

STRATIGRAPHIC SIGNIFICANCE OF THE EARLY RHAETIAN OSTRACODS FROM THE PROPOSED NORIAN/RHAETIAN GSSP AT STEINBERGKOGEL (LATE TRIASSIC, UPPER AUSTRIA)

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Abstract – The ostracod associations from the *Paracochloceras suessi* Zone (Early Rhaetian, Late Triassic) of the proposed Norian/Rhaetian GSSP at Steinbergkogel (Upper Austria) are listed and compared with those from the *Vandaites stuerzenbaumi* and *Choristoceras marshi* zones (Middle and Late Rhaetian). The associations from these three zones are closely related, and the differences in diversity between each other are caused by different ecological conditions. The alleged mass extinction in ostracods at the base of the *Vandaites stuerzenbaumi* Zone, the former base of the Rhaetian, cannot be confirmed.

INTRODUCTION

The ostracods from the Rhaetian Zlambach and Kössen formations of the Northern Calcareous Alps (Austria and Upper Bavaria) are well known (Bolz, 1969, 1970a, 1970b, 1971; Kozur, 1971; Kollmann, 1969, 1963; Kristan-Tollmann, 1970, 1971a, 1971b, 1971c, 1973; Urlichs, 1972). However, different stratigraphic classifications of the Zlambach Formation have been published in the literature on ostracods: Late Norian (Kozur, 1971a), Late Norian and Rhaetian (Kollmann, 1963; Kristan-Tollmann, 1970, 1971a, 1971b, 1971c, 1973), Rhaetian (Kollmann, 1960), or Late Norian to Rhaetian (Bolz, 1969, 1970a, 1970b, 1971, 1974). To obtain a reliable ostracod stratigraphy calibrated to the standard ammonoid zones, the biostratigraphic positions of the most important ostracod-bearing Rhaetian localities from the Northern Calcareous Alps, especially those from the Hallstatt region (Upper Austria and Styria), are updated based on new ammonoid findings (provided by L. Krystyn and M. Maslo) and on ammonoids recorded in literature. However, the subdivision of the Rhaetian underwent some changes in the last few decades. The early classifications have been summarized by Wiedmann et al. (1979) and Krystyn (1980: 74, 2007a, fig. 1). It is unnecessary to discuss in detail the follow-up changes which happened to the latest Triassic chronostratigraphic scale with up- and down-scaling of the Norian-Rhaetian boundary respectively revisions in the ammonoid zonal and subzonal scheme (Krystyn, 1990). After an intensive discussion within the Norian-Rhaetian boundary working group of the Subcommittee on Triassic

Stratigraphy, the base of the Rhaetian has been proposed at the first appearance of the conodont *Misikella posthernsteini*. By this, the Rhaetian includes now three ammonoid zones (*Paracochloceras suessi*, *Vandaites stuerzenbaumi*, and *Choristoceras marshi*) of which the oldest corresponds to part of the former classical Upper Norian of the Hallstatt Limestone Formation. This stratigraphic subdivision in *Paracochloceras suessi*, *Vandaites stuerzenbaumi*, and *Choristoceras marshi* zones (= Early, Middle, and Late Rhaetian) is adopted here. By incorporating the *Paracochloceras suessi* Zone to the Rhaetian, no terrigenous sediments from which ostracods could easily be extracted were left in the Northern Calcareous Alps and elsewhere in the western Tethys to the Norian. There are also no reports of Late Norian ostracods extracted from limestones by acidic dissolution. Therefore, we are without any knowledge of the immediate pre-Rhaetian ostracod fauna and without any idea on eventual changes in the ostracod fauna at the new Norian/Rhaetian boundary.

STRATIGRAPHIC DISTRIBUTION OF THE OSTRACODS AT STEINBERGKOGEL

Five samples comprising moderately preserved ostracods are at hand from thin marl beds of the uppermost Hallstatt Limestone Formation (*Paracochloceras suessi* Zone) which consists of grey well-bedded limestone beds at the Steinbergkogel locality (near Hallstatt/Upper Austria) (Fig. 1). The taxonomy of the Bairdiidae is adopted from Bolz (1971), and the taxonomy of

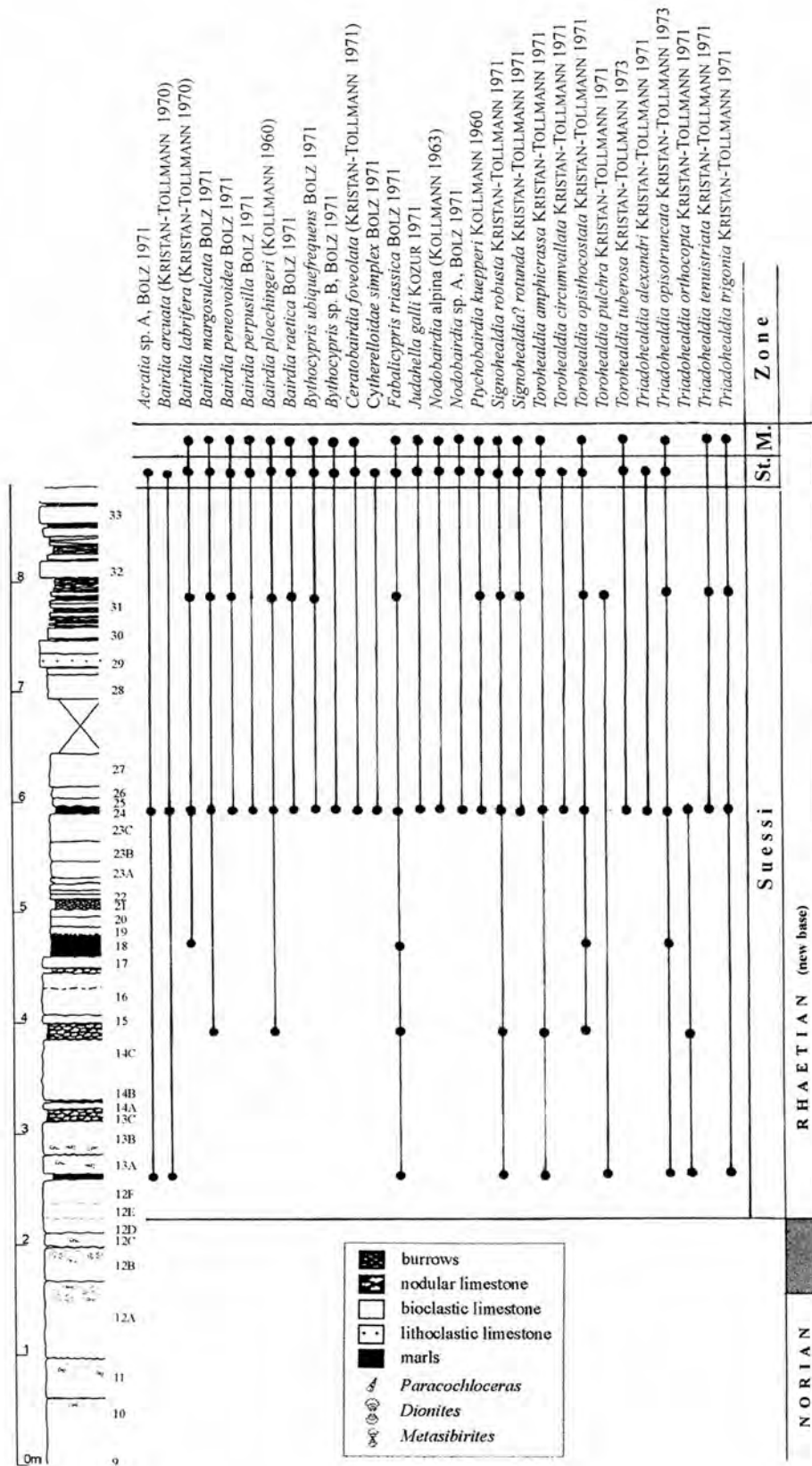


Figure 1 – Stratigraphic ranges of the ostracods from the *Paracochloceras suessi* Zone (Early Rhaetian) of Steinbergkogel (Upper Austria, section). Section from Krystyn et al., 2007b, fig. 6: section B+C). M. = *Choristoceras marshi* Zone, St. = *Vandaites stuerzenbaumi* Zone.

<i>P. suessi</i>	<i>V. stuerzenbaumi</i>	<i>Ch. marshi</i>	Zone	
Roßmoos, Steinbergkogel	Grünbachgraben, Höllgraben, Mühlgraben, Weißloferbach	Ampelsbach Fischerwiese, Rotwandl, Weißloferbach	Localities recorded by BOLZ (1970, 1971), supplemented by Steinbergkogel	
X	X	X	<i>Bairdia acerta</i> BOLZ 1971	Bairdiidae
	X		<i>Bairdia arcuata</i> (KRISTAN-TOLLMANN 1970)	
X	X	X	<i>Bairdia austriaca</i> (KOLLMANN 1963)	
	X		<i>Bairdia bicostata</i> (KRISTAN-TOLLMANN 1969)	
X	X		<i>Bairdia cincta</i> (KOLLMANN 1963)	
	X	X	<i>Bairdia fastigata</i> BOLZ 1971	
	X		<i>Bairdia hians</i> (KOLLMANN 1963)	
	X	X	<i>Bairdia labrifera</i> (KRISTAN-TOLLMANN 1970)	
X	X	X	<i>Bairdia margosulcata</i> BOLZ 1971	
	X		<i>Bairdia marginotumida</i> (KRISTAN-TOLLMANN 1969)	
X	X	X	<i>Bairdia penevoidea</i> BOLZ 1971	
	X	X	<i>Bairdia perdata</i> BOLZ 1971	
X	X	X	<i>Bairdia perpusilla</i> BOLZ 1971	
X	X	X	<i>Bairdia ploechingeri</i> (KOLLMANN 1960)	
X	X		<i>Bairdia raetica</i> BOLZ 1971	
	X	X	<i>Bairdia salisburgensis</i> (KOLLMANN 1963)	
X	X		<i>Bairdia ventriosa</i> BOLZ 1971	
X	X	X	<i>Bairdiacypris multidentata</i> BOLZ 1971	
X	X	X	<i>Bythocypris ubiquefrequens</i> BOLZ 1971	
	X	X	<i>Ceratobairdia triassica</i> BOLZ 1971	
X	X	X	<i>Fabalicypis triassica</i> BOLZ 1971	
X	X	X	<i>Lobobairdia salinaria</i> KOLLMANN 1963	
X	X	X	<i>Lobobairdia triassica</i> (KOLLMANN 1963)	
X	X	X	<i>Lobobairdia umbonata</i> (KOLLMANN 1963)	
X	X	X	<i>Nodobairdia alpina</i> (KOLLMANN 1963)	
X	X	X	<i>Nodobairdia dentata</i> BOLZ 1971	
	X		<i>Nodobairdia nodata</i> BOLZ 1971	
	X		<i>Nodobairdia triassica</i> BOLZ 1971	
	X		<i>Ptychobairdia circumvallata</i> KRISTAN-TOLLM. 1970	
X	X	X	<i>Ptychobairdia kuepperi</i> KOLLMANN 1960	
	X		<i>Ptychobairdia oberhauseri</i> KOLLMANN 1963	
	X	X	<i>Triebelina bicornuta</i> (KOLLMANN 1963)	
	X	X	<i>Triebelina longiforma</i> BOLZ 1971	
	X	X	<i>Triebelina ornata</i> (KOLLMANN 1963) *)	
	X		<i>Triebelina parva</i> BOLZ 1971 **)	
	X	X	<i>Triebelina reticulata</i> (KRISTAN-TOLLMANN 1970)	
X	X	X	<i>Cytherelloidea circumscripta</i> (BLAKE 1876)	Cytherelloidea
	X	X	<i>Cytherelloidea latereticulata</i> BOLZ 1970	
	X	X	<i>Cytherelloidea percostata</i> BOLZ 1970	
X	X	X	<i>Cytherelloidea plana</i> BOLZ 1970	
X	X	X	<i>Cytherelloidea pulchella</i> BOLZ 1970 ***)	
X	X		<i>Cytherelloidea simplex</i> BOLZ 1970	
X	X	X	<i>Cytherelloidea triassica</i> BOLZ 1970	
	X	X	<i>Cytherelloidea unicastata</i> BOLZ 1970	
X	X	X	<i>Cytherelloidea valida</i> BOLZ 1970	

Table 1 – . Updated ranges of the ostracod species of the Bairdiidae and Cytherelloidea recorded by Bolz (1969, 1970a, 1971), except those in open nomenclature. *) junior synonym: *Dicerobairdia variolaria* Kristan-Tollmann (1971). **) junior synonym: *Dicerobairdia trinodosa* Kristan-Tollmann (1971). *** = *Cytherelloidea buisensis* Donze (1966).

Kristan-Tollmann (1970, 1971a, 1971b, 1971c, 1973) is still used here, though the healdiid genera and species introduced by her should be revised. The ostracod assemblages from Steinbergkogel are dominated both in diversity and abundance by Healdiidae. Smooth-shelled Bairdiidae are also highly diverse but poorly abundant, and ornamented Bairdiidae are merely represented by single *Ptychobairdia* specimens. The bairdiid species found at Steinbergkogel have been furthermore recorded from the lowermost Zlambach Formation just above the Hallstatt Limestone Formation (*Paracochloceras suessi* Zone) at the locality Roßmoos north-east of Bad Goisern (Upper Austria) by Bolz (1974: 327). Most species of the Bairdiidae and Healdiidae recorded from these localities range from the *Paracochloceras suessi* Zone into the younger *Vandaites stuerzenbaumi* and *Choristoceras marshi* zones (Fig. 1, Tab. 1). Merely, some species of the genera *Triadohealdia* and *Torohealdia* are hitherto unknown from younger zones, probably because they are still not investigated from there.

The ostracod assemblages from the Zlambach Formation which are dominated in diversity by Healdiidae and smooth-shelled Bairdiidae represent deep-water conditions. The water depth of the Hallstatt Basin has been supposed to be below 250 and 300 m estimating the height of the palaeoslope from the platform to the basin at Gosaukamm/Salzburg (Krystyn, 1991: 66). Ostracod assemblages from the Alpine Late Anisian with a similar faunal content have been interpreted as representatives of deep-shelf or even bathyal environments (Kozur, 1971b, 1972: 634). Another association, also with an abundance especially of ornamented Bairdiidae (*Ptychobairdia*) and furthermore of smooth-shelled Bairdiidae (*Bairdia*, *Bairdiacypris*, *Bythocypris*) has been described from the Early Pliensbachian of the Pontides/Turkey (Lord & Lambourne, 1991: 382). It represents deep-water, perhaps bathyal conditions. In contrast, ostracod genera indicating neritic environments are very rare in the *Paracochloceras suessi* Zone at Steinbergkogel. Only single specimens of *Nodobairdia* and *Judahella* are recorded from there.

IS THERE AN END-NORIAN BIOTIC CRISIS IN OSTRACODS?

McRoberts et al. (2008: 726) stated that “it has long been recognized that an extraordinary event took place around the Norian/Rhaetian boundary that primarily affected the pelagic fauna dominated by monotid bivalves and ammonoids.” This mass extinction has been also alleged in ostracods at the former Norian/Rhaetian boundary (Kozur, 1971b: 4, 1972: 627, 1980: 122; Kozur & Mostler, 1972: 349). To check up this assumption, the stratigraphic ranges of the Bairdiidae and Cytherelloidea from the Zlambach Formation described by Bolz (1969, 1970a, 1970b, 1971) are updated. Not only a decrease in diversity is missing at the boundary from the *Paracochloceras suessi* Zone to the *Vandaites stuerzenbaumi* Zone, but in contrast an increase in diversity has been observed from 18 species of Bairdiidae in the *Paracochloceras suessi* Zone to 36 species in the *Vandaites stuerzenbaumi* Zone and a decrease to 24 species in the *Choristoceras marshi* Zone (Tab. 1). The reason for this increase is first of all the first appearance of

Nodobairdia and *Triebelina* species in the *Vandaites stuerzenbaumi* Zone besides a higher diversity in smooth-shelled Bairdiidae. *Nodobairdia* and *Triebelina* which originally lived in the neritic zone have been transported downslope and redeposited in deeper water of the adjacent Hallstatt Basin. Allogenic beds with an input of neritic associations are rare in the basal sediments of the *Paracochloceras suessi* Zone at Steinbergkogel, but frequent in the *Vandaites stuerzenbaumi* and *Choristoceras marshi* zones at other localities. The decrease in diversity in the *Choristoceras marshi* Zone mainly results from a lower diversity of smooth-shelled *Bairdia* species which had a high diversity in deep-shelf and bathyal environments. Therefore, the differences in the ostracod diversity between the three Rhaetian zones result from different ecological conditions. The stratigraphic distribution of the Cytherelloidea is similar. After Bolz (1970a), six species have been recorded in the *Paracochloceras suessi* Zone, nine in the *Vandaites stuerzenbaumi* Zone, and eight in the *Choristoceras marshi* Zone (Tab. 1). However, Cytherelloidea are very rare in the Zlambach Formation and thus insignificant for ecological interpretations.

CONCLUSIONS

The faunistic relationships between the ostracods of the *Paracochloceras suessi*, *Vandaites stuerzenbaumi*, and *Choristoceras marshi* zones are very close: All ostracod species recorded from the *Paracochloceras suessi* Zone, except few *Triadohealdia* and *Torohealdia* species, range into the *Vandaites stuerzenbaumi* Zone and most of them also into the *Choristoceras marshi* Zone (Fig. 1, Tab. 1). This stratigraphic distribution of the ostracods corroborates the formal incorporation of the *Paracochloceras suessi* Zone to the Rhaetian Stage. Ostracods from the Late Norian in the revised sense are unknown, and therefore, a comparison with ostracod associations older than *Paracochloceras suessi* Zone (Early Rhaetian) is impossible.

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