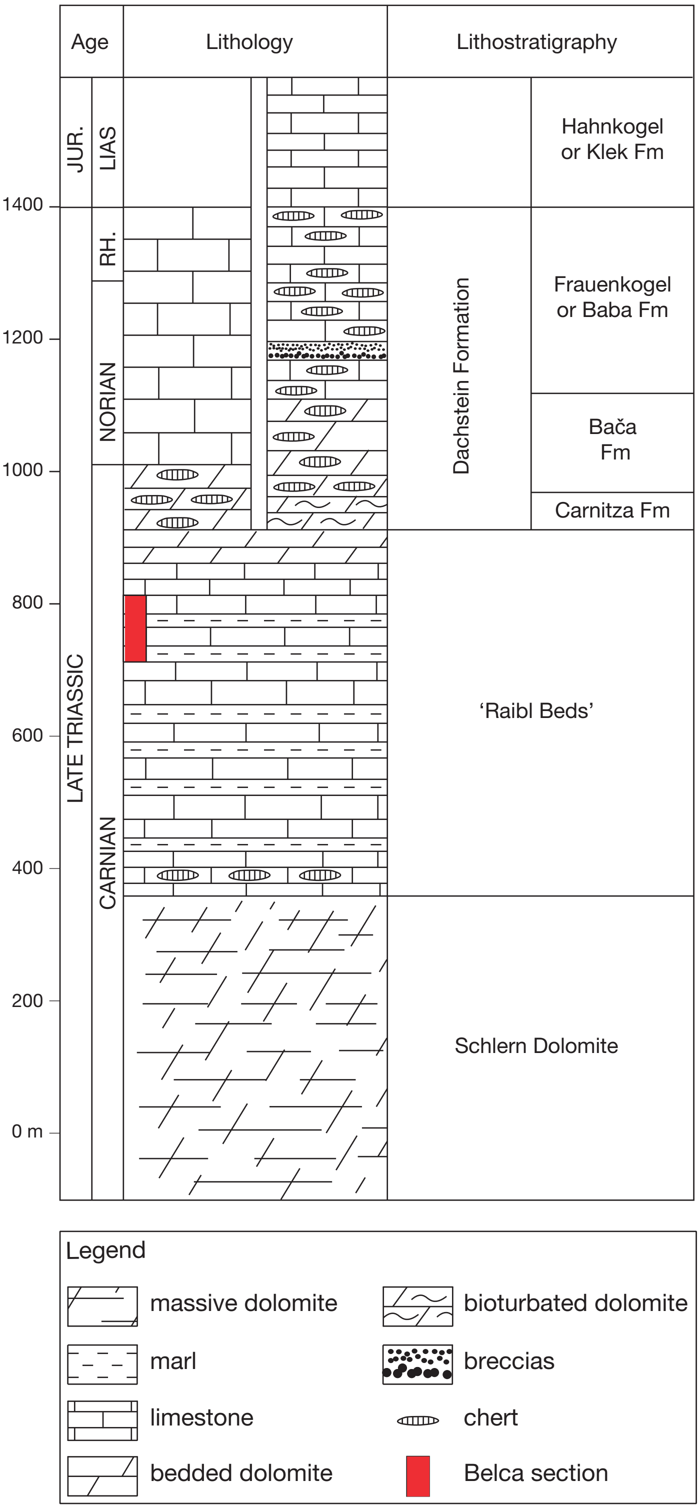


FIG. 2. — Schematic lithostratigraphic column of the Triassic formations in the Košuta Nappe and in Hahnkogel Unit (modified from Kolar-Jurkovšek *et al.* 2005).

Nicoraella?, sponge spicules, holothurians were also found in the lower part of the section. A few samples from the upper part of the section yielded isolated whorls and segments of thalli of the alga *Clypeina besici* Pantić (Kolar-Jurkovšek & Jurkovšek 2003a, b). The ammonites *Trachyceras aonoides* and *Austrotrachyceras austriacum* have been recovered from the base of the succession (Jurkovšek 1987). The 'Raibl Beds' carbonates that are well exposed in the Belca section contain involutinid, ammodiscid and endothyrid foraminifera.

The conodont *Nicoraella*? *budaensis* Kozur & Mock, 1989 confirms the Carnian age of the Belca succession (Kolar-Jurkovšek *et al.* 2005). In the Slovenian sections this species

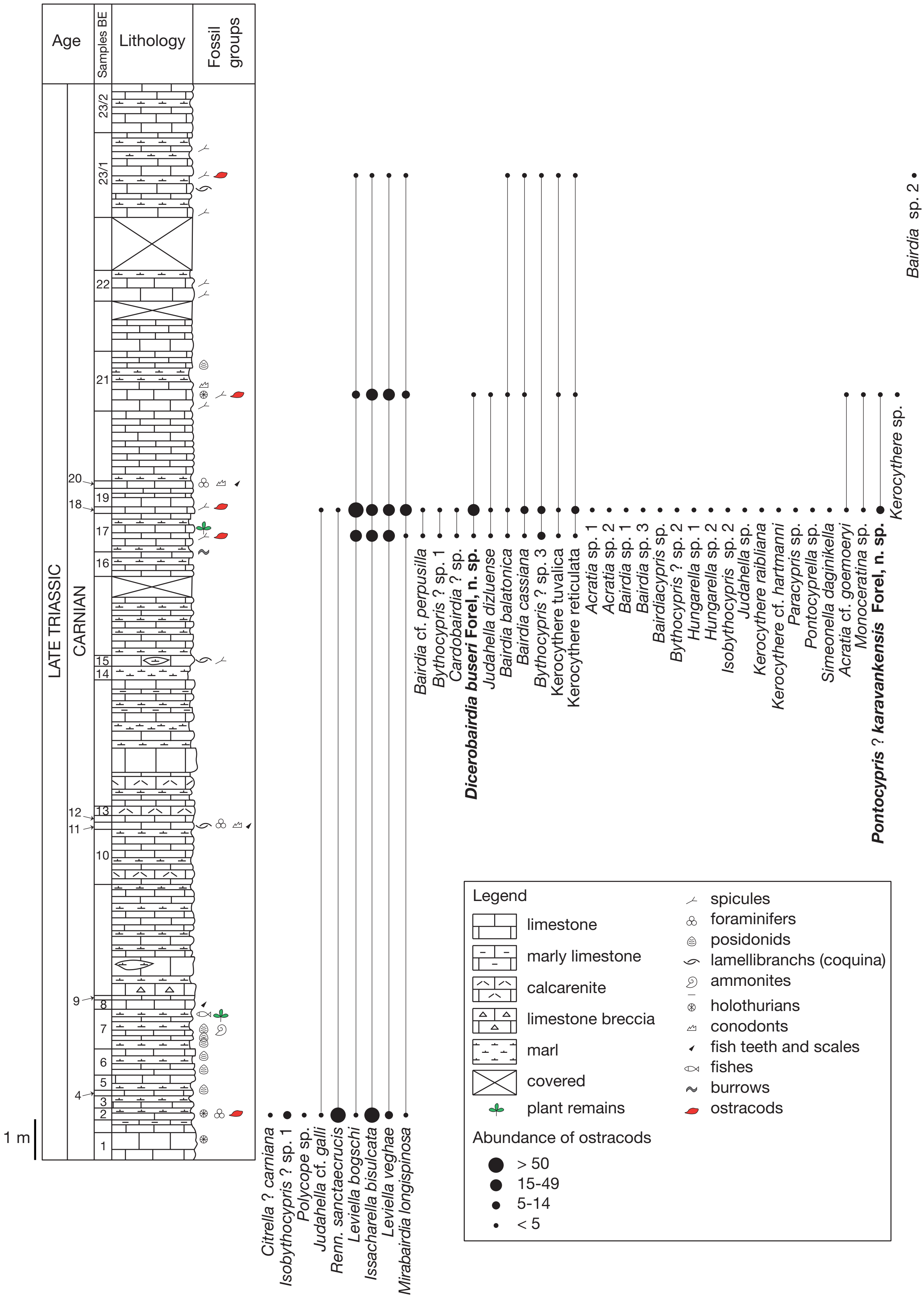


FIG. 3. — Distribution of ostracod species through the Belca section, Karavanke Mountains, northwestern Slovenia.

occurs as monofauna and indicates the stressful conditions of the Carnian Pluvial Event (Kolar-Jurkovšek & Jurkovšek 2010). The geographic distribution of *Nicoraella*? *budaensis* is limited to Central Europe where it is an important regional marker designating the late Julian-?earliest Tuvalian *Nicoraella*? *budaensis* conodont Range Zone (Rigo *et al.* 2018; Kolar-Jurkovšek & Jurkovšek 2019).This Carnian attribution is further confirmed by the dasyclad alga *Clypeina besici* Pantić (Kolar-Jurkovšek & Jurkovšek 2003a, b). The occurrence of the benthic foraminifera *Aulotortus sinuosus*, *A. tumidus*, *Prorakusia salaji*, *Pilamminella kuthani* and *Endothyra kuepperi* correspond to the Carnian *Pilamminella kuthani* foraminifer Interval-Zone (Salaj *et al.* 1988; Kolar-Jurkovšek *et al.* 2005).

MATERIAL AND METHODS

Thirty-eight samples spanning the 85m succession exposed at Belca section were collected in 1994 for conodont investigation (Fig. 3). The samples have been processed by cold acetolysis and five yielded identifiable silicified ostracods: BE2, BE17, BE18, BE21 and BE23/1 (Fig. 3). Thirty-nine species belonging to 21 genera are identified and figured (Figs 4, 6-8, 11). Two species are newly described here: *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp.

The growth of ostracods occurs by moulting and ontogenetic stages are labelled A (adult), A-1, A-2, A-3, etc., in order of decreasing size. The ontogeny of podocopid ostracods generally consists of eight juvenile stages and one adult stage (e.g., Horne *et al.* 2002). When plotted, the length and height of the instars gather into separate successive data-point clusters, with gaps separating each cluster from one another. To reconstruct the ontogeny of species in Belca, height/length diagrams have been drawn, where right and left valves of detached and complete carapaces are distinguished; right and left valves of carapaces serve as anchor points for the delimitation of ontogenetic stages (Figs 5, 9, 10, 12, 13). For each species, this method accounts for the difference of size between the valves and its possible variations through the ontogeny. It furthermore permits to constrain the large dispersal of the height/length scatter plots when specimens are plotted without distinction of their nature (left valve, right valve or carapace). When possible, the ontogenetic stages are distinguished and labelled. For several species, specimens are abundant in Belca and probably reflect different successive populations. For this reason, some portions of the ontogenetic development of *Renngartenella sanctaecrucis* and *Issacharella bisulcata* are only described and discussed but are not divided into stages.

SYSTEMATIC PALAEONTOLOGY (by MBF)

In the present contribution, we follow the general classification of Moore (1961) and Horne *et al.* (2002). The taxonomy of the Cytheroidea is based on the amendations of Whatley & Boomer (2000). Species left in open nomenclature, except for peculiar ones, are omitted. All species are illustrated to allow future comparison and understanding of these unique assemblages (Figs 4, 6-8, 11). For morphological descriptions, we follow Maddocks (2015): the degree of slope of the anterodorsal and posterodorsal borders are measured on external lateral views of the carapaces or valves, with 0 being horizontal. The length convention is as follows: < 0.40 very small, 0.40-0.50 small, 0.50-0.70 medium, 0.70-1.00 large, > 1.00 very large.

All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number.

Class OSTRACODA Latreille, 1802
Order PODOCOPIDA Sars, 1866
Suborder PODOCOPINA Sars, 1866
Superfamily BAIRDIOIDEA Sars, 1887
Family BAIRDIIDAE Sars, 1887

Genus *Bairdia* McCoy, 1844

TYPE SPECIES. — *Bairdia curta* McCoy, 1844 subsequently designated by Ulrich & Bassler (1923).

Bairdia balatonica Méhes, 1911
(Fig. 4E)

Bairdia balatonica Méhes, 1911: 13, 14, pl. 1, fig. 8-11. — *non* Széles 1965: 414, fig. 4. — Monostori 1995: 42, pl. 2, fig. 1 only. — ? Monostori 1995: 42, pl. 2, figs 2, 3. — Forel & Crasquin 2011: 252, fig. 5A. — Monostori & Tóth 2013: 309, pl. 2, figs 1-4 only. — ? Monostori & Tóth 2013: 309, pl. 2, fig. 5. — Crasquin *et al.* 2018: 134, 135, fig. 6P.

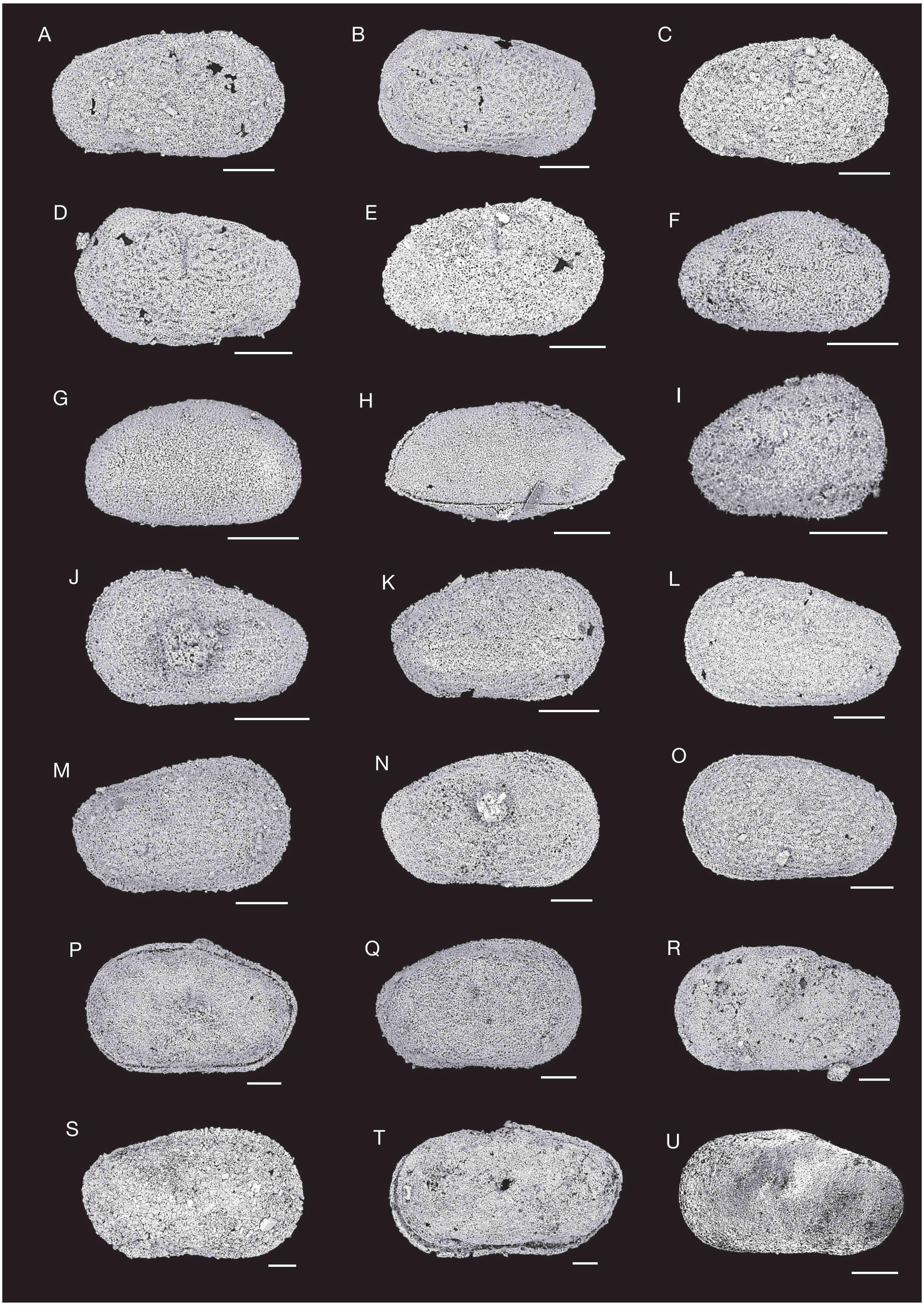
Bairdia cf. *balatonica* – Méhes *in* Kristan-Tollmann 1978: 81, pl. 1, figs 1-3.

Bairdia dadayi Méhes, 1911: 17, 18, pl. 1, figs 29, 30. — Széles 1965: 412, 413, fig. 1.

EXAMINED MATERIAL. — One left valve and several fragments.

OCCURRENCE. — Spathian-Anisian, Early-Middle Triassic, South Tibet (Forel & Crasquin 2011); Anisian (Monostori 1995), La-

FIG. 4. — Ostracods from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number: **A**, **B**, *Acratia* cf. *goemeryi* Kozur, 1970 emend. Forel *et al.* (2019a); **A**, lateral view of a right valve, BE21 (GeoZS6132); **B**, lateral view of a left valve, BE18 (GeoZS6133); **C**, *Acratia* sp. 1, lateral view of a broken left valve, BE18 (GeoZS6134); **D**, *Acratia* sp. 2, lateral view of a left valve, BE18 (GeoZS6135); **E**, *Bairdia balatonica* Méhes, 1911, lateral view of a left valve, BE17 (GeoZS6136); **F-H**, *Bairdia cassiana* (Reuss, 1869); **F**, lateral view of a right valve, BE18 (GeoZS6137); **G**, lateral view of a right valve, BE18 (GeoZS6138); **H**, right lateral view of a complete carapace, BE23/1 (GeoZS6139); **I**, *Bairdia* cf. *perpusilla sensu* Forel *et al.* (2019a), lateral view of a left valve, BE17 (GeoZS6140); **J**, *Bairdia* sp. 1, right lateral view of a complete carapace, BE18 (GeoZS6141); **K**, *Bairdia* sp. 2, lateral view of a right valve, BE23/1 (GeoZS6142); **L**, **M**, *Bairdia* sp. 3; **L**, lateral view of a left valve, BE18 (GeoZS6143); **M**, lateral view of a left valve, BE18 (GeoZS6144); **N**, *Bairdiacypris* sp. 1, lateral



view of a right valve, BE18 (GeoZS6145); **O**-**U**, *Dicerobairdia buseri* Forel, n. sp.; **O**, Holotype, lateral view of a left valve, BE18 (GeoZS6146); **P**, right lateral view of a complete carapace, BE21 (GeoZS6147); **Q**, lateral view of a left valve, BE17 (GeoZS6148); **R**, lateral view of a left valve, BE18 (GeoZS6149); **S**, Paratype, lateral view of a right valve, BE18 (GeoZS6150); **T**, lateral view of a right valve, BE18 (GeoZS6151); **U**, lateral view of a left valve, BE18 (GeoZS6152). Scale bars: 100 µm.

dinian (Monostori & Tóth 2013) and early Carnian (Méhes 1911; Széles 1965), Middle-Late Triassic, Balatón Highland, Hungary; early Carnian, Late Triassic, Southern Alps, Italy (Kristan-Tollmann 1978); *Tropites dilleri* zone, late Carnian, Late Triassic, Sicily, Italy (Crasquin *et al.* 2018); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Dimensions. — Fig. 5A.

Discussion

This species occurs in samples BE17, 18, 21 and 23/1 of the Belca section but it is not abundant (Fig. 3). *Bairdia balatonica* Méhes, 1911 was described from the early Carnian, Late Triassic, of Hungary (Méhes 1911). Since then, it has been more largely documented and appears as typical of the Spathian-Carnian time interval, spreading from South Tibet (Forel & Crasquin 2011) to Hungary (e.g., Monostori 1995; Monostori & Tóth 2013). *Bairdia balatonica* identified from the early Carnian, Late Triassic, of Hungary by Széles (1965) is excluded because the drawn specimen is very asymmetric laterally and the right valve is uniformly rounded without the anterodorsal and posterodorsal angulations shown on the type material of Méhes (1911). Of the three specimens attributed to *B. balatonica* Méhes, 1911 in Monostori (1995) from the Anisian, Middle Triassic, of Hungary, two have a triangular dorsal overlap (Monostori 1995: pl. 2, figs 2, 3) : the attribution to *B. balatonica* is therefore questioned. One of the five specimens from the Ladinian, Middle Triassic, of Hungary (Monostori & Tóth 2013) is questioned as belonging to *B. balatonica* for the same reason (Monostori & Tóth 2013: pl. 2, fig. 5). These three specimens from the Middle Triassic of Hungary (Monostori 1995; Monostori & Tóth 2013) might represent an undescribed species characterized by its triangular dorsal overlap of left valve over right one. Lastly, Monostori & Tóth (2013) considered that *B. ventriosa* Bolz, 1971 from the late Norian-Rhaetian, Late Triassic, of the Northern Calcareous Alps (Bolz 1971) fit into the variations of the lateral outline of *B. balatonica*. However, the surface of *B. ventriosa* is evenly pitted so that we do not consider this synonymy as relevant.

The dimensions of all Carnian specimens available in the literature that are considered as truly belonging to *B. balatonica* have been plotted in Fig. 5A. The Carnian specimens gather into four scatter plots, which might correspond to the ontogenetic stages A-3 to Adult. However, each of the identified group correspond to one specimen from one locality: for this reason and until more material is made available, we choose not to attribute precise ontogenetic stages to these groups. For the Carnian stage, the largest specimens are reported from Italy (Kristan-Tollmann 1978). The development of *B. balatonica* is marked by the elongation of the valves, from plump and short posteriorly for the smaller specimen shown in Crasquin *et al.* (2018), to more elongate with dorsal angulations, slightly caudate posterior border and more pronounced posterodorsal concavity in the largest materiel illustrated by Kristan-Tollmann (1978).

Bairdia cassiana (Reuss, 1869)
(Fig. 4F-H)

Cythere cassiana Reuss, 1869: 108.

Bairdia cassiana – Gümbel 1869: 180, pl. 5, figs 18, 19. — Styk 1958: 171, fig. 3/1. — Urlichs 1970: 705, 706, pl. 1, figs 1, 2. — Kristan-Tollmann 1978: 81, pl. 1, fig. 4; pl. 6, fig. 6. — Kristan-Tollmann *et al.* 1991b: 200, pl. 1, fig. 5. — Monostori & Tóth 2013: 310, pl. 2, figs 7, 8, 10; 2014: 26, pl. 1, fig. 14. — Mette *et al.* 2014: pl. 2, fig. 1. — Crasquin *et al.* 2018: 134, fig. 6M.

Bairdia cassiana rotundidorsata Monostori, 1995: 42, pl. 2, figs 4, 5.

Bairdia (*Rectobairdia*) *garciai* Crasquin-Soleau & Grădinaru, 1996: 77, 78, pl. 2, figs 5, 8.

Examined material. — Four right valves, four left valves and several fragments.

Occurrence. — Early Carnian, Late Triassic, Southern Alps, Italy (Reuss 1869; Gümbel 1869; Urlichs 1970; Kristan-Tollmann 1978); Carnian, Late Triassic, Święty Krzyż Mountain, Poland (Styk 1958); Carnian, Late Triassic, Zsämbek-14 borehole, Transdanubian Range, Hungary (Kristan-Tollmann *et al.* 1991b); Late Anisian, Middle Triassic, Balatón Highland, Hungary (Monostori 1995); Early Anisian, Middle Triassic, North Dobrogea, Romania (Crasquin-Soleau & Grădinaru 1996); Ladinian, Middle Triassic, Balatón Highland, Hungary (Monostori & Tóth 2013, 2014); Middle Anisian, Middle Triassic, Northern Calcareous Alps, Austria (Mette *et al.* 2014); *Tropites dilleri* zone, late Carnian, Late Triassic, Sicily, Italy (Crasquin *et al.* 2018); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Dimensions. — Fig. 5B.

Discussion

Bairdia cassiana (Reuss, 1869) has been found in all samples from BE17 to BE23/1 where it is not abundant, and it is moderately abundant in BE18 (Fig. 3). *Bairdia cassiana* is typical of the Middle and early Late Triassic of Europe, as shown by the synonym list. The height/length scatter plot of all Carnian specimens is shown in Fig. 5B (the dimensions of the specimens cited without mention of their nature, i.e. right valve, left valve or carapace, have been omitted). The largest specimens are from the Ladinian of Hungary (Monostori & Tóth 2013, 2014). The separate measurements of right and left valves of complete carapaces show that the degree of overlap is relatively constant during the ontogeny of this species. The left valve is slightly longer than the right valve in the first instars compared to later stages. The ontogenetic development of *B. cassiana* is also marked by the elongation of the posterior border.

Genus *Dicerobairdia* Kollmann, 1963

Type species. — *Dicerobairdia bicornuta* Kollmann, 1963 by original designation.

Dicerobairdia buseri Forel, n. sp.
(Fig. 4O-U)

urn:lsid:zoobank.org:act:6B59784E-073E-4D76-8C70-B3706E500C8A

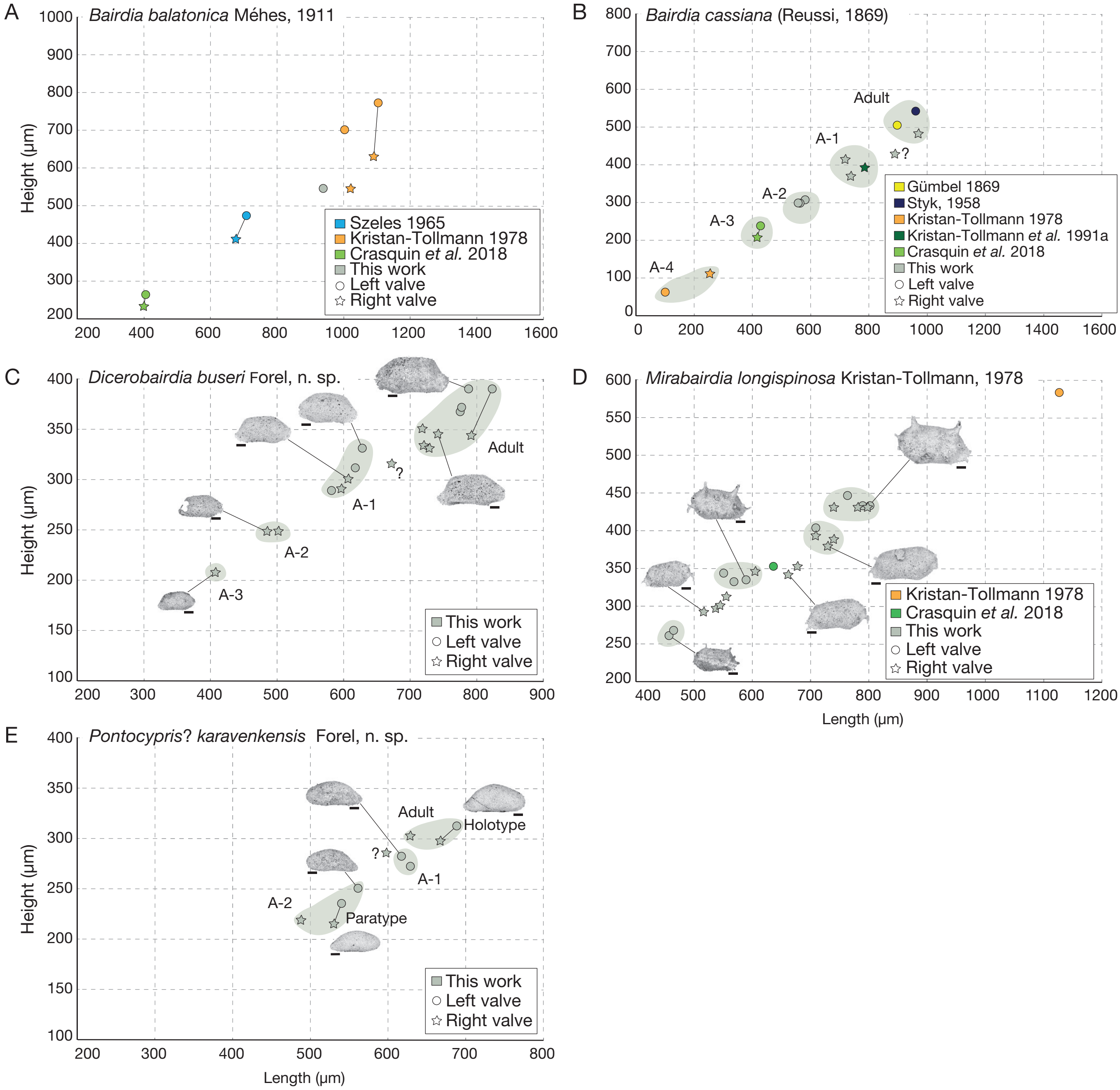


FIG. 5. — Height/Length scatter plots of species recovered from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. In all diagrams, the dimensions of right and left valves of complete carapaces are linked. **A**, *Bairdia balatonica* Méhes, 1911; **B**, *Bairdia cassiana* (Reuss, 1869); **C**, *Dicerobairdia buseri* Forel, n. sp., all specimens are from the Belca section (this work); **D**, *Mirabairdia longispinosa* Kristan-Tollmann, 1978; **E**, *Pontocypris*? *karavankensis* Forel, n. sp. all specimens are from the Belca section (this work). Scale bars: 100 µm.

TYPE MATERIAL. — Holotype: left valve (Fig. 4O), BE18 (GeoZS6146). — Paratype: right valve (Fig. 4S), BE18 (GeoZS6150).

EXAMINED MATERIAL. — One carapace, nine left valves, ten right valves and several fragments.

DERIVATION OF NAME. — In honour of Prof. Dr. Stanko Buser (University of Ljubljana, Slovenia) for his outstanding contribution to the knowledge of the Slovenian geology.

OCCURRENCE. — *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 17, 18, 21 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIAGNOSIS. — A new species with reticulate lateral surface and poorly expressed dorso-lateral ornaments.

DIMENSIONS. — Fig. 5C.

DESCRIPTION

A large and relatively thick-shelled species with subrectangular outline in lateral view; greatest height located at the anterodorsal angulation at both valves, greatest length below mid-height; dorsal margin tripartite at both valves with anterodorsal angulation *c.* 30° and posterodorsal angulation *c.* 55°; anterodorsal border straight and long (from *c.* 28% of maximum of length in adult forms, Fig. 4Q, to *c.* 32% in younger instars, Fig. 4T); dorsal border long and straight to gently convex (from *c.* 49% of maximum of length in adult forms, Fig. 4Q, to *c.* 53% in younger instars, Fig. 4T); posterodorsal border steep and relatively short (*c.* 20% of maximum of length in adult and younger forms), close to straight in the youngest form, with a terminal concavity that accentuates through ontogeny; ventral border long (from *c.* 57% of maximum of length in adults, Fig. 4Q, to *c.* 48% in younger instars, Fig. 4T), with oral concavity located in anterior part; posteroventral border about ⅓$^{\text{rd}}$ of maximum of height, very convex and bordered with marginal denticles visible at well preserved specimens (e.g., Fig. 4Q, R, U); anteroventral border longer than posteroventral border, gently convex and flanged by marginal denticles visible at well preserved specimens; anterior maximum of curvature large and located around to slightly below mid-height; posterior maximum of convexity narrower, located below ⅓$^{\text{rd}}$ of maximum of height; anterodorsal, dorsal, posterodorsal and posteroventral borders and upper part of anteroventral border laterally compressed; anterior margin bordered by a large and low ridge in lower ⅔$^{\text{rd}}$, which then runs perpendicular to it and parallel to ventral margin, ending at the laterally compressed posteroventral area; two small elongate and reduced horns are built parallel to anterodorsal and posterodorsal borders at both valves; lateral surface evenly reticulate, with preferential longitudinal organisation of the reticulation visible at some specimens.

DISCUSSION

Dicerobairdia buseri Forel, n. sp. occurs from samples BE17 to BE21 in the Belca section, and it is relatively abundant in BE18 (Fig. 3). *Dicerobairdia buseri* Forel, n. sp. differs from *D. torulosa* Kristan-Tollmann, 1970 from the late Ladinian, Middle Triassic, of Dolomites, Italy (Kristan-Tollmann 1970) by lacking the small ventrolateral ridges at both valves and by the stronger development of the sub-anterodorsal and sub-posterodorsal horns at adult stage. The new species also differs from *D. acornuta* Kristan-Tollmann, 1978 from the early Carnian, Late Triassic, of Dolomites, Italy (Kristan-Tollmann 1978) by its subdorsal ornamentation at the right valve, which consists of sub-anterodorsal and sub-posterodorsal reduced horns rather than a continuous subdorsal ridge. At the left valve, the dorsal ornamentation of *D. buseri* Forel, n. sp. differs in being sub-anterodorsal and sub-posterodorsal elongate horns rather than a continuous ridge as in *D. acornuta*. *Dicerobairdia buseri* Forel, n. sp. also shows secondary reticulation all over the lateral surface whereas *D. acornuta* is micromammillate.

The specimens of *Dicerobairdia buseri* Forel, n. sp. from Belca section are distributed into at least four ontogenetic stages, from A-3 to Adult in ascending order (Fig. 5C). Noteworthy, left valves only occur in A-1 and Adult stages, while A-3 and A-2 stages are only known by right valves. The ontogenetic development of *D. buseri* Forel, n. sp. is marked by an overall increase in the length of the ventral border. The development from A-3 to A-1 is dominated by the increase of the dimensions. The transition from A-1 to Adult records the enhancement of the ventral ridge and the terminal concavity at posterodorsal border.

Genus *Mirabairdia* Kollmann, 1963

TYPE SPECIES. — *Mirabairdia pernodosa* Kollmann, 1963 by original designation.

Mirabairdia longispinosa Kristan-Tollmann, 1978
(Fig. 6E-H)

Mirabairdia longispinosa Kristan-Tollmann, 1978: 94-96, pl. 3, figs 1-3; pl. 7, fig. 5. — Forel *et al.* 2018: 10, figs 4-20, 4-21.

EXAMINED MATERIAL. — Eleven left valves, 18 right valves and several fragments.

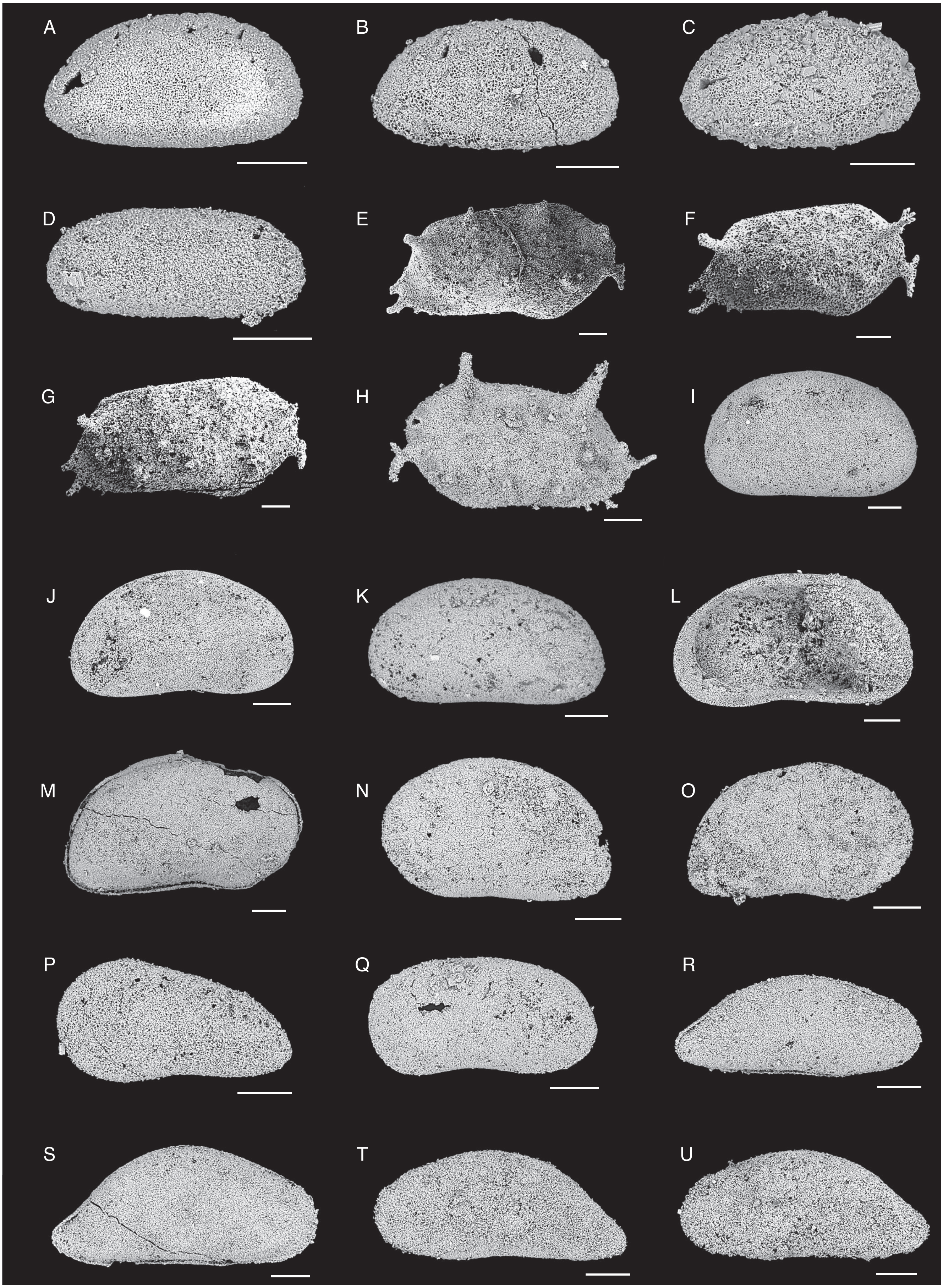
OCCURRENCE. — Cordovelian, early Carnian, Late Triassic, Ruones-Wiesen, Pralongia, Dolomites, Italy (Kristan-Tollmann 1978); *Spongotortilispinus moixi* radiolarian Zone, early Tuvalian, late Carnian, Late Triassic, Tavusçayiri Block, Sorgun Ophiolitic Mélange, southern Turkey, Huğlu Tuffite (Forel *et al.* 2018); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIMENSIONS. — Fig. 5D.

DISCUSSION

Mirabairdia longispinosa Kristan-Tollmann, 1978 has been found in all samples of the Belca section where is not abundant except in sample BE18 (Fig. 3). In the current state of our knowledge, this species is restricted to the Carnian of the western tethyan realm. The present record is the third known occurrence of *M. longispinosa* worldwide: it was described from the Cordovelian, early Carnian, Late Triassic, of Italy (Kristan-Tollmann 1978), and was more recently documented from the Tuvalian, late Carnian, Late Triassic, of Turkey (Forel *et al.* 2018). The present assemblage is unique in providing numerous specimens, making it possible to discuss the ontogenetic development of this species

FIG. 6. — Ostracods from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number: **A-C**, *Isobythocypris*? sp. 1; **A**, lateral view of a right valve, BE2 (GeoZS6153); **B**, lateral view of a right valve, BE2 (GeoZS6154); **C**, lateral view of a right valve, BE2 (GeoZS6155); **D**, *Isobythocypris* sp. 2, lateral view of a right valve, BE18 (GeoZS6156); **E-H**, *Mirabairdia longispinosa* Kristan-Tollmann, 1978; **E**, lateral view of a right valve, BE21 (GeoZS6157); **F**, lateral view of a right valve, BE18 (GeoZS6158); **G**, lateral view of a right valve, BE18 (GeoZS6159); **H**, lateral view of a left valve, BE17 (GeoZS6160); **I**, *Bythocypris*? sp. 1, lateral view of a right valve, BE18 (GeoZS6161); **J-L**, *Bythocypris*? sp. 2; **J**, lateral view of a right valve, BE18 (GeoZS6162); **K**, lateral view of a left valve, BE18 (GeoZS6163); **L**, internal view of a right valve, BE18 (GeoZS6164); **M-O**, *Bythocypris*? sp. 3; **M**, right lateral view of a complete carapace, BE17 (GeoZS6165); **N**, lateral view of a left valve, BE18 (GeoZS6166); **O**, lateral view of a right valve, BE18 (GeoZS6167); **P**, *Paracypris* sp., lateral view of a left valve, BE18 (GeoZS6168); **Q**, *Pontocyprella* sp., lateral view of a left valve, BE18 (GeoZS6169); **R-U**, *Pontocypris*? *karavankensis* Forel, n. sp.; **R**, Paratype, right lateral view of a complete carapace, BE18 (GeoZS6170); **S**, Holotype, right lateral view of a complete carapace, BE18 (GeoZS6171); **T**, lateral view of a left valve, BE18 (GeoZS6172); **U**, lateral view of a left valve, BE18 (GeoZS6173). Scale bars: 100 µm.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U

(Fig. 5D). It first appears that the holotype of *M. longispinosa* (left valve; Kristan-Tollmann 1978) is larger than all other known specimens. Therefore, if the holotype is assumed adult, then all specimens recovered from the Carnian layers of Belca and Turkey should be juveniles. However, until inner structures are available for this species, this hypothesis is difficult to confirm. Because of the important size gap between the holotype and the largest specimens in Belca, which is 800 µm in length, we decide not to attribute the successive scatter-points observable in Fig. 5D to any given ontogenetic stage. We rather discuss the successive ontogenetic groups relatively to the surrounding ones, without assuming precisely the stage they might correspond to. The right and left valves obtained in Belca gather into four successive scatter plots (Fig. 5D). The ontogeny of *M. longispinosa* is marked by the strengthening of the lateral sculpture of the valves, with short and frail spines in the smallest left valve developing into robust and thick spines in the largest left valve (Fig. 5D). As a rule, the left valves are more rounded and plump than the more elongate right valves: this pattern is observed quite early in the development of the species, although the smallest specimens are here only represented by left valves.

Superfamily CYPRIDOIDEA Baird, 1845
Family PONTOCYPRIDIDAE Müller, 1894

Genus *Pontocypris* Sars, 1866

TYPE SPECIES. — *Cythere* (*Bairdia*) *mytiloides* Norman, 1862 subsequently designated by Brady & Norman (1889).

Pontocypris*? *karavankensis Forel, n. sp.
(Figs 6R-U; 7A)

urn:lsid:zoobank.org:act:A5970888-0E6E-439B-84A0-40555CF417F0

TYPE MATERIAL. — Holotype: complete carapace (Fig. 6S), BE18 (GeoZS6171). — Paratype: complete carapace (Fig. 6R), BE18 (GeoZS6170).

EXAMINED MATERIAL. — Three right valves, three left valves and two complete carapaces.

DERIVATION OF NAME. — The specific epithet refers to the Karavanke Mountains in Slovenia, where is located the Belca section, type locality of the species.

OCCURRENCE. — *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE18, 21 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIAGNOSIS. — A species with moderately elongate lateral outline, posterodorsal terminal concavity and concavity at the lower part of anteroventral border.

DIMENSIONS. — Fig. 5E.

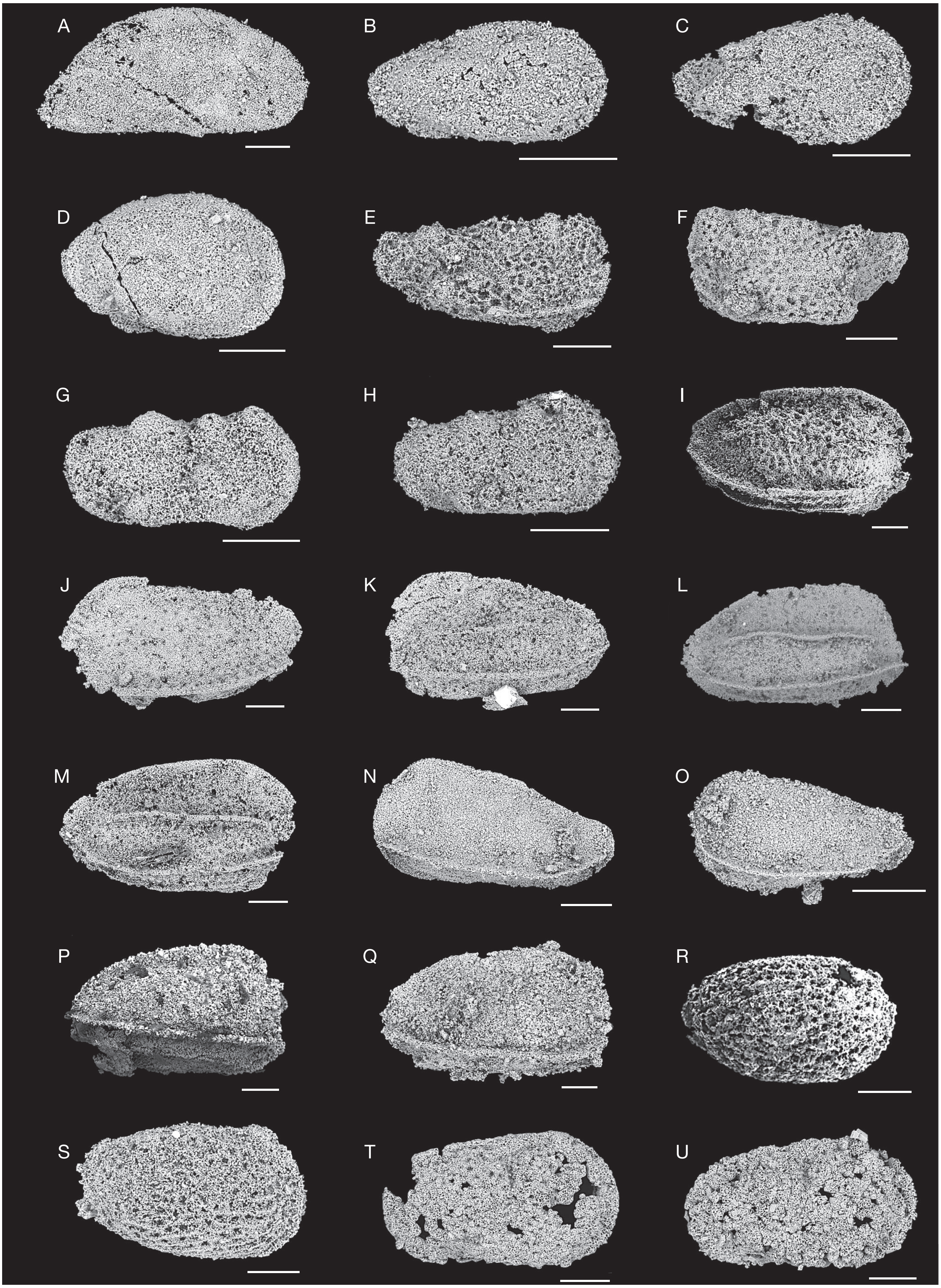
DESCRIPTION

A thin-shelled species of medium size, subtriangular and moderately elongate in lateral view with greatest height at mid-length and greatest length in the lower ⅓rd of height; left valve larger than right valve, overlapping it all around with maximum at dorsal margin and ventral border; dorsal margin uniformly convex at both valves, without visible angulations, anterior slope straight and gentle (*c.* 20°), posterior slope steeper (*c.* 40°) with terminal concavity; anterior border largely rounded with maximum of curvature slightly below mid-length; posterior border tapered, narrow, pointed upward, with maximum of convexity in the lower ¼th of height; ventral margin long, nearly straight at left valve, with tenuous median oral concavity; anteroventral border rounded with gentle concavity at the lower part, steeply raised upward; posteroventral border short and gently convex; surface smooth.

DISCUSSION

Pontocypris? *karavankensis* Forel, n. sp. is restricted to the samples BE18 and 21 of the Belca section, with few specimens (Fig. 3). We attribute this species with doubt to the genus *Pontocypris* Sars, 1866 because the material precludes the description of internal features. *Pontocypris*? *karavankensis* Forel, n. sp. is close to several species from the Triassic period, which have been attributed to different genera. It is first close to *Bairdia finalyi* Méhes, 1911 from the Smithian-Ladinian interval of the Balatón Highland, Hungary (Méhes 1911) but differs in being less elongate, with posterior border located more ventrally and anterior border less bairdiid. It is also close to *Fabalicypris* sp. 1 from the Rhaetian, Late Triassic, of Austria (only illustrated by a left valve; Mette & Mohtat-Aghai 1999), which differs by its more elongate and less pointed posterior extremity and more rounded anterior border. The *Fabalicypris* generic attribution is rejected for the Belca material as the typical abrupt anteroventral offset of the overlap of this genus is not observed. *Pontocypris*? *karavankensis* Forel, n. sp. is finally close to *P. richardsoni* Anderson, 1964 from the Rhaetian, Late Triassic, of UK (Anderson 1964), from which it differs by its

FIG. 7. — Ostracods from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number: **A**, *Pontocypris*? *karavankensis* Forel, n. sp., lateral view of a right valve, BE18 (GeoZS6174); **B**, **C**, *Monoceratina* sp.; **B**, lateral view of a right valve, BE21 (GeoZS6175); **C**, lateral view of a right valve, BE18 (GeoZS6176); **D**, *Citrella*? *carniana* Forel *in* Forel *et al.* 2019, lateral view of a right valve, BE2 (GeoZS6177); **E**, **F**, *Judahella dizluense* Kristan-Tollmann, 1980; **E**, lateral view of a right valve, BE18 (GeoZS6178); **F**, lateral view of a left valve, BE21 (GeoZS6179); **G**, *Judahella* cf. *galli* Kozur & Bolz *in* Bunza & Kozur, 1971, lateral view of a right valve, BE18 (GeoZS6180); **H**, *Judahella* sp., lateral view of a right valve, BE18 (GeoZS6181); **I**, *Kerocythere* cf. *hartmanni* Bolz & Kozur *in* Bunza & Kozur, 1971, lateral view of a right valve, BE18 (GeoZS6182); **J**, *Kerocythere raibliana* (Gümbel, 1869), lateral view of a left valve, BE18 (GeoZS6183); **K-M**, *Kerocythere reticulata* Kristan-Tollmann, 1972; **K**, lateral view of a left valve, BE18 (GeoZS6184); **L**, lateral view of a right valve, BE18 (GeoZS6185); **M**, lateral view of a right valve, BE18 (GeoZS6186); **N**, **O**, *Kerocythere tuvalica* Kozur, 1971; **N**, lateral view of a left valve, BE17 (GeoZS6187); **O**, lateral view of a left valve, BE21 (GeoZS6188); **P**, **Q**, *Kerocythere* sp. 1; **P**, lateral view of a right valve, BE21 (GeoZS6189); **Q**, lateral view of a right valve, BE21 (GeoZS6190); **R**, **S**, *Simeonella daginikella* Forel *in* Forel *et al.* 2019; **R**, lateral view of a right valve, BE18 (GeoZS6191); **S**, lateral view of a right valve, BE18 (GeoZS6192); **T**, **U**, *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973; **T**, lateral view of a right valve, A-1, BE2 (GeoZS6193); **U**, lateral view of a right valve, A-1, BE2 (GeoZS6194). Scale bars: 100 µm.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U

more tapered and less elongate posterior end, terminal posterodorsal concavity and posterior border slightly pointed upward. The size dispersal shown in Fig. 5E indicates the presence of several ontogenetic stages. Owing to the size difference of the right and left valves of *P.*? *karavankensis* Forel, n. sp., at least three ontogenetic stages are recognized, A-2 to Adult. The ontogenetic development of this species is mainly characterized by the strengthening of the lateral asymmetry of the valves, the increase of the maximum of height, enlargement of anterior margin and posterior border becoming pointed upward.

Superfamily CYTHEROIDEA Baird, 1850
Family CYTHERURIDAE Müller, 1894

Genus *Citrella* Oertli, 1959

TYPE SPECIES. — *Citrella nitida* Oertli, 1959 by original designation.

Citrella*? *carniana Forel *in* Forel Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019
(Fig. 7D)

Citrella? *carniana* Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019a: 39, figs 20K-O.

Cytheropteron? cf. *triassica* – Kozur *in* Kristan-Tollmann *et al.* 1991a: 201, pl. 4, fig. 4.

EXAMINED MATERIAL. — One right valve.

OCCURRENCE. — Middle Carnian, Late Triassic, Transdanubian Midmountains, Western Hungary (Kristan-Tollmann *et al.* 1991a); *Tetraporobrachia haeckeli* radiolarian Zone, Julian, Carnian, Late Triassic, Mersin Mélange, southern Turkey, Huğlu Tuffite (Forel *et al.* 2019a); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, sample BE2 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIMENSIONS. — L = 345 µm, H = 223 µm (BE2 [GeoZS6177]).

DISCUSSION

Citrella? *carniana* has only been found in sample BE2 of Belca section, where it is rare (Fig. 3). This species is until now only known from the Carnian stage. The specimens from the type locality in Turkey range from 250 to 400 µm in length and from 169 to 238 µm in height (Forel *et al.* 2019a). The specimen obtained from the Belca section might therefore not be an adult but rather a late juvenile.

Genus *Judahella* Sohn, 1968
emend. Whatley & Boomer (2000)

TYPE SPECIES. — *Judahella tsorfatia* Sohn, 1968, by original designation.

DISCUSSION

We follow the revision of Whatley & Boomer (2000) in considering *Mostlerella* Kozur *in* Bunza & Kozur, 1971 as a junior synonym of *Judahella* Sohn, 1968 and in considering subgenera of *Judahella* as not valid.

Judahella dizluense Kristan-Tollmann *in* Kristan-Tollmann, Tollmann & Hamedani, 1980
(Fig. 7E, F)

Judahella (*Judahella*) *dizluense* Kristan-Tollmann *in* Kristan-Tollmann, Tollmann & Hamedani, 1980: 190, pl. 9, fig. 16. — Forel *et al.* 2019a: 35, fig. 18I.

Mostlerella dizluense – Kristan-Tollmann *in* Mette & Mohtat-Aghai 1999: 55, 56, pl. 6, figs 11, 12.

EXAMINED MATERIAL. — Four right valves, two left valves.

OCCURRENCE. — Rhaetian, Late Triassic, Bagerabad, Iran (Kristan-Tollmann *et al.* 1980); Rhaetian, Late Triassic, Tyrol, Austria (Mette & Mohtat-Aghai 1999); *Tetraporobrachia haeckeli* radiolarian Zone, Julian, Carnian, Late Triassic, Mersin Mélange, southern Turkey, Huğlu Tuffite (Forel *et al.* 2019a); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18, 21 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DISCUSSION

Judahella dizluense occurs in samples BE17 to BE21, in which it is not abundant (Fig. 3). Because of the preservation state of the material in Belca, the specimens were not measured. The present record is the second Carnian occurrence of this species.

Genus *Kerocythere* Kozur & Nicklas, 1970

TYPE SPECIES. — *Kerocythere raibliana* (Gümbel, 1869) subsequently designated by Kozur & Nicklas (1970: 313).

Kerocythere raibliana (Gümbel, 1869)
(Fig. 7J)

Cythere raibliana Gümbel, 1869: 184, pl. 6, figs 36a, b.

Kerocythere raibliana – Urlichs 1972: 685, pl. 2, figs 9-13 only. — Liebermann 1979: 102, pl. 5, fig. 4. — Kolar-Jurkovšek 1990: 84, 85, pl. 14, fig. 5. — Monostori 1994: 319, figs 5/1-3, 6/4.

Kerocythere (*Kerocythere*) *raibliana raibliana* – Kristan-Tollmann 1972: 44, 45, pl. 1, figs 5-7. — Kristan-Tollmann *et al.* 1991b: 203, 204, pl. 2, figs 1-3.

EXAMINED MATERIAL. — Four right valves, two left valves.

OCCURRENCE. — Early Carnian, Late Triassic, Raibl, Southern Alps, Italy (Gümbel 1869); Early Carnian, Late Triassic, Raibl Beds, Raibl, Southern Alps, Italy (Kristan-Tollmann 1972); Norian-Rhaetian, Late Triassic, Kössen Beds, Austria (Urlichs 1972); Carnian, Late Triassic, Italian Alps (Liebermann 1979); Carnian, Late Triassic, Beli potok, Slovenia (Kolar-Jurkovšek 1990); Carnian, Late Triassic,Transdanubian range, Hungary (Kristan-Tollmann *et al.* 1991b); Early Carnian, Late Triassic, Balatón Highland, Hungary (Monostori 1994); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, sample BE18 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Discussion

This rare species has only been found in sample BE18 of the Belca section (Fig. 3). Because of their preservation state, the specimens from Belca were not measured. Of the six specimens illustrated from the Norian-Rhaetian, Late Triassic, of Austria (Urlichs 1972), Kristan-Tollmann *et al.* (1991b: 203, 204) rejected to specimens (Urlichs 1972: pl. 2, figs 11, 12), questioned three others (Urlichs 1972: pl. 2, figs 9, 10, 13) and considered only one specimen (Urlichs 1972: pl. 2, fig. 14) as belonging to *Kerocythere raibliana* (Gümbel, 1869). However, they provided no discussion to support this choice. Here we do not follow this taxonomic choice and rather reject the specimen shown on the plate 2, figure 14 in Urlichs 1972 because it displays an anteromarginal ridge, which is lacking in *K. raibliana* but is present in *K. hartmanni* (Bolz & Kozur *in* Bunza & Kozur, 1971).

Kerocythere reticulata Kristan-Tollmann, 1972
(Fig. 7K, M)

Kerocythere reticulata Kristan-Tollmann, 1972: 46, pl. 2, figs 4, 5.

Examined material. — Five right valves, three left valves.

Occurrence. — Early Carnian, Late Triassic, Cave del Predil, Julian Alps, Italy (Kristan-Tollmann 1972); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Discussion

Kerocythere reticulata Kristan-Tollmann, 1972 has been retrieved from samples BE17 to 23/1 of Belca section, where it is relatively rare (Fig. 3). The present record is the first occurrence of this species outside Italy.

Kerocythere tuvalica Kozur *in* Bunza & Kozur, 1971
(Fig. 7N, O)

Kerocythere tuvalica Kozur *in* Bunza & Kozur, 1971: 51, 52, pl. 4, fig. 15. — Forel *et al.* 2019a: fig. 20C.

Examined material. — Four left valves, several fragments.

Occurrence. — Tuvalian, Carnian, Late Triassic, Veszprem, Bakony, Hungary (Bunza & Kozur 1971); *Tetraporobrachia haeckeli* radiolarian Zone, Julian, Carnian, Late Triassic, Mersin Mélange, southern Turkey, Huğlu Tuffite (Forel *et al.* 2019a); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Discussion

Kerocythere tuvalica Kozur *in* Bunza & Kozur, 1971 is present in samples BE17 to 23/1 of the Belca section, where it is rare (Fig. 3).

Family LIMNOCYTHERIDAE Klie, 1938

Genus Simeonella Sohn, 1968

Type species. — *Simeonella brotzenorum* Sohn, 1968 by original designation.

Simeonella daginikella Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019
(Fig. 7R, S)

Simeonella daginikella Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019a: 41, 43, figs 22A-E.

Examined material. — Two right valves, one left valve.

Occurrence. — *Tetraporobrachia haeckeli* radiolarian Zone, Julian, Carnian, Late Triassic, Mersin Mélange, southern Turkey, Huğlu Tuffite (Forel *et al.* 2019a); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, sample BE18 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Dimensions. — L = 393-430 µm, H = 236-359 µm (this work).

Discussion

This rare species has only been found in sample BE18 of the Belca section, where it is not abundant (Fig. 3). *Simeonella daginikella* is very close to *S. brotzenorum* Sohn, 1968 from the Carnian, Late Triassic, of Israel (Sohn 1968) from which it differs by its narrower posterior border bearing a series of small spines and its overall smaller dimensions (*S. brotzenorum*: L = 420-510 µm, H = 260-310 µm; *S. daginikella*: L = 326-400 µm, H = 179-256 µm). The specimens of *S. brotzenorum* Sohn, 1968 from the Carnian of Israel documented by Gerry *et al.* (1990) show the same size difference compared to *S. daginikella*. *Simeonella brotzenorum norica* Bunza & Kozur, 1971 was subsequently described from the late Norian, Late Triassic, of Austria (Bunza & Kozur 1971) based on its stronger lateral inflation, absence of eye-knot and broader ventral margin compared to *S. brotzenorum* Sohn, 1968. *Simeonella daginikella* is very close to *S. brotzenorum norica* Bunza & Kozur, 1971 from which it differs by its posterior spines. The synonymy between *S. daginikella* and *S. brotzenorum norica* should be carefully considered by investigating specimens from the type locality using SEM given that *S. brotzenorum norica* was only drawn.

Family indet.

Genus *Renngartenella*
Schneider *in* Mandelstam,
Schneider, Kuznetsova & Katz, 1957

Type species. — *Renngartenella pennata* Schneider *in* Mandelstam Schneider, Kuznetsova & Katz, 1957 by original designation.

Renngartenella sanctaecrucis
Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973
(Figs 7T, U; 8A-E)

Renngartenella sanctaecrucis Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973: 215, 217-219, pl. 8, figs 1-6; pl. 11, figs 1, 3, 5, 6; pl. 12, fig. 10 — Liebermann 1979: 215, pl. 5, fig. 2 — Basha 1982: pl. 1, fig. 15 — Gerry *et al.* 1990: 96, pl. 1, figs 11-13 — Monostori 1994: 320, 322, figs 5/5-7 — Keim *et al.* 2001: fig. 8C.

EXAMINED MATERIAL. — More than 60 isolated valves.

OCCURRENCE. — Julian, early Carnian, Late Triassic, Heiligkreuz Formation, Italy (Kristan-Tollmann & Hamedani 1973); Carnian, Late Triassic, Italian Alps (Liebermann 1979); Cordevolian, Carnian, Late Triassic, Jordan (Basha 1982); Carnian, Late Triassic, Devora-2A and Ramallah-1 boreholes, Israel (Gerry *et al.* 1990); Early Carnian, Late Triassic, Balatón Highland, Hungary (Monostori 1994); Carnian, Late Triassic, Heiligkreuz Formation, Dolomites, Northern Italy (Keim *et al.* 2001); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 18 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIMENSIONS. — Fig. 9.

DISCUSSION

Renngartenella sanctaecrucis has been found in samples BE2 and BE18 of the Belca section (Fig. 3). While it is rare in sample BE18, it is very abundant in sample BE2. In the present state of our knowledge, *R. sanctaecrucis* is restricted to the Julian, early Carnian, Late Triassic. The length and height of all specimens available in the literature and in the present work are plotted in Fig. 9. The size range of left valves is wider than that of right valves, the smallest and largest known specimens being left valves. There is no overlap of the size of the left valves between Belca and other localities, those found in Belca being significantly smaller. The same is not true for right valves as the size of the type material from Italy (Kristan-Tollmann & Hamedani 1973) overlaps the range of the Belca specimens. To reconstruct the ontogeny of *R. sanctaecrucis*, we used the ontogenetic information provided in the literature and complete carapaces provide correlation points. Fig. 9 first shows that the size difference between left and right valves of complete carapaces is not important: this limited dispersal is an additional tool to discuss the possible ontogenetic stages of *R. sanctaecrucis*. The anchor points ensured by complete carapaces allow the identification of the largest two stages, identified as A-1 and Adult (Fig. 9). The upper limit of the large scatter plot preceding A-1 is very close for both valves so that these larger specimens might correspond to A-2. The youngest juveniles identified are left valves, as shown by their significant size difference with the smallest right valves. However, in the absence of additional characters such as inner structures, it is nearly impossible to further subdivide this large scatter plot. A common lower limit can be identified as shown by the dashed line in Fig. 9 but no inner boundary can be recognized.

Monostori (1994) formulated the hypothesis of sexual dimorphism for *R. sanctaecrucis* occurring in Hungary, elongate adults with narrowly arched posterior possibly being males. In Belca, only one right valve of adult has been identified so that the pattern discussed by Monostori (1994) cannot be recognized for adults at this locality. However, these two morphologies are visible in the present material, which also occur in the type material from the Heiligkreuz Formation in Italy (Kristan-Tollmann & Hamedani 1973). The first morphology has asymmetric anterior and posterior margins, with posterior end slightly subtriangular and maximum of curvature located lower than anterior one (Kristan-Tollmann & Hamedani 1973: pl. 8, figs 1-3, 5; Fig. 8C, E). The second morphology is more rectangular in outline, with posterior end located higher and more rounded to subvertical at some specimens (Kristan-Tollmann & Hamedani 1973: pl. 8, figs 4, 6; Fig. 8A, B, D). In the present state of our reconstruction, the two morphologies are visible very early in the development of this species. Following Monostori (1994), we interpret the first morphology as being males and the second one as being females.

Superfamily SIGILLIOIDEA Mandelstam, 1960
Family SIGILLIDAE Mandelstam, 1960

Genus *Cardobairdia* van den Bold, 1960
emend. McKenzie (1967)

TYPE SPECIES. — *Cardobairdia ovata* van den Bold, 1960 by original designation.

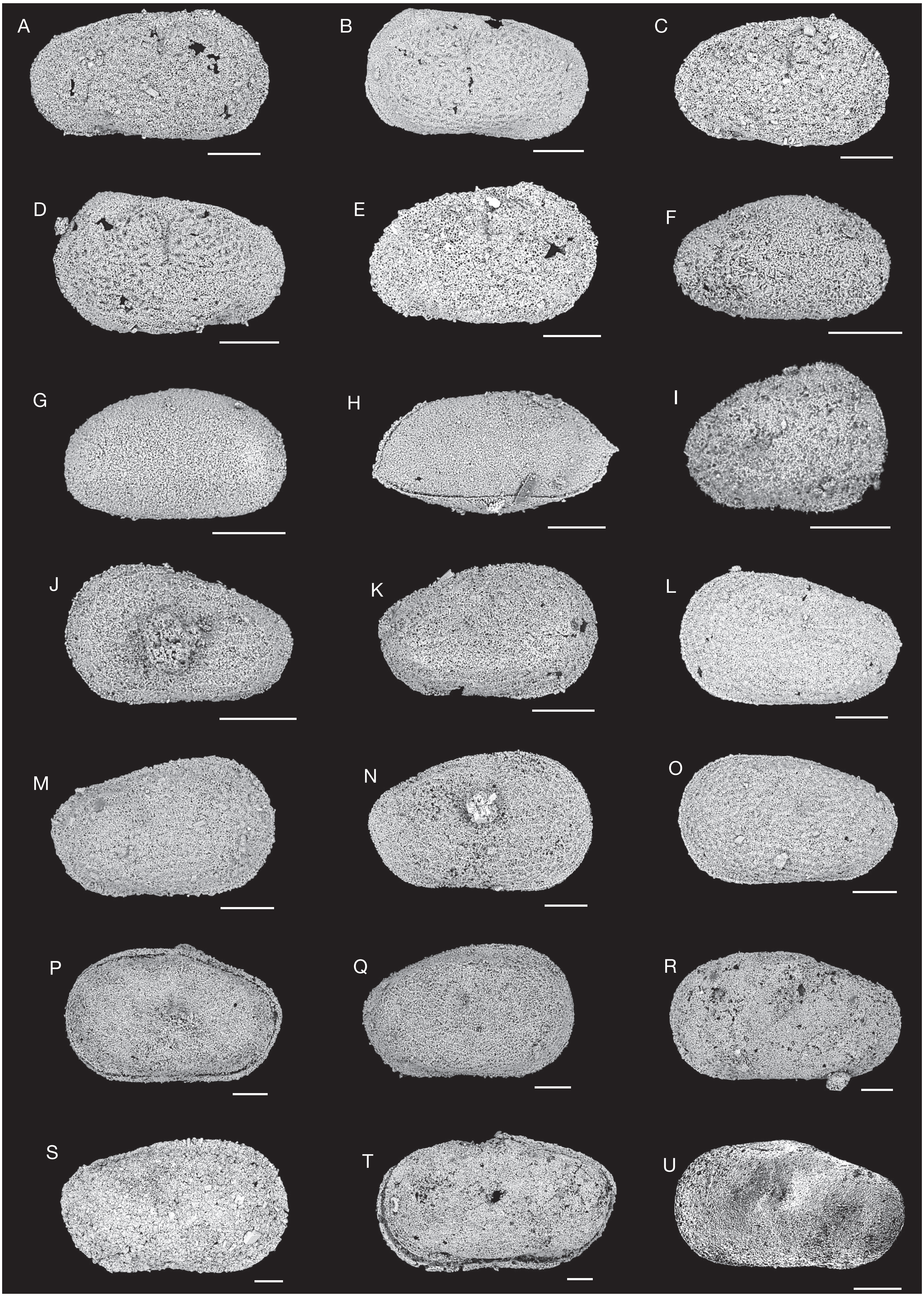
Cardobairdia? sp.
(Fig. 8H)

EXAMINED MATERIAL. — One complete carapace and one right valve.

OCCURRENCE. — *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE17, 18 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIMENSIONS. — L = 425 µm, H = 208 µm (BE17 [GeoZS6202]).

FIG. 8. — Ostracods from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number: **A-E**, *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973; **A**, lateral view of a right valve, BE2 (GeoZS6195); **B**, lateral view of a left valve, BE2 (GeoZS6196); **C**, lateral view of a right valve, BE2 (GeoZS6197); **D**, lateral view of a left valve, BE2 (GeoZS6198); **E**, lateral view of a right valve, BE2 (GeoZS6199); **F**, *Hungarella* sp. 1, lateral view of a right valve, BE18 (GeoZS6200); **G**, *Hungarella* sp. 2, lateral view of a right valve, BE18 (GeoZS6201); **H**, *Cardobairdia*? sp., right lateral view of a complete carapace, BE17 (GeoZS6202); **I-U**, *Issacharella bisulcata* Kozur, 1972 emend. Kristan-Tollmann *in* Kristan-Tollmann *et al.* 1991b; **I**, lateral view of a right valve, BE18 (GeoZS6203); **J**, lateral view of a left valve, A-5, BE21 (GeoZS6204); **K**, lateral view of a right valve, A-4, BE2 (GeoZS6205); **L**, lateral view of a left valve, A-4, BE2 (GeoZS6206); **M**, lateral view of a right valve, BE2 (GeoZS6207); **N**, lateral view of a right valve, BE18 (GeoZS6208); **O**, lateral view of a left valve, A-3, BE2 (GeoZS6209); **P**, left lateral view of a carapace, A-2, BE17 (GeoZS6210); **Q**, lateral view of a right valve, BE21 (GeoZS6211); **R**, lateral view of a left valve, A-1, BE17 (GeoZS6212); **S**, lateral view of a right valve, A-1, BE2 (GeoZS6213); **T**, left lateral view of a carapace, Adult, BE17 (GeoZS6214); **U**, lateral view of a left valve, Adult, BE18 (GeoZS6215). Scale bars: 100 µm.


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U

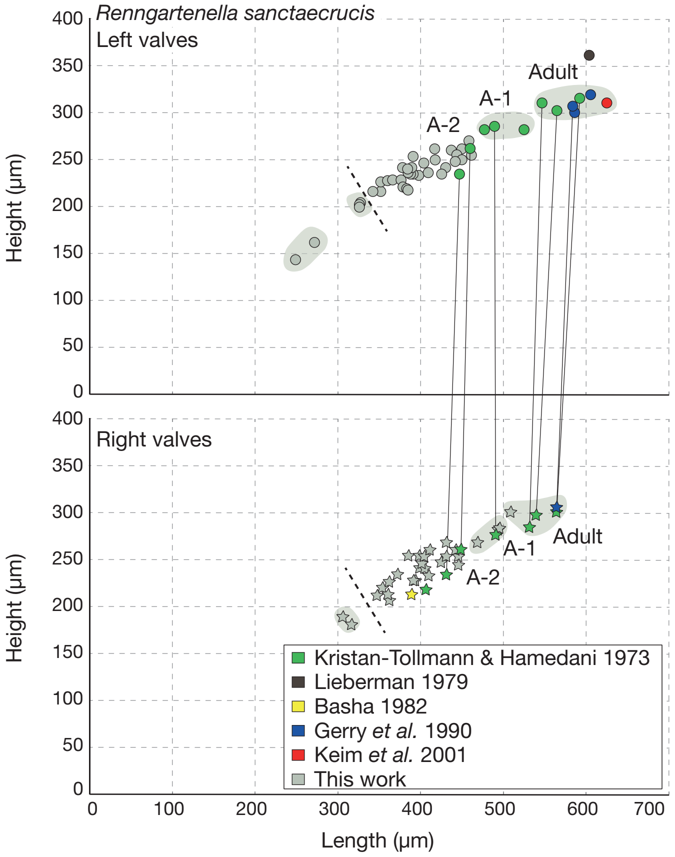


Fig. 9. — Height/Length scatter plots of *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973. The dimensions of right and left valves of complete carapaces are linked.

Discussion

This species is rare in the sampled section and has only been found in samples BE17 and 18 (Fig. 3). The genus *Cardobairdia* was described from the Middle Eocene of Trinidad (van den Bold 1960). Since then, it has been abundantly reported from Jurassic layers of western Tethys (e.g., Apostolescu 1959; Szczechura & Blaszyk 1968; Boomer 1991, 1992; Harloff & Jäger 1994; Monostori 1996; Boomer *et al.* 1998; Ainsworth & Boomer 2001; Olempska & Blaszyk 2001; N'Zaba-Makaya *et al.* 2003; Beher 2004). Until now, the oldest *Cardobairdia* was documented from the Early Jurassic of southern England (Lord & Boomer 1988), of the Fastnet Basin off southwestern Ireland (Ainsworth 1986, 1987), of northern Wales (Boomer 1991) and of the continental slope off western Australia (Lord *et al.* 1993). Noteworthy, the doubt on the generic attribution of the Belca's specimens refers to the impossibility to observe their inner structures of the specimens and to confirm that the present material belongs to *Cardobairdia* such as described from Cenozoic deposits. However, the lateral morphology of *Cardobairdia*? sp. from Belca conforms to the morphology of Jurassic occurrences, for which inner structures are most of the time not observed as well. In the present state of our knowledge, *Cardobairdia*? sp. from the Belca section is the oldest occurrence of this genus worldwide.

Order PLATYCOPIDA Sars, 1866
Suborder PLATYCOPINA Sars, 1866
Superfamily Cytherelloidea Sars, 1866
Family Cytherellidae Sars, 1866

Genus *Issacharella* Sohn, 1968

Type species. — *Issacharella blakei* Sohn, 1968 by original designation.

Issacharella bisulcata Kozur, 1972
emend. Kristan-Tollmann in Kristan-Tollmann *et al.* (1991b)
(Fig. 8I-U)

Issacharella bisulcata Kozur, 1972: 22, pl. 1, figs 1, 5-7 — Kristan-Tollmann *et al.* 1991b: 205, pl. 3, fig. 2; pl. 4, figs 1-3, 5-7.

Examined material. — More than 100 specimens, including isolated valves and complete carapaces.

Occurrence. — Carnian, Late Triassic, Veszprem, Balatón highland, Hungary (Kozur 1972); Carnian, Late Triassic, Transdanubian range, Hungary (Kristan-Tollmann *et al.* 1991b); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Dimensions. — Fig. 10.

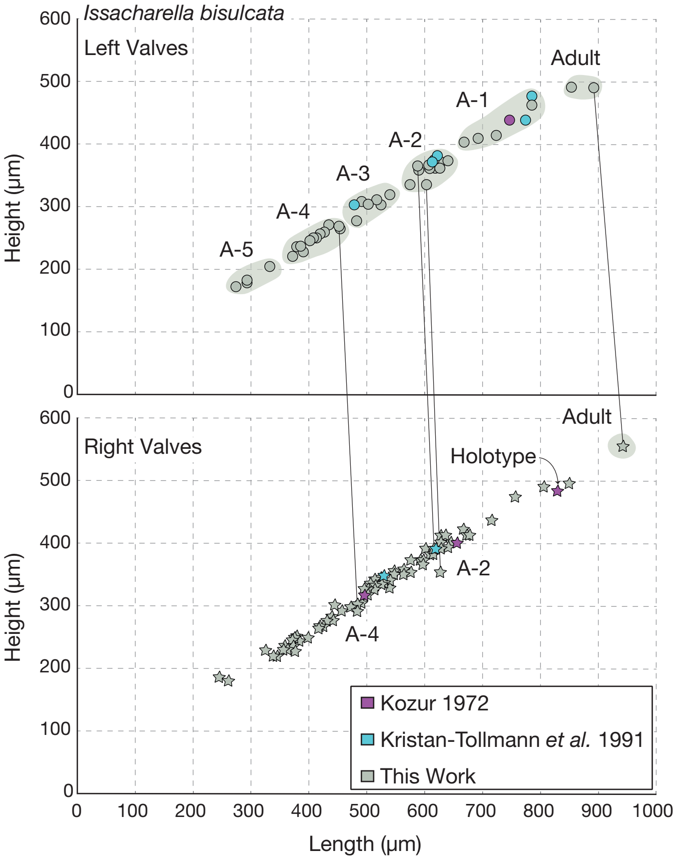


Fig. 10. — Height/Length scatter plots of *Issacharella bisulcata* Kozur, 1972 emend. Kristan-Tollmann *in* Kristan-Tollmann *et al.* (1991b). The dimensions of right and left valves of complete carapaces are linked.

Discussion

Issacharella bisulcata Kozur, 1972 emend. Kristan-Tollmann *in* Kristan-Tollmann *et al.* (1991b) has been found in all samples of the Belca section, where it is relatively abundant except for sample BE23/1 (Fig. 3). Until the present record, this species was only recorded from the Carnian of Hungary. Kristan-Tollmann *et al.* (1991b) considered that this species was described on early juveniles and that the holotype designated by Kozur (1972) was a late juvenile. The largest known specimen is recorded from Belca section and confirms the diagnostic of Kristan-Tollmann *et al.* (1991b) that the holotype of *I. bisulcata* is not an adult. The only four carapaces of this species, all from the Belca section, show that the overlap is present quite early in the development of this species (Fig. 10). As was already identified by Kristan-Tollmann *et al.* (1991b), the ontogeny of *I. bisulcata* is mainly marked by the enlargement of the posterior margin, which is narrow in young specimens and becomes larger during the ontogeny. The carapaces of young juveniles are therefore more assymetric in lateral view (e.g., Fig. 8I-K) than older juveniles and adults (e.g., Fig. 8R-U), with slightly less convex ventral margin and a straight to only slightly convex dorsal margin.

Genus *Leviella* Sohn, 1968

Type species. — *Leviella bentori* Sohn, 1968 by original designation.

Leviella bogschi Kozur, 1972
(Fig. 11A-J)

Leviella bogschi Kozur, 1972: 20, pl. 1, fig. 4; pl. 2, figs 1-7. — Kristan-Tollmann *et al.* 1991b: 206, pl. 3, figs 1, 3.

Examined material. — More than 100 specimens, including isolated valves and complete carapaces.

Occurrence. — Carnian, Late Triassic, Veszprem, Balatón highland, Hungary (Kozur 1972); Carnian, Late Triassic, Transdanubian range, Hungary (Kristan-Tollmann *et al.* 1991b); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

Dimensions. — Fig. 12.

Discussion

Leviella bogschi Kozur, 1972 has been found in all samples of the Belca section. It is rare in samples BE2 and BE23/1 but is moderately abundant in samples BE17 to BE21 (Fig. 3). This species is another species typical of the Carnian that was only known from Hungary until the Belca record. The dispersal of the sizes of both left and right valves in Belca is the largest observed until now for this species, with the smallest known specimens and the largest documented left valve. Kristan-Tollmann *et al.* (1991b) stated that the holotype of this species described by Kozur (1972) is not a mature stage:

this observation is confirmed with the specimens from Belca, for both valves (Fig. 12). Until now, three complete carapaces of *L. bogschi* are known to science [one from Kozur (1972), two from this work]. The gaps between the successive scatter plots in *L. bogschi* are well marked and allow the distinction of six ontogenetic stages for the left valves (A-5 to Adult) and seven for the right valves (A-6 to Adult). In early juveniles, the valves are very assymetric with narrow posterior end and weakly developed lateral ridges. The ontogenetic development of *L. bogschi* is marked by the progressive enlargement of the posterior end of the carapaces and strengthening of the lateral ridges and sulcus. The three carapaces known from this species belong to the Adult, A-1 and A-5 stages (Fig. 12). Although rare, these carapaces show that the overlap of RV over LV occurs as early as A-5 and increases through the ontogenetic development.

Leviella veghae Kozur, 1972
(Fig. 11K-T)

Leviella veghae Kozur, 1972: 21, pl. 1, fig. 3; pl. 2, figs 8-14.

Leviella raibliana – Kristan-Tollmann & Hamedani 1973: 213, pl. 12, figs 1, 2.

Leviella fraterna – Kristan-Tollmann *et al.* 1991b: 206, pl. 3, fig. 7.

EXAMINED MATERIAL. — More than 100 specimens, including isolated valves and complete carapaces.

OCCURRENCE. — Carnian, Late Triassic, Veszprem, Balatón highland, Hungary (Kozur 1972); Late Carnian, Late Triassic, marl layer in the middle part of the Opponitzer Limestone Formation, Göstling/Ybbs, Austria (Kristan-Tollmann & Hamedani 1973); Carnian, Late Triassic, Raibl, Southern Alps, Italy (Kristan-Tollmann & Hamedani 1973); Carnian, Late Triassic, Transdanubian range, Hungary (Kristan-Tollmann *et al.* 1991b); *Nicoraella*? *budaensis* conodont zone, late Julian-?earliest Tuvalian, Carnian, Late Triassic, samples BE2, 17, 18, 21, 23/1 (Fig. 3), Belca section, 'Raibl Beds', Karavanke Mountains, Slovenia (this work).

DIMENSIONS. — Fig. 13.

DISCUSSION

Leviella veghae Kozur, 1972 has been retrieved from all studied samples in Belca section. It is moderately abundant in BE2, abundant in samples BE17 to BE21 and rare in BE23/1 (Fig. 3). All the specimens available from the literature are gathered in Fig. 13. At least six ontogenetic stages are reconstructed from the right valves, where the gaps between the successive scatter plots are more clearly visible than for the left ones. Thanks to the complete carapaces documented from the present work, the stages A-1, A-2 and A-4 are constrained for right valves as well. On the basis of the ontogenetic stages here reconstructed, the holotype of *L. veghae* (a right valve) is an adult. The ontogenetic development of *L. veghae* is very similar to *L. bogschi* in that it mainly witnesses the progressive enlargement of the posterior end of the carapaces as well as the development of the lateral structures.

DISCUSSION

DIVERSITY OF OSTRACODS AT BELCA SECTION

Although ostracods have been previously documented from Triassic layers in Slovenia (e.g., Kolar-Jurkovšek 1990, 1991), the present contribution is the first complete taxonomic and palaeoecologic analysis of ostracod assemblages from the Carnian, Late Triassic, of this area. For the present work, five samples (BE2, 17, 18, 21, 23/1) from the 'Raibl Beds' outcropping in the Karavanke Mountains in northwestern Slovenia have yielded ostracods: a total of 12 families, 21 genera and 39 species have been found (Table 1; Fig. 3). At the species level, two species are new to science (*Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp.), 14 were previously documented from other Triassic localities (*Bairdia balatonica* Méhes, 1911; *B. cassiana* (Reuss, 1869); *B.* cf. *perpusilla sensu* Forel *et al.* (2019a); *Citrella*? *carniana* Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019; *Issacharella bisulcata* Kozur, 1972 emend. Kristan-Tollmann *in* Kristan-Tollmann *et al.* 1991b; *Judahella dizluense* Kristan-Tollmann, 1980; *Kerocythere raibliana* (Gümbel, 1869); *K. reticulata* Kristan-Tollmann, 1972; *K. tuvalica* Kozur *in* Bunza & Kozur, 1971; *Leviella bogschi* Kozur, 1972; *L. veghae* Kozur, 1972; *Mirabairdia longispinosa* Kristan-Tollmann, 1978; *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973; *Simeonella daginikella* Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019) and 23 are compared to other species or kept in open nomenclature due to poor preservation and/or paucity of material.

In the present state of our knowledge, the new species *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp. are endemic to Slovenia during the Carnian. Ten of the 14 species previously known from the literature are also restricted to the Carnian stage: *Bairdia* cf. *perpusilla, Citrella*? *carniana*, *Issacharella bisulcata, Kerocythere reticulata, K. tuvalica, Leviella bogschi, L. veghae, Mirabairdia longispinosa*, *Renngartenella sanctaecrucis, Simeonella daginikella.* Several of these species are restricted to the northwestern Palaeo-Tethys area, as shown in the Systematic Palaeotology section. *Bairdia* cf. *perpusilla, Citrella*? *carniana*, *Kerocythere tuvalica, Mirabairdia longispinosa* and *Simeonella daginikella*

FIG. 11. — Ostracods from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic. All specimens are deposited in the micropalaeontology collections of the Geological Survey of Slovenia, under the numbers GeoZS6132 to GeoZS6239, preceded by sample number: **A-J**, *Leviella bogschi* Kozur, 1972; **A**, left lateral view of a carapace, A-1, BE21 (GeoZS6216); **B**, lateral view of a left valve, A-1, BE18 (GeoZS6217); **C**, lateral view of a left valve, A-2, BE18 (GeoZS6218); **D**, lateral view of a right valve, A-2, BE18 (GeoZS6219); **E**, lateral view of a left valve, A-3, BE18 (GeoZS6220); **F**, lateral view of a right valve, A-3, BE18 (GeoZS6221); **G**, lateral view of a right valve, A-3, BE18 (GeoZS6222); **H**, left lateral view of a carapace, A-5, BE21 (GeoZS6223); **I**, lateral view of a right valve, A-5, BE17 (GeoZS6224); **J**, lateral view of a right valve, A-6, BE18 (GeoZS6225); **K-T**, *Leviella veghae* Kozur, 1972; **K**, lateral view of a left valve, A-5, BE18 (GeoZS6226); **L**, lateral view of a right valve, A-5, BE18 (GeoZS6227); **M**, left lateral view of a carapace, A-4, BE21 (GeoZS6228); **N**, lateral view of a right

valve, A-4, BE17 (GeoZS6229); **O**, lateral view of a right valve, A-3, BE18 (GeoZS6230); **P**, lateral view of a left valve, A-3, BE18 (GeoZS6231); **Q**, lateral view of a right valve, A-2, BE21 (GeoZS6232); **R**, lateral view of a left valve, A-1, BE18 (GeoZS6233); **S**, lateral view of a right valve, A-1, BE18 (GeoZS6234); **T**, lateral view of a left valve, Adult, BE18 (GeoZS6235); **U**, *Polycope* sp., lateral view of a complete carapace, BE2 (GeoZS6236). Scale bars: 100 µm.

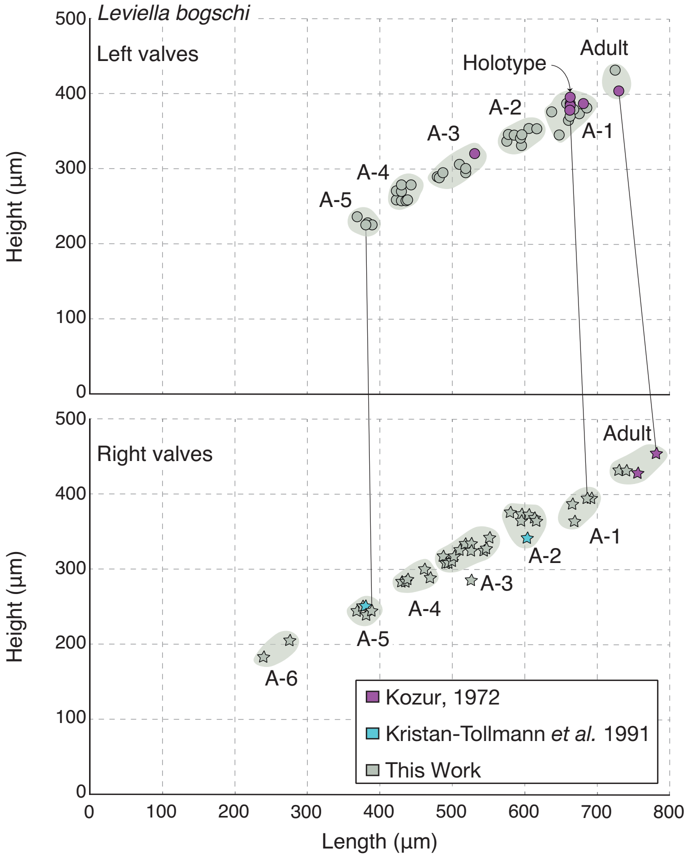


FIG. 12. — Height/Length scatter plots of *Leviella bogschi* Kozur, 1972. The dimensions of right and left valves of complete carapaces are linked.

extend southwards to the Mersin Mélange in southern Turkey (Forel *et al.* 2018, 2019a), and *Renngartenella sanctaecrucis* also occurs in Jordan (Basha 1982) and Israel (Sohn 1968; Gerry *et al.* 1990). The distribution of these taxa during the Carnian therefore encompasses the northwestern margin of the Palaeo-Tethys and extends southwards to the southwestern margin and to the Cimmerian Blocks.

As for the stratigraphic distribution of the encountered taxa, the case of *Bairdia balatonica* Méhes, 1911 is interesting. Its earliest occurrence has been reported from the Spathian-Anisian interval of Tibet (Forel & Crasquin 2011; Forel *et al.* 2011) and it seems that this species later spread to the north-western margin of the Palaeo-Tethys from the Anisian to the Carnian (Hungary, Italy, Slovenia; Méhes 1911; Széles 1965; Kristan-Tollmann 1978; Monostori 1995; Monostori & Tóth 2013; Crasquin *et al.* 2018). Only *Judahella dizluense* and *Kerocythere raibliana* extend higher in the Late Triassic (Kristan-Tollmann 1972; Kristan-Tollmann *et al.* 1980; Mette & Mohtat-Aghai 1999).

The generic diversity of ostracod assemblages in Belca ranges from six in BE23/1 to 19 in BE18; the species diversity ranges from nine in BE2 and BE23/1 to 33 in BE18 (Fig. 3). Genera and species both document an increase in diversity in the lower part of the Belca section (samples BE2 to BE18), a peak in BE18, followed by a decrease towards the top of the section. Following Fürsich & Wendt (1977), Nützel & Kaim (2014) and Haussmann & Nützel (2015), the specimens of each species were counted articulated plus higher number of left or right valves. Individual rarefaction analyses and diversity indices (Shannon-Wiener and Simpson) were calculated with PAST (Hammer *et al.* 2001). Rarefaction curves show the expected number of taxa as a function of the number of specimens in each sample: they are illustrated in Fig. 14A. The rarefaction curve for sample BE2 flattens out gradually and demonstrate that further sampling would not have provided a significant number of new species so that the assemblage in BE2 represents the original diversity of the ostracod fauna. On the opposite, the rarefaction curves for BE17, 18, 21 and in particular for BE23/1, indicate that taxa count is not representative of the entire fauna and that a larger sample would have given better counts and higher diversity levels. Sample BE23/1 is poor displays a low abundance compared to other assemblages of the Belca section. Diversity was calculated for each sample using the Simpson and Shannon-Wiener indices (Fig. 14B). Shannon-Wiener index (H in Fig. 14B; Shannon & Weaver, 1949), is relatively insensitive to sample size and allows for a deeper analysis of species richness taking into account the number of specimens of each species. To further reduce the effect of sample size, we compared H with the Simpson index of dominance (1-D in Fig. 14B; Simpson, 1949) whose high values indicate low diversity. This index is close to 1 when the species in a community are evenly distributed and drops towards 0 when the community is dominated by one or few

Table 1. — Taxonomic list of all ostracod species identified from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic.

- Class OSTRACODA Latreille, 1802
  - Order PODOCOPIDA Sars, 1866
    - Suborder PODOCOPINA Sars, 1866
      - Superfamily Bairdioidea Sars, 1887
        - Family Bairdiidae Sars, 1887
          - *Acratia* cf. *goemeryi* Kozur, 1970 emend. Forel *et al.* (2019a) [BE18, 21]
          - *Acratia* sp. 1, 2 [BE18]
          - *Bairdia balatonica* Méhes, 1911 [BE17, 23/1]
          - *Bairdia cassiana* (Reuss, 1868) [BE17, 18, 21, 23/1]
          - *Bairdia* cf. *perpusilla* Bolz, 1971 *sensu* Forel *et al.* (2019a) [BE17, 18]
          - *Bairdia* sp. 1, 3 [BE18]
          - *Bairdia* sp. 2 [BE23/1]
          - *Bairdiacypris* sp. [BE18]
          - *Dicerobairdia belcaensis* Forel, n. sp. [BE17, 18, 21]
          - *Isobythocypris*? sp. 1 [BE2]
          - *Isobythocypris* sp. 2 [BE18]
          - *Mirabairdia longispinosa* Kristan-Tollmann, 1978 [BE2, 17, 18, 21, 23/1]
        - Family Bythocyprididae Maddocks, 1969
          - *Bythocypris*? sp. 1 [BE17, 18]
          - *Bythocypris*? sp. 2 [BE18]
          - *Bythocypris*? sp. 3 [BE17, 18, 23/1]
      - Superfamily Cypridoidea Baird, 1845
        - Family Paracyprididae Sars, 1866
          - *Paracypris* sp. [BE18]
        - Family Pontocyprididae Müller, 1894
          - *Pontocyprella* sp. [BE18]
          - *Pontocypris*? *karavankensis* Forel, n. sp. [BE18, 21]
      - Superfamily Cytheroidea Baird, 1850
        - Family Bythocytheridae Sars, 1928
          - *Monoceratina* sp. [BE18, 21]
        - Family Cytheruridae Müller, 1894
          - *Citrella*? *carniana* Forel *in* Forel Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019 [BE2]
          - *Judahella dizluense* Kristan-Tollmann, 1980 [BE17, 18, 21]
          - *Judahella* cf. *galli* Kozur & Bolz *in* Bunza & Kozur, 1971 [BE2, 18]
          - *Judahella* sp. [BE18]
          - *Kerocythere* cf. *hartmanni* Bolz & Kozur *in* Bunza & Kozur, 1971 [BE18]
          - *Kerocythere raibliana* (Gümbel, 1869) [BE18]
          - *Kerocythere reticulata* Kristan-Tollmann, 1972 [BE17, 18, 21, 23/1]
          - *Kerocythere tuvalica* Kozur, 1971 [BE17, 18, 21, 23/1]
          - *Kerocythere* sp. [BE21]
        - Family Limnocytheridae Klie, 1938
          - *Simeonella daginikella* Forel *in* Forel, Tekin, Okuyucu, Bedi, Tuncer & Crasquin, 2019 [BE18]
        - Family indet.
          - *Renngartenella sanctaecrucis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973 [BE2, 18]
      - Superfamily Sigillioidea Mandelstam, 1960
        - Family Sigillidae Mandelstam, 1960
          - *Cardobairdia*? sp. [BE17, 18]
    - Suborder METACOPINA Sylvester-Bradley, 1961
      - Superfamily Healdioidea Harlton, 1933
        - Family Healdiidae Harlton, 1933
          - *Hungarella* sp. 1, 2 [BE18]
  - Order PLATYCOPIDA Sars, 1866
    - Suborder PLATYCOPINA Sars, 1866
      - Superfamily Cytherelloidea Sars, 1866
        - Family Cytherellidae Sars, 1866
          - *Issacharella bisulcata* Kozur, 1972 emend. Kristan-Tollmann *in* Kristan-Tollmann *et al.* (1991b) [BE2, 17, 18, 21, 23/1]
          - *Leviella bogschi* Kozur, 1972 [BE2, 17, 18, 21]
          - *Leviella veghae* Kozur, 1972 [BE2, 17, 18, 21, 23/1]
  - Order MYODOCOPIDA Sars, 1866
    - Suborder MYODOCOPINA Sars, 1866
      - Superfamily Polycopoidea Sars, 1866
        - Family Polycopidae Sars, 1866
          - *Polycope* sp. [BE2]

species. Consequently, diversity indices in Belca (Fig. 14B) substantify part of the generic and specific patterns described above: a pronounced increase of diversity (and decrease of the dominance) from BE2 to BE18, which records the maximum of specific diversity of the Belca section, followed by an important reduction of the diversity up to BE21. The confidence intervals of the species diversity in BE21 and BE23/1 are large so that any difference is undistinguishable and the diversity patterns of the assemblages in the upper part of the Belca section are biased. The taxa involved in the observed diversity changes are discussed below, as well as their palaeoenvironmental implications.

Composition of the ostracod assemblages

The most diversified assemblage in terms of species and genera occurs in sample BE18, with 11 families. The familial composition of the successive Carnian ostracod assemblages at Belca section is shown in Fig. 15. The most diversified family is Bairdiidae (genera *Acratia, Bairdia, Bairdiacypris, Dicerobairdia, Isobythocypris, Mirabairdia*): they occur in

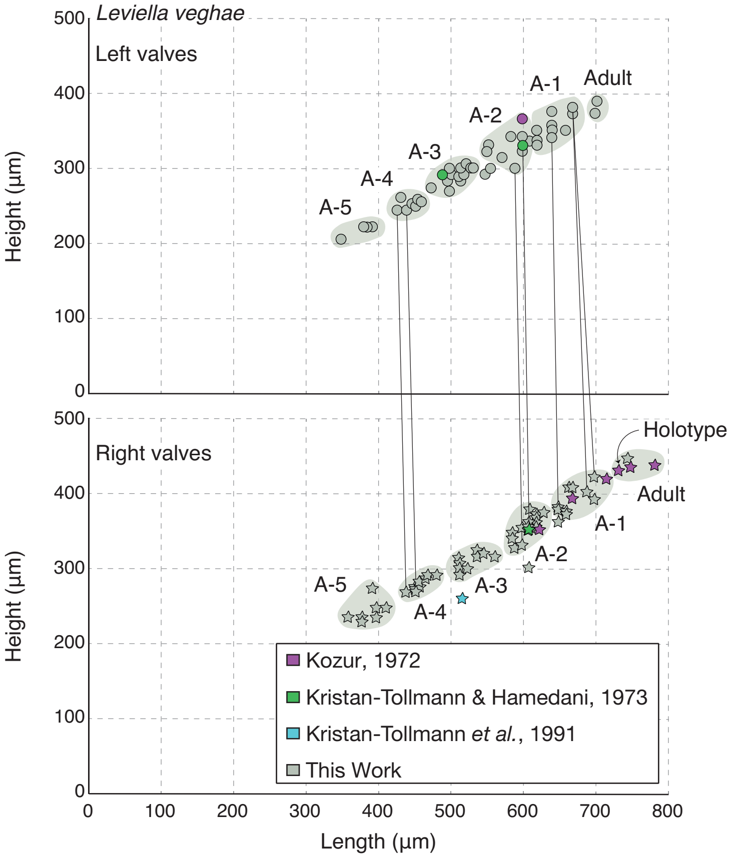


FIG. 13. — Height/Length scatter plots of *Leviella veghae* Kozur, 1972. The dimensions of right and left valves of complete carapaces are linked.

all studied samples, ranging from 25% (sample BE2) to 44% (sample BE23/1) of the species and from 25% (sample BE2) to 40% (sample BE21) of the genera. The second most diversified family is Cytheruridae (genera *Citrella*, *Judahella*, *Kerocythere*), which represent between 21% (sample BE18) and 31% (sample BE21) of the species, and between 11% (sample BE18) to 25% (sample BE2) of the genera. Cytherellidae (genera *Issacharella*, *Leviella*) is the third most diversified family with 9% (sample BE18) to 33% (sample BE2) of the species and 11% (sample BE18) to 33% (sample BE23/1) of the genera. The fourth family is Bythocyprididae (genus *Bythocypris*), being between 9% (sample BE18) and 15% (sample BE17) of the species, and between 5% (sample BE18) and 17% (sample BE23/1) of the genera. Pontocyprididae (genera *Pontocypris*, *Pontocyprella*) are between 6% (sample BE18) and 8% (sample BE21), and around 10% of the genera in samples BE18 and 21. Sigillidae (genus *Cardobairdia*) are between 3% (sample BE18) and 7% (sample BE17) of the species, and between 5% (sample BE18) and 11% (sample BE17) of the genera. The indeterminate family (genus *Renngartenella*) represents between 3% (sample BE18) and 11% (sample BE2) of the species, and between 5% (sample BE18) and 12.5% (sample BE2) of the genera. Polycopidae (genus *Polycope*) are 11% of the species and 12.5% of genera of sample BE2. Healdiidae (genus *Hungarella*) are 6% of the species and 5% of the genera of sample BE18. Finally, Limnocytheridae (genus *Simeonella*) and Paracyprididae (genus *Paracypris*) each represents 3% of the species and 5% of the genera of sample BE18.

The assemblage in sample BE2 differs from all other assemblages in Belca in being composed in equal proportions of Bairdiidae (genera *Dicerobairdia*, *Isobythocypris*), Cytheruridae (genera *Citrella*, *Judahella*) and Cytherellidae (genera *Issacharella*, *Leviella*), each being 25% of the genera (Fig. 15). In terms of species, Cytherellidae are slightly more diversified with 33% of the assemblage, while Bairdiidae and Cytheruridae each account for 22%. Polycopidae (genus *Polycope*) and the indeterminate family (genus *Renngartenella*) represent equal secondary proportions of the assemblage. The abundances of each species further underline the specificity of the sample BE2, with the massive dominance of *Renngartenella sanctaecrucis* and *Issacharella bisulcata* (Fig. 3), which is further substantified by the diversity indices (Fig. 14). *Issacharella bisulcata* is still present in the following samples but its abundance slightly decreases. Conversely, *Renngartenella sanctaecrucis* is extremely rare in sample BE18 and absent from the other assemblages. The samples BE17 to 23/1 furthermore record the diversification of the Bairdiidae and Cytheruridae.

Palaeoenvironmental implications

The influence of transportation from shallower and/or deeper areas needs to be discussed before any paleoenvironmental interpretation of the recovered assemblages can be proposed. The autochthonous or allochthonous nature of ostracod assemblages can be determined using the proportion of carapaces *versus* isolated valves as well as the demographic structure of populations (e.g., Boomer *et al*. 2003). In all Belca samples, the ostracod assemblages are *in situ* with no preferred alignment or orientation, indicating little or no post-mortem transportation. With the exception of the sample BE23/1 that yielded few specimens, all studied assemblages consist of a mixture of adults and juveniles as shown for several of the species reported here (Figs 5, 9, 10, 12). In all studied samples, adults as well as juveniles are mainly disarticulated valves that correspond to a wide range of large and small instars, although the smallest specimens are mostly lacking. These elements all point to a moderate energy thanatocoenosis with some post-mortem disturbance but the assemblages are still good indicators of palaeoenvironment (Boomer *et al*. 2003). This observation is in line with the thin valves of the bivalve *Posidonia*: they are found in both marlstone and limestone layers and are generally articulated with the convex side oriented downward, pointing to a relatively quiet sedimentary environment.

As shown in the previous section, the taxonomic composition of the successive ostracod assemblages in Belca section records an important shift upward. The base of the section (sample BE2) records the thriving of *Renngartenella sanctaecrucis* and *Issacharella bisulcata*. The upper part of the section (samples BE17 to 23/1) is marked by the disappearance of *Renngartenella sanctaecrucis*, a much higher diversity of Bairdiidae and high abundance of other Cytherellidae (*Leviella bogschi*, *L. veghae*).

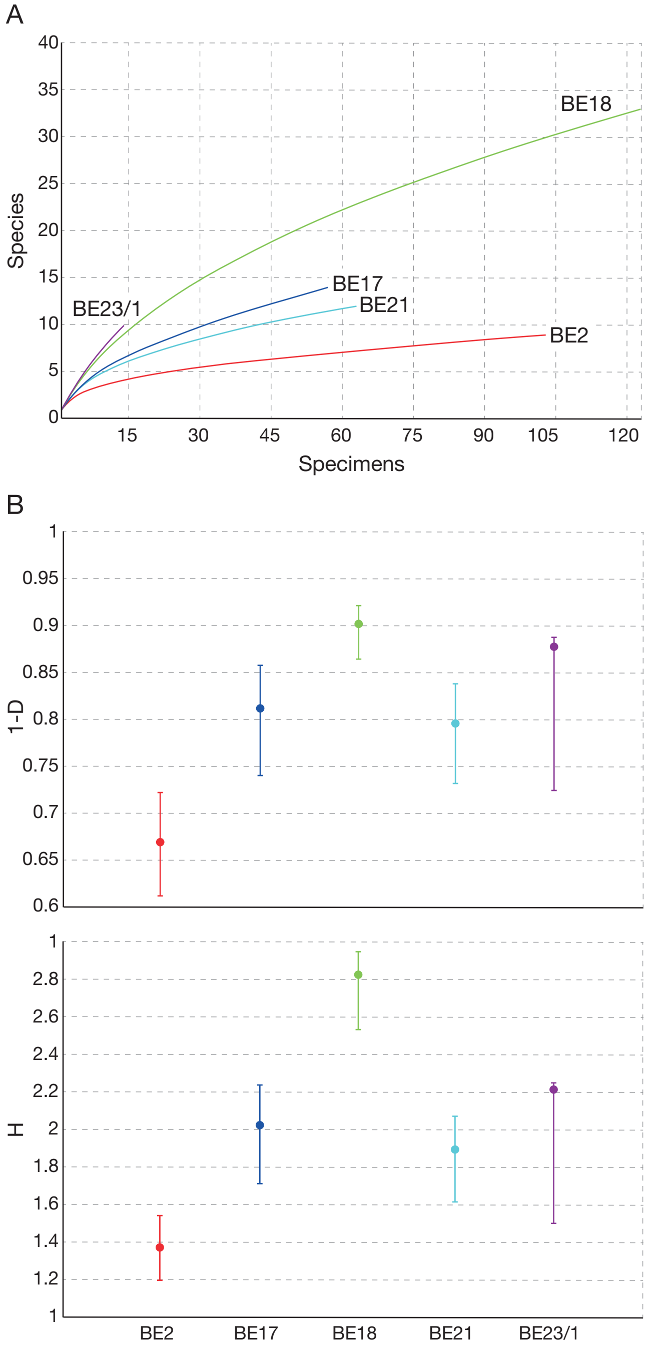


Fig. 14. — **A**, individual rarefaction curves, **B**, diversity indices (Shannon-Wiener and Simpson) of ostracods assemblages from the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic.

The large dominance of the *Renngartenella sanctaecrucis* and *Issacharella bisulcata* in BE2 suggests an atypical depositional environment probably related to salinity issues. This interpretation is substantiated by the sudden lithological change near sample BE2. This suggests strong inputs of land-derived terrigenous material, possibly from river input, which influenced the water salinity. However, some of the associated species, although not abundant, are typical of open marine conditions (*Leviella*, *Mirabairdia*) and suggest some mixing with normal marine waters. Gerry *et al.* (1990) have interpreted the typically Carnian species *R. sanctaecrucis* as stenohaline. Later, Monostori (1994) considered that it might be euryhaline because of its association with *Simeonella brotzenorum* Sohn, 1968. In the Carnian of Hungary, Monostori (1994) further considered that the dominance of *R. sanctaecrucis* might indicate a lesser salinity deviation than the dominance of *S. brotzenorum*. All these elements strengthen the conclusion of a salinity depletion occurring in sample BE2. It is worth noting that *I. bisulcata* was traditionally considered as an open marine taxon. The co-dominance of *I. bisulcata* and *R. sanctaecrucis* in sample BE2 and the abundant persistence of *I. bisulcata* through the Belca section highlights the environmental plasticity of this species. The thriving of *R. sanctaecrucis* associated to high abundances of Cytherellidae in Belca is reminiscent of the assemblages described by Monostori (1994) from the Carnian of Hungary. In Hungary, this assemblage is furthermore associated with the abundance of *S. brotzenorum*, indicating a stronger salinity deviation. *Kerocythere raibliana* has furthermore been interpreted by Monostori (1994) as appearing in normal saline environments: the salinity deviation in sample BE2 is here further confirmed

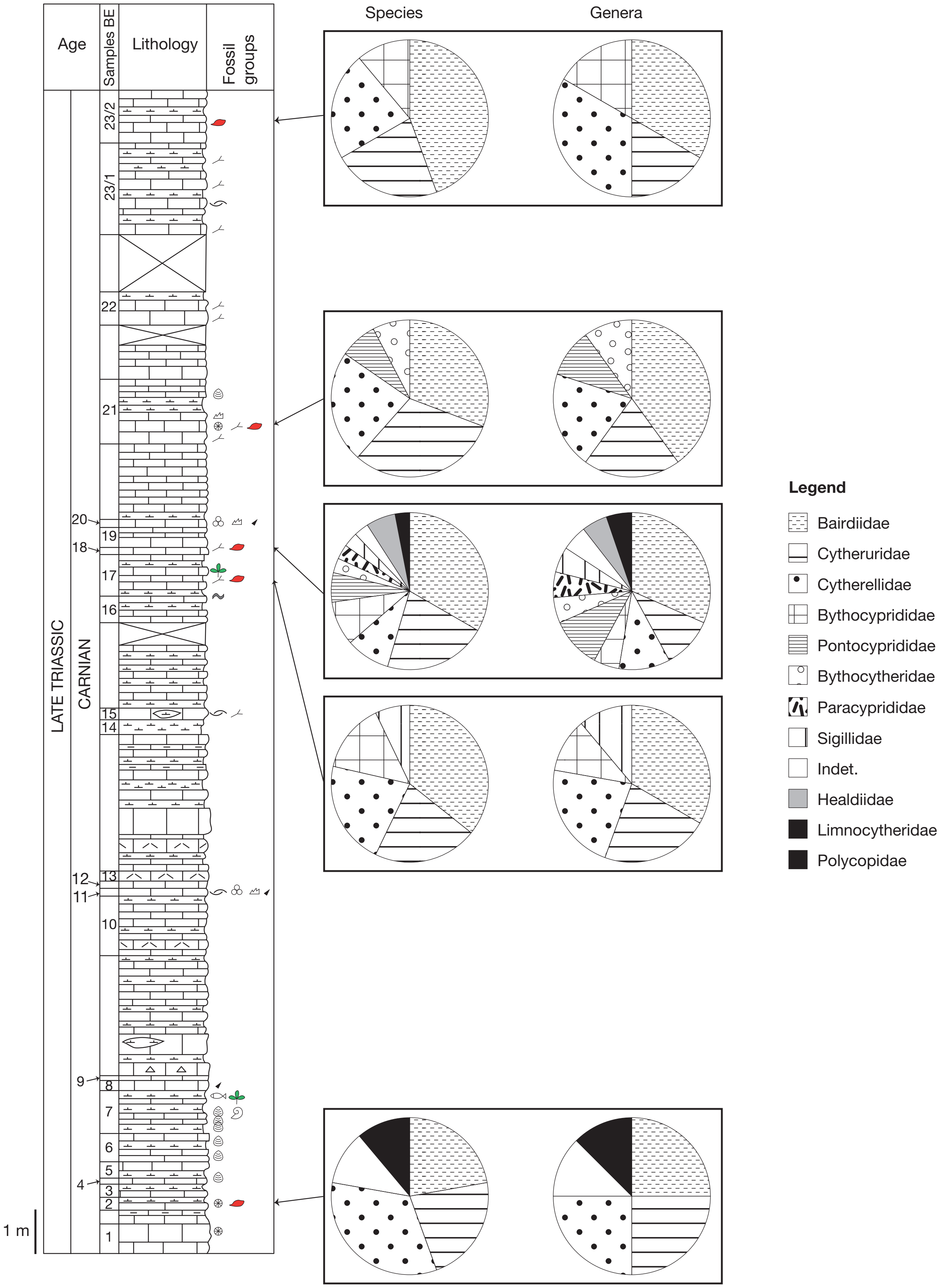


FIG. 15. — Circular diagrams of faunal composition of ostracod assemblages from examined samples of the Belca section, Karavanke Mountains, northwestern Slovenia, Carnian, Late Triassic.

by the absence of such species, which only occur higher in the Belca section (Fig. 3).

The increase in normal saline, open marine taxa in the upper part of the Belca section (samples BE17 to 23/1), including the genera *Bairdia*, *Dicerobairdia*, *Issacharella*, *Judahella*, *Leviella*, *Mirabairdia* (e.g., Sohn 1968; Monostori 1994), documents the shift to open marine, normal salinity conditions. The occurrence of shallow sublittoral forms (*Dicerobairdia, Judahella*; Sohn 1968; Monostori 1994) develops in BE17 onwards. The oldest lower Jurassic *Cardobairdia* from southern England, northern Wales, the Fastnet Basin off south-western Ireland and the continental slope off western Australia, are thought to have lived on muddy bottoms of the sublittoral zone (Ainsworth 1986, 1987; Lord & Boomer 1988; Boomer 1991; Lord *et al.* 1993). This aspect is further substantiated by the persistent occurrence of *Kerocythere tuvalica* from samples 17 to 23/1, which has been identified as marine soft bottom dwellers (Bunza & Kozur 1971). The occurrence of taxa closely related to deep-shelf forms (*Acratia* cf. *goemoeryi*; Fig. 4A, B) as well as posteriorly elongate *Acratia* (*Acratia* sp. 2; Fig. 4D) might indicate a relatively deep position on the shelf for assemblages of samples BE18 and 21 (Kozur 1971; Kozur *et al.* 1974; Monostori 1994). These elements point to a relatively intermediate position within the sublittoral zone for the upper part of the Belca section (samples BE17 to BE23/1).

Mirabairdia longispinosa Kristan-Tollmann, 1978 is until now only known from the Carnian of the Cassian Formation exposed at Pralongia section in Italy (Kristan-Tollmann 1978) and of the Huğlu Tuffite in Turkey (Forel *et al.* 2018). The Upper Triassic Cassian Formation has been described as a carbonate platform to basinal deposit (e.g., Fürsich & Wendt 1977; Wendt & Fürsich 1980; Wendt 1982). On the other hand, the studied sample at the Huğlu Tuffite corresponds to a moderately shallow subtidal environment submitted to short-lived environmental instabilities (e.g., Forel *et al.* 2018). The occurrence of *Mirabairdia longispinosa* Kristan-Tollmann, 1978 throughout the Belca section spanning the salinity restriction in BE2 further substantiates the plasticity of this typically Carnian taxa.

CONCLUSIONS

Ostracods of Carnian, Late Triassic, age have been retrieved from the 'Raibl Beds' cropping out at the Belca section located in the Karavanke Mountains in northwestern Slovenia. Thirty-nine species are found, including 2 newly described: *Dicerobairdia buseri* Forel, n. sp. and *Pontocypris*? *karavankensis* Forel, n. sp. We describe the ontogeny of several species in Belca and confirm the occurrence of sexual dimorphism for the typical Carnian species *Renngartenella sanctaecrusis* Kristan-Tollmann *in* Kristan-Tollmann & Hamedani, 1973. We report a major shift in diversity and dominance of the ostracod assemblages upward, witnessing a major shift from low-salinity levels related to the input of land-derived material to normal marine conditions in the intermediate sublittoral zone in the upper portion of Belca section.

Acknowledgements
This work was partially supported by the Slovenian Research Agency (program P1-0011). Facilities and technical staff of the Geological Survey of Slovenia are gratefully acknowledged, especially Marija Petrović for her skillful assistance in processing the samples. This is a contribution to the IGCP 632 – Continental Crises of the Jurassic. We are thankful to Dr Vincent Perrier (Université Lyon 1, France) and Dr Anisong Chitnarin (Suranaree University of Technology, Thailand) for their constructive remarks that improved an earlier version of this contribution.

REFERENCES

Ainsworth N. R. 1986. — Toarcian and Aalenian Ostracoda from the Fastnet Basin, offshore south-west Ireland. *Bulletin of the Geological Survey of Ireland* 3: 277-336.

Ainsworth N. R. 1987. — Pliensbachian Ostracoda from the Fastnet Basin, offshore southwest Ireland. *Bulletin of the Geological Survey of Ireland* 4: 41-62.

Ainsworth N. R. & Boomer I. 2001. — Upper Triassic and Lower Jurassic stratigraphy from exploration well L134/5-1, offshore Inner Hebrides, west Scotland. *Journal of Micropalaeontology* 20: 155-168. https://doi.org/10.1144/jm.20.2.155

Anderson F. W. 1964. — Rhaetic Ostracoda. *Bulletin of the Geological Survey of Great Britain* 21: 133-174.

Apostolescu V. 1959. — Ostracodes du Lias du Bassin de Paris. *Revue de l'Institut français du Pétrole* 14: 795-826.

Baird W. 1845. — Arrangement of the British Entomostraca, with a list of species, particularly noticing those which have as yet been discovered within the bounds of the Club. *History of the Berwickshire Naturalists' Club* 2:145-158. https://www.biodiversitylibrary.org/page/2408349

Baird W. 1850. — *The Natural History of the British Entomostraca*. Ray Society, London, 364 p. https://doi.org/10.5962/bhl.title.39641

Basha S. H. S. 1982. — Microfauna from the Triassic rocks of Jordan. *Revue de Micropaléontologie* 25: 3-11.

Beher E. 2004. — Ostracodenfauna und Biostratigraphie im Ober-Sinemurium von Süddeutschland und der Nordschweiz. *Stuttgarter Beiträge zur Naturkunde Serie B (Geologie und Paläontologie)* 349: 1-170. https://www.biodiversitylibrary.org/page/59775381

Bennett C. E. 2008. — A review of the Carboniferous colonisation of non-marine environments by ostracods. *Senckenbergiana Lethaea* 88: 37-46. https://doi.org/10.1007/BF03043976

Bennett C. E., Siveter D. J., Davies S. J., Williams M., Wilkinson I. P., Browne M. & Miller C. G. 2012. — Ostracods from freshwater and brackish environments of the Carboniferous of the Midland Valley of Scotland: the early colonization of terrestrial water bodies. *Geological Magazine* 149 (3): 366-396. https://doi.org/10.1017/S0016756811000719

Bold van den W. A. 1960. — Eocene and Oligocene Ostracoda of Trinidad. *Micropaleontology* 6 (2): 145-196. https://doi.org/10.2307/1484466

Bolz H. 1971. — Die Zlambach-Schichten (alpine Obertrias) unter besonderer Berucksichtigung der Ostrakoden, 1: Ostrakoden der Zlambach-Schichten, besonders Bairdiidae. *Senckenbergiana lethaea* 52: 129-283.

Boomer I. 1991. — Lower Jurassic ostracod biozonation of the Mochras borehole. *Journal of Micropalaeontology* 9 (2): 205-218. https://doi.org/10.1144/jm.9.2.205

Boomer I. 1992. — Lower Jurassic ostracods from Ilminster, Somerset, England. *Journal of Micropalaeontology* 11 (1): 47-57. https://doi.org/10.1144/jm.11.1.47

Boomer I., Ainsworth N. R. & Exton J. 1998. — A re-examination of the Pliensbachian and Toarcian Ostracoda of Zambujal, west-central Portugal. *Journal of Micropalaeontology* 17 (1): 1-14. https://doi.org/10.1144/jm.17.1.1

Boomer I., Horne D. J. & Slipper I. J. 2003. — The use of ostracods in palaeoenvironmental studies or what can you do with an Ostracod shell? *Palaeontological Society Papers* 9: 153-179. https://doi.org/10.1017/S1089332600002199

Brady G. S. & Norman A. M. 1889. — A Monograph of the Marine and Freshwater Ostracoda of the North Atlantic and of North Western Europe. Sect I. Podocopa. *Scientific Transactions of the Royal Dublin Society* 2: 63-270.

Breda A., Preto N., Roghi G., Furin S., Meneguolo R., Ragazzi E., Fedele P. & Gianolla P. 2009. — The Carnian pluvial event in the Tofane area (Cortina d'Ampezzo, Dolomites, Italy). *Geol. Alps* 6: 80-115.

Budkovi T. 1983. — Geologische Profile zur Geologischen Karte der Westlichen Karawanken zwischen Wurzenpass und Kahlkogel, 1:25 000. Amt der Kärntner Landesregierung und MOP, Ljubljana.

Budkovi T. 1999. — Geology of the Slovene Part of the Karavanke Road Tunnel. *Abhandlungen der Geologischen Bundesanstalt* 56 (2): 35-48.

Bunza G. & Kozur H. 1971. — Beiträge zur Ostracodenfauna der tethyalen Trias. *Geologisch-Paläontologische Mitteilungen Innsbruck* 1: 1-76.

Buser S. 1980. — Osnovna geološka karta SFRJ 1 : 100.000, Tolmač lista Celovec-Klagenfurt/Geological Map of SFRJ 1 : 100 000 (Explanatory Notes to the Sheet Celovec-Klagenfurt). Zvezni geološki zavod, Beograd, 62 p. (in Slovenian with English abstract).

Crasquin S. & Forel M. B. 2014. — Ostracods (Crustacea) through Permian-Triassic events. *Earth-Science Reviews* 137: 52-64. https://doi.org/10.1016/j.earscirev.2013.01.006

Crasquin S., Scuito F. & Reitano A. 2018. — Carnian ostracods (Crustacea) of the Mufara Formation (Monte Scalpello, Central-Eastern Sicily, Italy). *Annales de Paléontologie* 104: 129-142. https://doi.org/10.1016/j.annpal.2018.03.001

Crasquin-Soleau S. & Gr dinaru E. 1996. — Early Anisian ostracode fauna from the Tulcea unit (Cimmerian Notrh Dobrogean orogeny, Romania). *Annales de Paléontologie* 82: 59-116.

Crasquin-Soleau S. & Teherani K. 1995. — Première découverte d'ostracodes triasiques dans la formation de Khaneh Kat, Montagne Michparvar (Ouest Iran). *Revue de Micropaléontologie* 38: 27-36. https://doi.org/10.1016/S0035-1598(95)90223-6

Dal Corso J., Mietto P., Newton R. J., Pancost R. D., Preto N., Roghi G. & Wignall P. B. 2012. — Discovery of a major negative ^{13}C spike in the Carnian (Late Triassic) linked to the eruption of Wrangellia flood basalts. *Geology* 40 (1): 79-82. https://doi.org/10.1130/G32473.1

Dobruskina I. A., Jurkovšek B. & Kolar-Jurkovšek T. 2001. — Upper Triassic flora from "Raibl beds" of Julian Alps (Italy) and Karavanke Mts (Slovenia). *Geologija* 44 (2): 263-290. https://doi.org/10.5474/geologija.2001.019

Forel M. B. & Crasquin S. 2011. — In the aftermath of the Permian-Triassic boundary mass extinction: ostracod new species and genus from South Tibet. *Geodiversitas* 33 (2): 247-263. https://doi.org/10.5252/g2011n2a3

Forel M. B., Crasquin S., Brüwhiler T., Goudemand N., Bucher H., Baud A. & Randon C. 2011. — Ostracod recovery after Permian-Triassic boundary mass-extinction: The south Tibet record. *Palaeogeography, Palaeoclimatology, Palaeoecology* 308: 160-170. https://doi.org/10.1016/j.palaeo.2011.02.013

Forel M. B., Ozsvárt P. & Moix P. 2018. — Carnian (Late Triassic) ostracods from the Sorgun Ophiolitic Mélange (Southern Turkey): Taxonomy, palaeoenvironment, and evidence of predation. *Palaeontologia Electronica* 21.2.26A: 1-23. https://doi.org/10.26879/852

Forel M. B., Tekin U. K., Okuyucu C., Bedi Y., Tuncer A. & Crasquin S. 2019a. — Discovery of a long-term refuge for ostracods (Crustacea) after the end-Permian extinction: a unique Carnian (Late Triassic) fauna from the Mersin Mélange, southern Turkey. *Journal of Systematic Palaeontology* 17 (1): 9-58. https://doi.org/10.1080/14772019.2017.1391342

Forel M. B., Thuy B. & Wisshak B. 2019b. — Digging into the ancestral stocks of Jurassic lineages: Ostracods (Crustacea) from Carnian (Late Triassic) sponge mounds from the Maantang Formation (South China). *Bulletin de la Société géologique de France* 190 (9): 1-29. https://doi.org/10.1051/bsgf/2019009

Fürsich F. T. & Wendt J. 1977. — Biostratinomy and Palaeoecology of the Cassian Formation (Triassic) of the Southern Alps. *Palaeogeography, Palaeoclimatology, Palaeoecology* 22: 257-323. https://doi.org/10.1016/0031-0182(77)90005-0

Gerry E., Honigstein A., Rosenfeld A., Hirsch F. & Eshet Y. 1990. — The Carnian salinity crisis: ostracods and palynomorphs as indicators of palaeoenvironment, *in* Whatley R. & Maybury C. (eds), *Ostracoda and Global Events*. Chapman & Hall, London: 87-99.

Gümbel C. W. 1869. — VII. Ueber Foraminiferen, Ostracoden und mikroskopische Thier-Ueberreste in den St. Cassianer und Raibler Schichten. *Jahrbuch der Kaiserlich Königlichen Geologischen Reichsanstalt* 19: 175-186. https://www.biodiversitylibrary.org/page/36221559

Hammer Ø., Harper D. A. T. & Ryan P. D. 2001. — PAST: paleontological statistics software package for education and data analysis. *Palaeontologia Electronica* 4: 1-9.

Harloff J. & Jäger R. 1994. — Ostracoden aus dem Lias der Kalkalpen Bayerns und Nordtirols. *Stuttgarter Beiträge zur Naturkunde Serie B (Geologie und Paläontologie)* 205: 1-63. https://www.biodiversitylibrary.org/page/30064037

Haussmann I. M. & Nützel A. 2015. — Diversity and palaeoecology of a highly diverse Late Triassic marine biota from the Cassian Formation of north Italy. *Lethaia* 48: 235-255. https://doi.org/10.1111/let.12102

Horne D. J., Cohen A. & Martens K. 2002. — Taxonomy, morphology and biology of Quaternary and living Ostracoda, *in* Holmes J. A. & Chivas A. (eds), *The Ostracoda: Applications in Quaternary Research*. Geophysical Monograph, American Geophysical Union, Washington DC: 5-36. https://doi.org/10.1029/131GM02

Hornung T. & Brandner R. 2005. — Biochronostratigraphy of the Reingraben Turnover (Hallstatt Facies Belt): local black shale events controlled by regional tectonics, climatic change and plate tectonics. *Facies* 51 (1-4): 460-479. https://doi.org/10.1007/s10347-005-0061-x

Hornung T., Brandner R., Krystyn L., Joachimski M. M. & Lorenz K. 2007a. — Multistratigraphic Constraints on the NW Tethyan "Carnian Crisis", *in* Lucas S. G. & Spielmann J. A. (eds), The Global Triassic. *New Mexico Museum of Natural History and Science Bulletin* 41: 59-67.

Hornung T., Krystyn L. & Brandner R. 2007b. — A Tethys-wide mid-Carnian (Upper Triassic) carbonate productivity crisis: evidence for the Alpine Reingraben Event from Spiti (Indian Himalaya)? *Journal of Asian Earth Sciences* 30 (2): 285-302. https://doi.org/10.1016/j.jseaes.2006.10.001

Jurkovšek B. 1987. — Osnovna geološka karta SFRJ 1 : 100 000. Tolmač listov Beljak in Ponteba/Geological Map of SFRY 1: 100 000. Explanatory Notes to the Sheet Beljak in Pontebba. Zvezni Geološki Zavod, Beograd, 58 p. (in Slovenian with English abstract).

Keim L., Brandner R., Krystyn L. & Mette W. 2001. — Termination of carbonate slope progradation: an example from the Carnian of the Dolomites, Northern Italy. *Sedimentary Geology* 143: 303-323. https://doi.org/10.1016/S0037-0738(01)00106-3

Klie J. W. 1938. — Ostracoda, Muschelkrebse, *in* Dahl F. (ed.), *Die Tierwelt Deutschands und der augrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise, Crustacea III, Ostracoda*. Vol. 34. Verlag Von Gustav Fischer, Jena: 1-230.

Kolar-Jurkovšek T. 1990. — New ostracod and conodont species from the Triassic strata of Slovenia (NW Yugoslavia). *Geologija* 31-32: 219-224.

Kolar-Jurkovšek T. 1991. — Microfauna of Middle and Upper Triassic in Slovenia and its biostratigraphic significance. *Geologija* 33: 21-170. https://doi.org/10.5474/geologija.1990.001

Kolar-Jurkovšek T. & Jurkovšek B. 2003a. — *Clypeina* in the Belca section of the Karavanke Mts., Slovenia, *in* Mu X., Yuan X. & Kershaw S. (eds), Seventh International Symposium on Fossil Algae, abstracts: 33, 34.

Kolar-Jurkovšek T. & Jurkovšek B. 2003b. — *Clypeina besici* Pantić (Chlorophyta, Dasycladales) from the “Raibl Beds” of the western Karavanke Mountains, Slovenia. *Geologica Carpathica* 54 (4): 237-242.

Kolar-Jurkovšek T. & Jurkovšek B. 2010. — New paleontological evidence of the Carnian strata in the Mežica area (Karavanke Mts, Slovenia): Conodont data for the Carnian Pluvial Event. *Palaeogeography, Palaeoclimatology, Palaeoecology* 290 (1-4): 81-88. https://doi.org/10.1016/j.palaeo.2009.06.015

Kolar-Jurkovšek T. & Jurkovšek B. 2019. — Konodonti Slovenije/Conodonts of Slovenia. Geološki zavod Slovenije, Ljubljana, 260 p.

Kolar-Jurkovšek T., Ga dzicki A. & Jurkovšek B. 2005. — Conodonts and foraminifera from the “Raibl Beds” (Carnian) of the Karavanke Mountains, Slovenia: stratigraphical and palaeobiological implications. *Geological Quarterly* 49 (4): 429-438.

Kollmann K. 1963. — Ostracoden aus der alpinen Trias. II. Weitere Bairdiidae. *Jahrbuch der Geologischen Bundesanstalt* 106: 121-203.

Kozur H. 1971. — Die Bairdiacea der Trias. Teil 3: Einige neue Arten triassischer Bairdiacea und Bemerkungen zur Herkunft der Macrocyprididae (Cypridacea). *Geologisch Paläontologische Mitteilungen Innsbruck* 1: 1-18.

Kozur H. 1972. — Die Bedeutung triassischer Ostracoden für stratigraphische und paläoökologische Untersuchungen. *Mitteilungen der Gesellschaft für Geologie und Bergbaustudien* 21: 623-660.

Kozur H. W. & Bachmann G. H. 2010. — The Middle Carnian Wet Intermezzo of the Stuttgart Formation (Schilfsandstein), Germanic Basin. *Palaeogeography, Palaeoclimatology, Palaeoecology* 290 (1-4): 107-119. https://doi.org/10.1016/j.palaeo.2009.11.004

Kozur H. & Nicklas L. 1970. — Ostrakoden aus dem Plattenkalk- Niveau des Hauptdolomites (Rhätikon), *in* Mostler H. (eds), *Beiträge zur Mikrofazies und Stratigraphie von Tirol und Vorarlberg*. Festband des Geologischen Institutes, 300-Jahr-Feier Universität Innsbruck: 309-320.

Kozur H., Kampschuur W., Mulder-Blanken C. W. H. & Simon O. J. 1974. — Contribution to the Triassic ostracode faunas of the Betic Zone (southern Spain). *Scripta Geologica* 23: 1-56.

Kristan-Tollmann E. 1970. — Einige neue Bairdien (Ostracoda) aus der alpinen Trias. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen* 135: 268-310.

Kristan-Tollmann E. 1972. — Die obertriadischen Arten der Ostracoden-Gattung *Kerocythere* Kozur & Nicklas, 1970, und ihr stratigraphischer Wert. *Erdoel-Erdgas-Zeitschrift* 88: 43-49.

Kristan-Tollmann E. 1978. — Bairdiidae (Ostracoda) aus den obertriadischen Cassianer Schichten der Ruones-Wiesen bei Corvara in Südtirol. *Schriftenreihe der Erdwissenschaftlichen Kommissionen, Oesterreichische Akademie der Wissenschaften* 4: 77-104.

Kristan-Tollmann E. & Hamedani A. 1973. — Eine spezifische Mikrofaunen- Vergesellschaftung aus den Opponitzer Schichten der Oberkarn der niederoesterreichischen Kalkvoralpen. *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen* 143 (2):193-222.

Kristan-Tollmann E., Tollmann A. & Hamedani A. 1980. — Beiträge zur Kenntnis der Trias von Persien. II Zur Rhätfauna von Bagerabad bei Isfahan (Korallen, Ostracoden). *Mitteilungen der Österreichischen Geologischen Gesellschaft* 73: 163-235.

Kristan-Tollmann E., Haas J. & Kovacs S. 1991a. — Karnische Ostracoden und Conodonten der Bohrung Zsambek-14 im Transdanubischen Mittelgebirge (Ungarn), *in* Lobitzer H. & Csaszar G. (eds), *Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich-Ungarn, Wien*. Teil I. Geologische Bundesanstalt, Wien: 193-219.

Kristan-Tollmann E., Lobitzer H. & Solti G. 1991b. — Mikropaläontologie und Geochemie der Kössener Schichten des Karbonatplatform-Becken-Komplexes Kammerköhralm – Steinplatte (Tirol/Salzburg), *in* Lobitzer H. & Csaszar G. (eds), *Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich-Ungarn, Wien*. Teil I. Geologische Bundesanstalt, Wien: 155-191.

Krystyn L. 1978. — Eine neue Zonengliederung im Alpin-Mediterranen Unterkarn, *in* Zapfe H. (ed.), *Beiträge zur Biostratigraphie der Tethys-Trias*. Schriftenreihe der Erdwissenschaftlichen Kommission der Österreichischen Akademischen Wissenschaften 4: 37-75.

Krystyn L., Lein R., Schlaf J. & Bauer F. K. 1994. — Über ein neues obertriadisch-jurassisches Intraplatformbecken in den Südkarawanken. *Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich-Ungarn* 2: 409-416.

Kustatscher E., Bizzarini F. & Roghi G. 2011. — Plant fossils in the Cassian Beds and Other Carnian Formations of the Southern Alps (Italy). *Geo. Alps* 8: 146-155.

Latreille P. A. 1802. — *Genera crustaceorum et insectorum: secundum ordinem naturalem in familias disposita, iconibus exemplisque plurimis explicata*. Tomus 1. Koenig, Paris, 301 p. https://doi.org/10.5962/bhl.title.65741

Lein R., Schlaf J., Müller P. J., Krystyn L. & Jesinger D. 1995. — Neue Daten zur Geologie des Karawanken-Strassentunnels. *Geologisch-Paläontologische Mitteilungen* 20: 371-387.

Liebermann H. M. 1979. — Die Bivalven- und Ostracodenfauna von Raibl und ihr stratigraphischer. *Verhandlungen der Geologischen Bundesanstalt* 2: 85-131.

Lord A. R. & Boomer I. 1988. — The Lower and Middle Jurassic, *in* Keen M. C., Lord A. R. & Whatley R. C. (eds), *British Micropalaeontological Society Field Guide*. 6. The University College of Wales, Aberystwyth 79: 1-22.

Lord A. R., Malz H. & Apthorpe M. 1993. — Lower Jurassic Ostracoda from off Western Australia, *in* McKenzie K. G. & Jones P. J. (eds), Ostracoda in the Earth and Life Sciences. Proceedings of the Eleventh International Symposium on Ostracoda. A. A. Balkema, Rotterdam, Brookfield, 724: 109-121.

Maddocks R. F. 2015. — New and poorly known species of *Bairdoppilata* and *Paranesidea* (Bairdiidae, Ostracoda) from French Frigate Shoals and O’ahu, the Hawaiian Islands. *Zootaxa* 4059: 277-317. https://doi.org/10.11646/zootaxa.4059.2.3

Mandelstam M. I. 1960. — [Subfamily Sigilliuminae]. 398, *in* Chernysheva N. E. (ed.), *Osnovy paleontologii: Arthropoda, Trilobitomorpha et Crustaceomorpha*. State Scientific-Technological Publishing House, Moscow, 515 p. (in Russian).

Mandelstam M. I., Schneider G. F., Kuznetsova Z. V. & Katz F. I. 1957. — New genera of ostracodes in the families Cypridae and Cytheridae. *All-Union Palaeontological Society, Annual (Annals)* 16: 166-192 (in Russian).

McCoy F. 1844. — *A Synopsis of the Characters of the Carboniferous Limestone Fossils of Ireland*. Dublin University Press, Dublin, 207 p. https://doi.org/10.5962/bhl.title.11559

McKenzie K. G. 1967. — Saipanellidae: a new family of podocopid Ostracoda. *Crustaceana* 13: 103-113. https://doi.org/10.1163/156854067X00125

Méhes G. 1911. — Über Trias-Ostrakoden aus dem Bakony. Resultate der wissenschaftlichen Erforschung des Balatonsees. Anhang zu Band 1, Teil 1. *Paläaontologie der Umgebung des Balatonsees* 3: 1-38.

Mette W. & Mohtat-Aghai P. 1999. — Ostracods and foraminifera from Upper Triassic intrashelf basin deposits in the Northern Calcareous Alps. *Geologisch Paläontologische Mitteilungen Innsbruck* 24: 45-77.

Mette W., Honigstein A. & Crasquin S. 2014. — Deep-water ostracods from the Middle Anisian (Reifling Formation) of the Northern Calcareous Alps (Austria). *Journal of Micropalaeontology* 34: 71-91. https://doi.org/10.1144/jmpaleo2014-009

Monostori M. 1994. — Ostracod evidence of the Carnian salinity crisis in the Balatón Highland, Hungary. *Neues Jahrbuch für Geologie und Paläontologie* 193: 311-331.

Monostori M. 1995. — Environmental significance of the Anisian Ostracoda fauna from the Forrás Hill near Felsöörs (Balatón Highland, Transdanubia, Hungary). *Acta Geologica Hungarica* 39: 37-56.

Monostori M. 1996. — Pliensbachian ostracod fauna from condensed limestones of the Bakony Mts. (Transdanubian Central Range, Hungary). *Fragmenta Mineralogica et Palaeontologica* 18: 31-61.

Monostori M. & Tóth E. 2013. — Ladinian (Middle Triassic) silicified ostracod faunas from the Balatón Highland (Hungary). *Rivista Italiana di Paleontologia e Stratigrafia* 119: 303-323. https://doi.org/10.13130/2039-4942/6042

Monostori M. & Tóth E. 2014. — Additional Middle to Upper Triassic ostracod faunas from the boreholes of Transdanubian Central Range (Hungary). *Hantkeniana* 9: 21-43.

Moore R. C. 1961. — *Treatise on Invertebrate Paleontology. Part Q. Arthropoda 3, Crustacea, Ostracoda*. Geological Society of America and University of Kansas Press, Boulder and Lawrence, 442 p.

Müller G. W. 1894. — Die Ostracoden des Golfes von Neapel und der angrenzenden Meeres Abschnilte. *Fauna und Flora Neapel* 21: 1-404. https://doi.org/10.5962/bhl.title.7419

Norman A. M. 1862. — Contributions to British Carcinology. II. On species of Ostracoda new to Great Britain. *Annals and Magazine of Natural History* 3 (9): 43-55. https://doi.org/10.1080/00222936208681185

Nützel A. & Kaim A. 2014. — Diversity, palaeoecology and systematics of a marine fossil assemblage from the Late Triassic Cassian Formation at Settsass Scharte, N Italy. *Paläontologische Zeitschrift* 88 (4): 405-431. https://doi.org/10.1007/s12542-013-0205-1

N'Zaba-Makaya O., Andreu B., Brunel F., Mouterde R., Rey J. & Bordalo da Rocha R. 2003. — Biostratigraphie et paléoécologie des peuplements d'ostracodes dans le Domérien du Bassin Lusitanien, Portugal. *Ciências da Terra* 15: 21-44.

Oertli H. J. 1959. — Les ostracodes du Bathonien du Boulonnais; 1. Les 'micro-ostracodes'. *Revue de Micropaléontologie* 2: 115-126.

Ogg J. G. 2015. — The mysterious Mid-Carnian "Wet Intermezzo" global event. *Journal of Earth Sciences* 26 (2): 181-191. https://doi.org/10.1007/s12583-015-0527-x

Ogorelec B., Orehek S. & Burkovi T. 1999. — Lithostratigraphy of the Slovenian part of the Karavanke road tunnel. *Abhandlungen der Geologischen Bundesanstalt* 56 (2): 99-112.

Olempska E. & Blaszyk J. 2001. — A boreal ostracod assemblage from the Callovian of Lukow area, Poland. *Acta Palaeontologica Polonica* 46 (4): 553-582.

Preto N., Kustatscher E. & Wignall P. B. 2010. — Triassic climates – state of the art and perspectives. *Palaeogeography, Palaeoclimatology, Palaeoecology* 290 (1-4): 1-10. https://doi.org/10.1016/j.palaeo.2010.03.015

Reuss A. E. 1869. — Zur fossilen Fauna der Oligocänschichten von Gaas. *Sitzungsberichte der österreichischen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse* Abt. 1. 59 (3): 446-488. https://www.biodiversitylibrary.org/page/6354812

Rigo M., Preto N., Roghi G., Tateo F. & Mietto P. 2007. — A rise in the carbonate compensation depth of western Tethys in the Carnian (Late Triassic): deep-water evidence for the Carnian Pluvial Event. *Palaeogeography, Palaeoclimatology, Palaeoecology* 246 (2-4): 188-205. https://doi.org/10.1016/j.palaeo.2006.09.013

Rigo M., Mazza M., Karádi V. & Nicora A. 2018. — New Upper Triassic Conodont Biozonation of the Tethyan Realm. Chapter 6, *in* Tanner L. H. (ed.), The Late Triassic World. *Topics in Geobiology* 46: 189-235. https://doi.org/10.1007/978-3-319-68009-5_6

Roghi G., Gianolla P., Minarelli L., Pilati C & Preto N. 2010. — Palynological correlation of Carnian humid pulses throughout western Tethys. *Palaeogeography, Palaeoclimatology, Palaeoecology* 290 (1): 89-106. https://doi.org/10.1016/j.palaeo.2009.11.006

Salaj J., Trifonova E. & Gheorghian D. 1988. — A biostratigraphic zonation based on benthic foraminifera in the Triassic deposits of the Carpatho-Balkans. *Revue de Paléobiologie, Volume Spécial* 2 (1): 153-159.

Salas M. J., Vannier J. & Williams M. 2007. — Early Ordovician Ostracods from Argentina: their bearing on the origin of Binodicope and Palaeocope clades. *Journal of Paleontology* 81 (6): 1384-1395. https://doi.org/10.1666/05-134.1

Sars G. O. 1866. — Oversigt af marine Ostracoder. *Norske Videnskaps-Akademi, Förhandlingar* 1865: 1-130.

Sars G. O. 1887. — Nye bidrag til kundskaben om middelhavets invertebrafauna: 4. Ostracods mediterranea (sydeuropaeiske ostracoder). *Archiv for Mathematik og Naturvidenskab* 12: 173-324. https://www.biodiversitylibrary.org/page/29970665

Schlager W. & Schöelnberger W. 1974. — Das Prinzip stratigraphischer Wenden in der Schichtenfolge der Noedlichen Kalkalpen. *Mitteilungen der Geologischen Gesellschaft Wien* 66-67: 165-193.

Shannon C. E. & Weaver W. 1949. — *The Mathematical Theory of Communication*. University of Illinois Press, Urbana, 144 p.

Simms M. J. & Ruffell A. H. 1989. — Synchroneity of climatic change and extinctions in the Late Triassic. *Geology* 17: 265-268. https://doi.org/dbxk4w

Simms M. J. & Ruffell A. H. 1990. — Climatic and biotic change in the late Triassic. *Journal of the Geological Society* 147 (2): 321-327. https://doi.org/10.1144/gsjgs.147.2.0321

Simpson E. H. 1949. — Measurement of diversity. *Nature* 163: 188. https://doi.org/10.1038/163188a0

Siveter D. J. 2008. — Ostracods in the Palaeozoic? *Senckenbergiana Lethaea* 88: 1-9. https://doi.org/10.1007/BF03043973

Sohn I. G. 1964. — Significance of Triassic ostracodes from Alaska and Nevada. *United States Geological Survey Professional Paper* 501D: D40-D42.

Sohn I. G. 1968. — Triassic ostracodes from Makhtesh Ramon, Israel. *Bulletin of the Geological Survey of Israel* 44: 1-71.

Sohn I. G. 1987. — Middle and Upper Triassic Marine Ostracoda from the Shublik Formation, Northeastern Alaska. *United States Geological Survey Bulletin* 1664: C1-C24.

Styk O. 1958. — Triassic microfauna in the neighbourhood of Chrzanow and the north- western part of the Mesozoic periphery of the Swiety Kryzyz Mts. *Bulletin Poland Instytut Geologiczny* 121. *Micropalaeontological Researches in Poland* 3: 163-176.

Szczechura J. & Blaszyk J. 1968. — *Cardobairdia inflata* n. sp. from the Middle Jurassic of Poland and its taxonomic position within Ostracoda. *Acta Palaeontologica Polonica* 13: 185-197.

Széles M. 1965. — Ostracodåk a Bakonyi Nosztori-Volgy felsokarni rétegeibol. *Földtani Közlöny* 45: 412-417.

Ulrich E. O. & Bassler R. S. 1923. — Paleozoic Ostracoda: their morphology, classification and occurrence. *Maryland Geological Survey, Silurian* 9: 271-391.

Urlichs M. 1970. — Variability of some Ostracods from the Cassian Beds (Alpine Triassic) depending on the ecology. *Bulletin du Centre de Recherches Pau-SNPA* 5: 695-715.

Urlichs M. 1972. — Ostracoden aus den Kössener Schichten und ihre Abhängigkeit von der Ökologie. *Mitteilungen der Gesellschaft der Geologie und Bergbaustudenten in Österreich* 21: 661-710.

Wendt J. 1982. — The Cassian patch reefs (Lower Carnian, Southern Alps). *Facies* 6: 185-202. https://doi.org/10.1007/BF02536685

Wendt J. & Fürsich F. T. 1980. — Facies analysis and palaeogeography of the Cassian Formation, Triassic, Southern Alps. *Rivista Italiana di Paleontologia* 85: 1003-1028.

WHATLEY R. & BOOMER I. D. 2000. — Systematic review and evolution of the early Cytheruridae (Ostracoda). *Journal of Micropalaeontology* 19: 139-151. https://doi.org/10.1144/jm.19.2.139

WILLIAMS M., LENG M. L., STEPHENSON M. H., ANDREWS J. E., WILKINSON I. P., SIVETER D. J., HORNE D. J. & VANNIER J. M. C. 2006. — Evidence that Early Carboniferous ostracods colonised coastal flood plain brackish water environments. *Palaeogeography, Palaeoclimatology, Palaeoecology* 230: 299-318. https://doi.org/10.1016/j.palaeo.2005.07.021

YE C. H., GAO Y. S., HOU Y. T. & CAO M. Z. 1977. — Mesozoic and Cenozoic Ostracode Fauna from Yunnan. *Mesozoic Fossils from Yunnan, China* 2: 153-330 (in Chinese).

Submitted on 13 February 2019;
accepted on 25 September 2019;
published on 10 September 2020.