

OSTRACODS ACROSS THE PERMIAN-TRIASSIC BOUNDARY IN WESTERN TETHYS: THE BULLA PARASTROTOTYPE (SOUTHERN ALPS, ITALY)

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Received: February 27, 2008; accepted: May 26, 2008

Key words: Ostracods, Permian-Triassic boundary, Bulla section, Italy.

Abstract. Investigation of the ostracod fauna of the parastratotype of the Permian-Triassic boundary at Bulla in the Southern Alps produced 62 species belonging to 31 genera. They are all discussed and figured. This paper presents results of the first description of ostracods from this important site. One genus, *Bairdiacratia* n. gen., and 13 species are new: *Glyptopleurina pasinii* n. sp., *Knoxiella ventrospinosa* n. sp., *Knightina bullaensis* n. sp., *Bairdia ortiseiensis* n. sp., *B. cheni* n. sp., *B. (Rectobairdia) kershawi* n. sp., *Bairdiacratia qinglai* n. gen. n. sp., *B. tergilata* n. gen. n. sp., *Microcheilnella lata* n. sp., *Parabythocythere chongpani* n. sp., *Cavellina bellerophonella* n. sp., *C. alpina* n. sp. and *C. triassica* n. sp. The palaeoecological analysis of each unit is produced. The unconformity-paraconformity U1 is clearly reflected in the ostracod assemblages and is marked by a drop in diversity and abundance of specimens. It was followed by a change in the ostracod faunal composition. The Bulla Member displays maximum ostracod diversity and abundance linked with the transgressive trend reported for this period. The unconformity-paraconformity U2, at the boundary between the Bellerophon and Werfen formations (Bulla and Lower Tesero members) is the main extinction level for ostracods. The Lower Tesero, Lower Mazzin and Upper Tesero members have very poor faunas. The lower part of the Upper Mazzin Mb. is characterized by an uneven burst of diversity before the great period of taxonomic paucity observed during the late Griesbachian all over the world.

Riassunto. Per mezzo dell'analisi delle faune ad ostracodi del parastratotipo del limite Permiano-Triassico a Bulla (BZ) nelle Alpi Meridionali, sono state identificate 62 specie appartenenti a 31 generi. La loro discussione e documentazione iconografica è argomento di questo lavoro. Vengono descritti un nuovo genere, *Bairdiacratia* n. gen., e 13 nuove specie: *Glyptopleurina pasinii* n. sp., *Knoxiella ventrospinosa* n. sp., *Knightina bullaensis* n. sp., *Bairdia ortiseiensis* n. sp., *B. cheni* n. sp., *B. (Rectobairdia) kershawi* n. sp., *Bairdiacratia qinglai* n. gen. n. sp., *B.*

tergilata n. gen. n. sp., *Microcheilnella lata* n. sp., *Parabythocythere chongpani* n. sp., *Cavellina bellerophonella* n. sp., *C. alpina* n. sp. and *C. triassica* n. sp. Per ciascuna unità litostratigrafica viene riportata l'analisi paleoecologica. Le associazioni ad ostracodi riflettono in modo evidente la superficie di discontinuità U1 (unconformity-paraconformity 1) che separa l'Unità ad ostracodi (Ostracod and peritidal dolomite unit) e il Membro di Bulla (Bulla Mbr) della Formazione a Bellerophon, con un calo drastico in diversità e abbondanza. La maggiore diversità e abbondanza delle faune ad ostracodi è associata alla fase trasgressiva del Membro di Bulla. Il principale evento di estinzione ad ostracodi coincide con la superficie di discontinuità U2 (unconformity-paraconformity 2) posta in corrispondenza del limite formazionale fra la Formazione a Bellerophon e la Formazione di Werfen, fra i membri di Bulla e del Tesero Inferiore. I membri del Tesero Inferiore, Mazzin Inferiore e Tesero Superiore presentano una fauna ad ostracodi veramente povera. La parte inferiore del Membro del Mazzin Superiore è caratterizzata da un irregolare incremento di diversità che precede il periodo di scarsa tassonomia osservato a livello mondiale durante il tardo Griesbachiano.

Introduction

The Bulla section in the Southern Alps is the parastratotype section for the Permian-Triassic (P-T) boundary. It was located at that time in western Tethys whereas the P-T stratotype at Meishan in China was located near the eastern border of Tethys. The Bulla section, well-known from many investigations, has been described in detail by Perri (1991), Farabegoli & Perri (1998), Perri & Farabegoli (2003) and Farabegoli et al. (2007 and references therein). Apart from a preliminary note (Pasini 1981) on ostracods from the upper part of the Bellerophon Formation at Digonera and Rio Bar-

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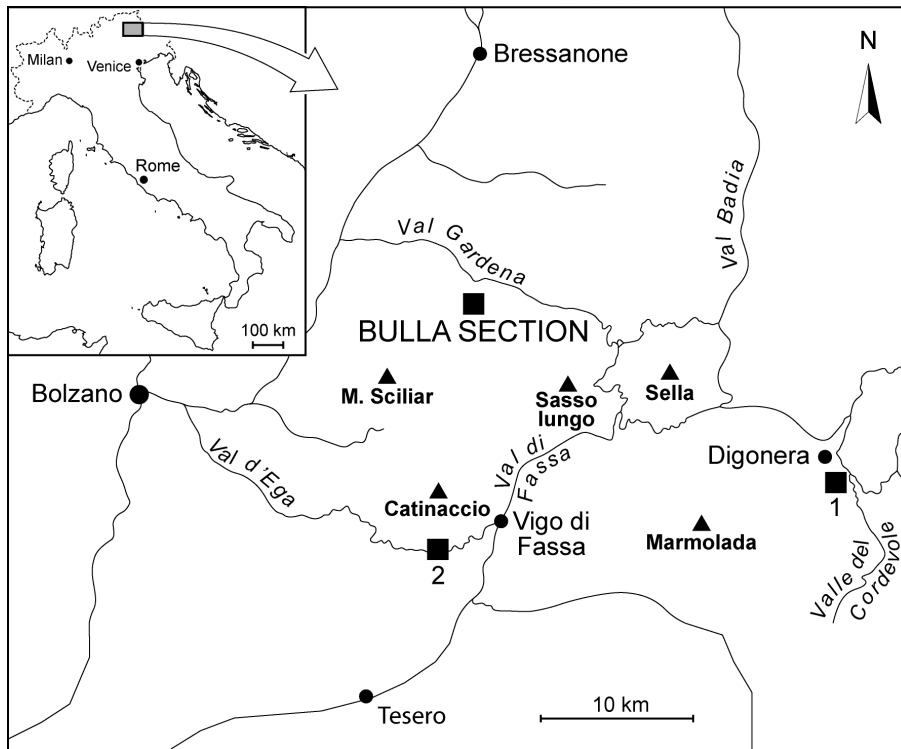


Fig. 1 - Location of the Bulla section, Bulla (Bolzano), Southern Alps, northern Italy, showing principal roads. Digonera (1) and Rio Barbide (2) are locations of Pasini's ostracod faunas.

bide (28 km SE and 16 km S of Bulla respectively; Fig. 1), ostracods from the P-T boundary interval in the Southern Alps have not been documented. Pasini (1981) described one new species, *Sargentina dolomitica*, here referred to the synonymy of *S. postacuta* Zálányi, 1974, one species in open nomenclature *Glyptopleurina* (?) sp. A (here referred to *G. pasinii* n. sp.) and figured a drepanellacean here attributed to *Neoulrichia pulchra* Kozur, 1981.

Of 47 samples processed by hot acetolysis (Lethiers & Crasquin-Soleau 1988; Crasquin-Soleau et al. 2005), 27 produced 62 species of ostracods referred to 31 genera; these are all figured.

Geological setting

This geological presentation is based on the publication of Farabegoli et al. (2007) and references therein. The Southern Alps Late Permian-Early Triassic succession is 40-600 m thick. On the new 1:50,000 Geologic Map of Italy, it is considered to consist of three informal units (Neri 2004): Val Gardena Sandstone (Lopingian), Bellerophon Formation (Lopingian) and Werfen Formation (latest Changhsingian-Olenekian). For this study, we sampled the upper part of the Bellerophon Fm. (Fig. 2) with its two units, the 'Ostracod unit' below and Bulla Mb. above, and the base of the Werfen Fm. with the interfingering succession of the Tesero and Mazzin members (see Farabegoli et al. 2007, Fig. 3).

Upper part of the Bellerophon Formation (Changhsingian):

- The 'Ostracod unit' (Changhsingian) is composed of grey silty dolomitic mudstone-wackestone alternating with subordinate grey to reddish shales (Fig. 2); thickness is ca 15 m. This unit was referred to mostly as the natural "regressive" fill over the previous algal shallow-marine environment (e.g. Massari et al. 1994). Only the upper 2 m were sampled for this study (samples 05BUSC1 to 05BU1B).

- The Bulla Mb. overlies the 'Ostracod unit' with an unconformable-paraconformable erosional surface, referred to as "U1" by Farabegoli et al. (2007). U1 documents a rapid sea-level fall, followed by a very short period of subaerial emersion that produced cementation of the old sea floor. The Bulla Mb. consists of 135 cm of dark grey to black fossiliferous limestone (packstone-wackestone) alternating with subordinate siltstone and marl (Perri & Farabegoli 2003). No conodonts have been found in this member in the Bulla section. It was deposited in shore-face to foreshore environments of an otherwise open shallow sea near the base of fair-weather waves (i.e. at a depth of 2-6 m). This event U1 and its related hiatus could correspond to the limit between sequences SQ2 and SQ3 of Zhang et al. (1996) in Meishan D section, i.e. to beds 24d-e because it contains "abraded bioclasts" caused by "short-term exposures on land" (Zhang et al. 1996; p.73-77). All members of this unit were sampled (samples 05BU1C to 05BU7A). Incidentally, the upper part of the Bulla Mb. produced the most diverse assemblage of foraminifers from the Bel-

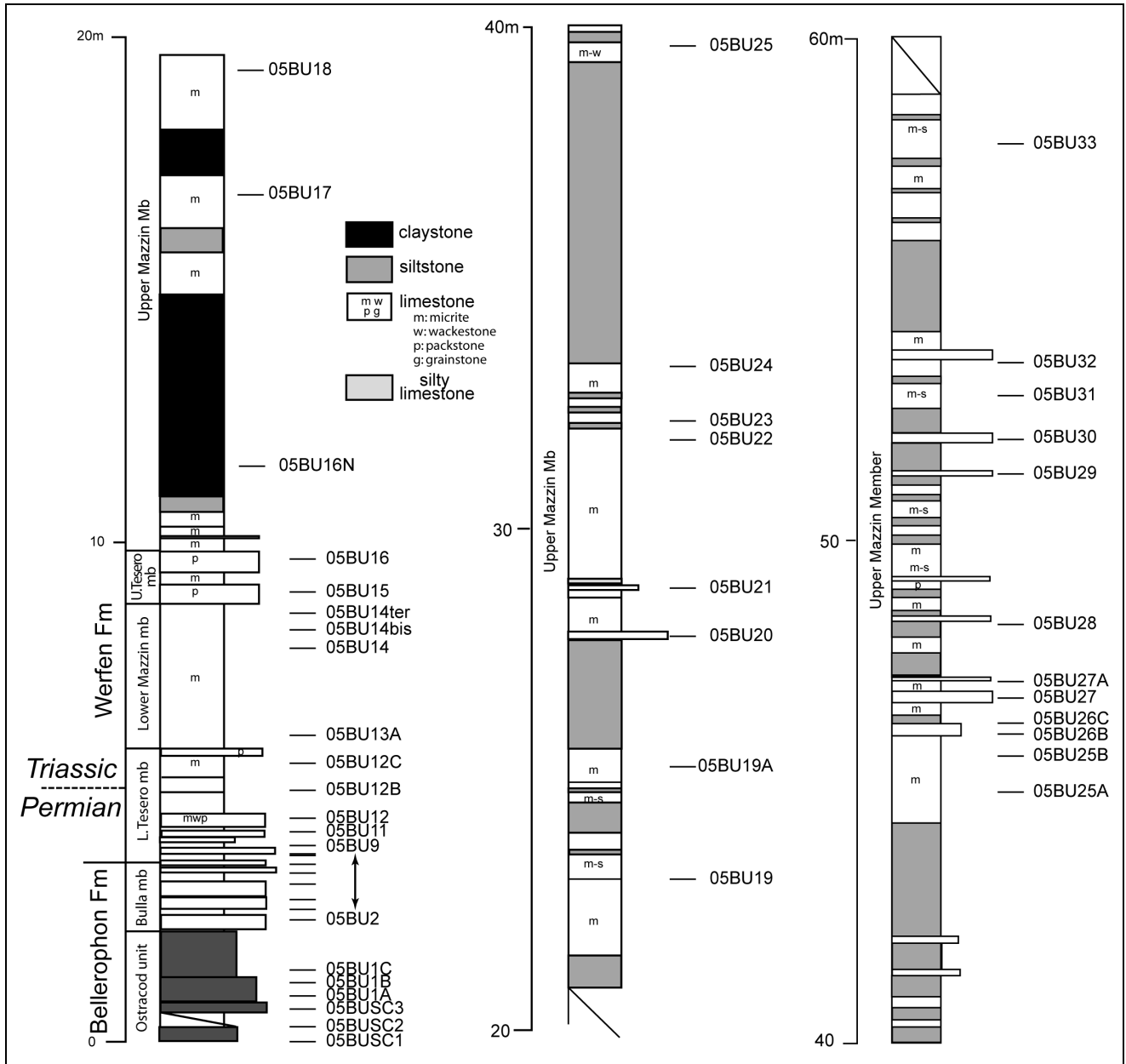


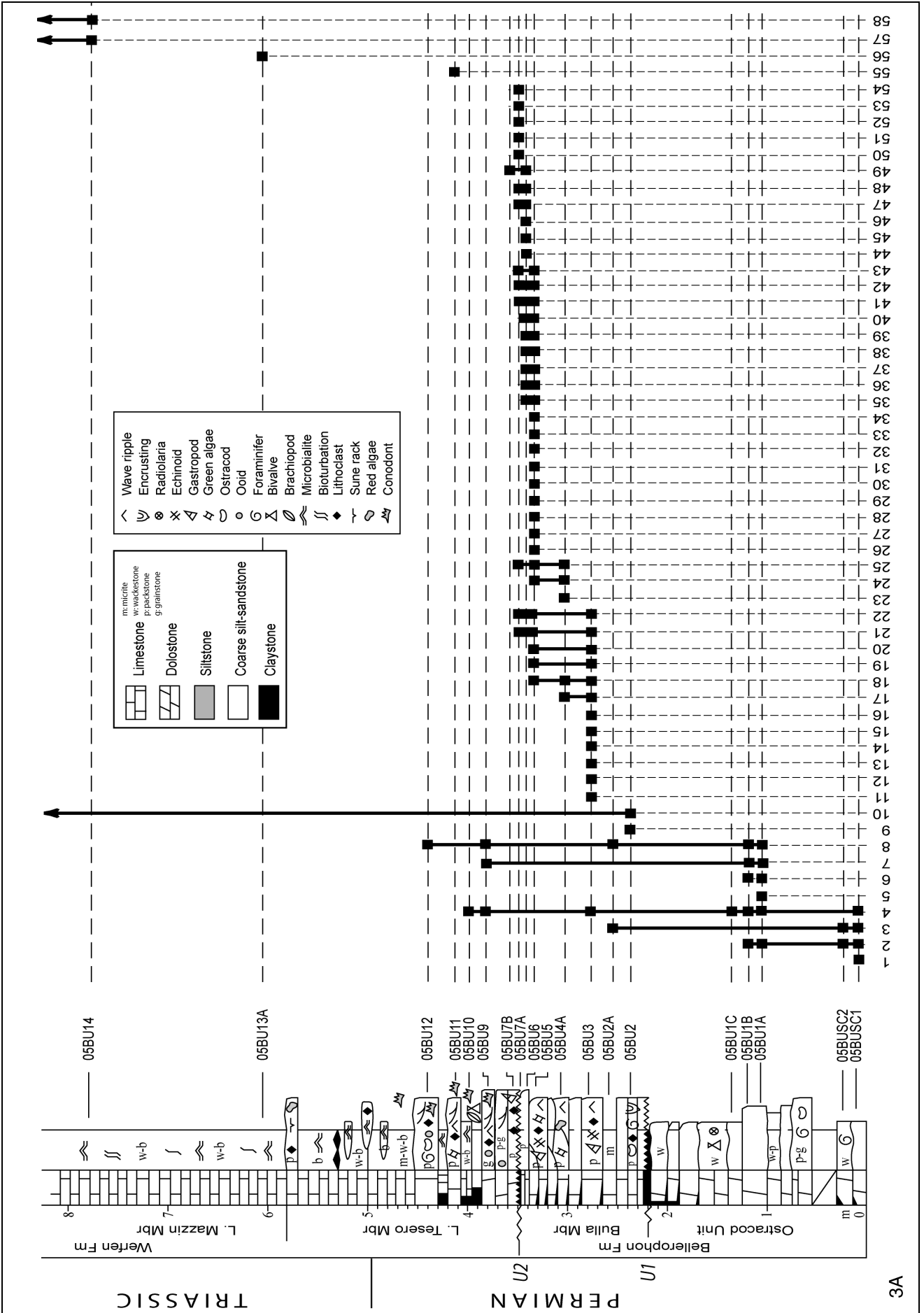
Fig. 2 - Stratigraphic columns of the Bulla section (from Farabegoli et al. 2007) with sample locations.

lerophon Fm. in the Southern Alps (Broglia Loriga et al. 1988).

- The boundary between the Bellerophon and Werfen formations is a sharp paraconformable – unconformable surface referred to as “U2” by Farabegoli et al. (2007) and interpreted as the boundary of a short-term sequence produced by a rapid sea-level fall, followed locally by a very short period of subaerial emersion. This E2 event could be correspond to Bed 26 in Meishan D section which is interpreted as representing a fall in sea-level and low-stand tract (Farabegoli et al. 2007; p. 123). The maximum of biodiversity decrease (“E1”) in the Southern Alps brackets U2 (Farabegoli et al. 2007).

Werfen Formation:

- The Lower Tesero Mb. (2.3 m, samples 05BU7B-05BU13) is mainly dark grey limestone with subordinate silty shale interbeds. The very base (samples 05BU7B-05BU8) is a 20 cm dark grey, mixed terrigenous-calcareous “layer” with hummocky cross-bedding and wave ripples. The next ca 80 cm (samples 05BU9-05BU12) consists of four bed/bedsets of oolitic grainstone-packstone with hummocky and wave ripples alternating with subordinate silty shale, pelletoid wackestone and subplanar to lenticular-columnar microbialitic layers. Sample 05BU10 has produced a few fish teeth and an abundant conodont fauna including *Hindeodus praeparvus*, *H. typicalis* and *Isarcicella prisca* associated



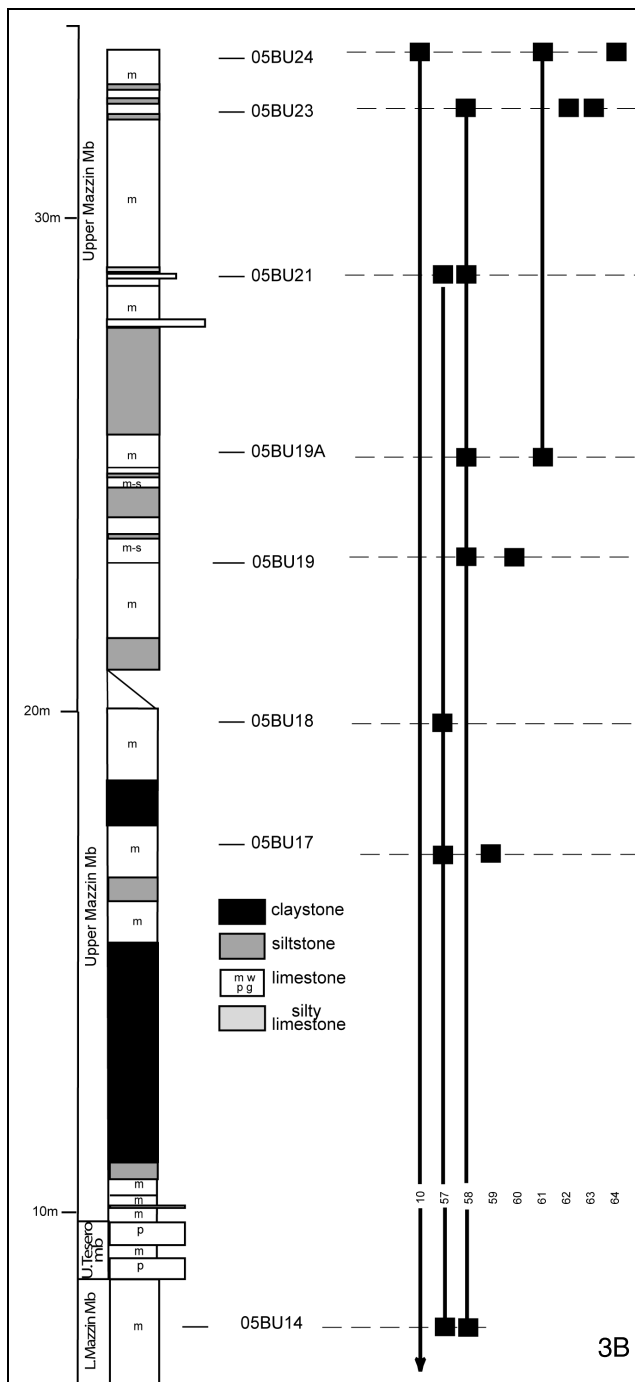


Fig. 3 - Stratigraphic columns of the Bulla section with vertical distributions of the ostracod faunas (for species names see Tab. 1). 3A: lower part; 3B: upper part.

with the entry of *I. peculiaris*. The following interval, samples 05BU11-05BU12, consists of two oolitic packstone layers containing reworked lithoclasts separated by a silty shale layer. Samples 05BU12A-05BU12B (ca 50 cm) consists of alternating cm-beds of pelletoidal wackestone, silty mudstone, siltstone and discontinuous, dome-shaped microbialites. Interval 05BU9-05BU12A has been referred to the late *praeparvus* Zone (late Changhsingian) (Perri & Farabegoli 2003).

The base of 05BU12B is the inferred P-T boundary in the Bulla section. *Hindeodus typicalis*, *H. pisai*, *Isarcicella prisca* and *I. turgida* occur in association with the index of the beginning of Triassic, *H. parvus*.

The interval top 05BU12B-top 05BU13 (ca 80 cm) consists of parallel-bedded and often lenticular, microbialitic layers. These pass laterally to silty marls and siltstones with wave ripples. It is referred to the *parvus* Zone. The Lower Tesero Mb. (05BU7B-05BU13) is interpreted as a short-term transgressive-regressive cycle.

- The Lower Mazzin Mb., a 2.90 m interval from top of 05BU13A to base of 05BU15, is composed of grey mudstone and pelletoid-lumped wackestone with planar microbialitic structures. Bioturbation is present and may be frequent; a few layers display mottled structure. Fossils are rare (ostracods, gastropods); only the lower part of this interval 05BU13A-05BU13B, still referred to the *parvus* Zone, produced a few small *H. parvus*. The environment is interpreted as calm, oxygenated, marine inner offshore, well below fair-weather waves. Absence or scarcity of grain-supported storm-layers (e.g. Tesero section) is in accord with relative deepening of a transgressing sea.

- The 1.35 m Upper Tesero Mb. consists of five oolitic-intraclastic beds (samples 05BU15-05BU16) alternating with mudstone-wackestone, thinning and fining upwards. Fossils are extremely scarce; no conodonts were found. This sequence can be explained in terms of lateral shifting of coastal facies and storm layers following rapid marine shallowing.

- The 60 m Upper Mazzin Mb. (samples 05BU16N-05BU33) corresponds to a major influx of fine terrigenous siliciclastic sediment. In the lower part, thin wavy-bedded, bioturbated grey siltstone alternates with thin beds of mudstone with occasionally prominent planar microbialitic lamination. Some calcarenitic storm layers are intercalated up-section (05BU16N-05BU25). Fossils are sparse. Rare foraminifers, small gastropods and ostracods accumulated in thin layers. *Lingula* occurs at 12 m from the base of the Werfen Fm. This brachiopod is considered in the context of the End-Permian mass extinction as a disaster taxon (Rodland & Bottjer 2001). At 16 m, sample BU18, the biotic diversity increases slightly with appearance of *Unionites* and microgastropods. At 18 m above the base of the Werfen Fm. (50 cm below 05BU19), the *Claraia wangi-griesbachi* group occurs in association with *Unionites canalensis*, aviculopectinids, *B. vaceki*, *Holopella gracilior*, *Lingula*, and ostracods. Recurring conodont faunas allow discrimination of three conodont biozones with entry of the biozonal markers *I. lobata* (BU23), *I. staeschei* (at 42.80 m, 05BU25A) and *I. isarcica* (at 45 m, 05BU27) (Perri & Farabegoli 2003). Conodont abundance and diversity is again re-established and can be compared with those of the 05BU9-05BU12B interval.

Late Induan-Early Olenekian conodont faunas of the Southern Alps are represented by very shallow-water taxa such as the multi-element species *Hadrodontina aequabilis*, *H. anceps* and *H. obliqua* (Perri & Andraghetti 1987; Perri 1991). The inferred depositional environment of the lower part is prograding thin deltaic lobes in a well ventilated, low-energy, shallow sea, probably with a substantial influx of brackish water. The unbioturbated upper interval marks return to schizohaline conditions with modest reduction in terrigenous input.

Ostracod palaeontology (SC)

Forty-seven samples bracketing the Permian-Triassic boundary were processed by hot acetolysis (Lethiers & Crasquin-Soleau 1988; Crasquin-Soleau et al. 2005), 27 of them producing ostracods. Sixty-two species belonging to 31 genera are identified and figured (Pl. 1-6). One genus and 13 species are new and are described here. One species is newly named. There are 27 species in open nomenclature because of insufficiency of material or inadequate preservation to justify extended treatment. All the ostracod species are illustrated and biostratigraphic data reported on Tab. 1.

All specimens are deposited in the Pierre et Marie Curie University (Paris, France) with collection numbers P6M.

Systematic Palaeontology

Abbreviations: L: length, H: height, W: width; AB: anterior border; VB: ventral border; PB: posterior border; DB: dorsal border; LV: left valve; RV: right valve.

Subphylum **Crustacea** Brünnich, 1772

Class **Ostracoda** Latreille, 1806

Subclass **Podocopa** Müller, 1954

Order **Palaeocopida** Henningsmoen, 1953

Suborder **Kloedenellocopina** Scott, 1961

Superfamily **Kloedenelloidea** Ulrich & Bassler, 1908

Family **Knoxitidae** Egorov, 1950

Genus *Langdaia* Wang, 1978

Type species: *Langdaia suboblunga* Wang, 1978

Langdaia laolongdongensis Crasquin-Soleau & Kershaw, 2005

Pl. 1, figs 1-2

2005 *Langdaia laolongdongensis* n. sp. Crasquin-Soleau & Kershaw, p. 135-137, pl. 2, figs 7-12.

Stratigraphic and geographic distribution. Earliest Griesbachian of Sichuan (Crasquin-Soleau & Kershaw 2005); samples 05BU14, 05BU19, 05BU19A, 05BU21, 05BU23, Mazzin Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Langdaia suboblunga Wang, 1978

Pl. 1, fig. 3

1978 *Langdaia suboblunga* gen. et sp. nov. Wang, p. 289, pl. 2, figs 8-11.

2005 *Langdaia suboblunga* Wang, 1978 – Crasquin-Soleau & Kershaw, pl. 2, figs 1-6.

Stratigraphic and geographic distribution. Early Triassic of Guizhou and Yunnan (Wang 1978), earliest Griesbachian of Sichuan (Crasquin-Soleau & Kershaw 2005), South China; sample 05BU19, Mazzin Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Genus *Glyptopleurina* Coryell, 1928

Type species: *Glyptopleurina montifera* Coryell, 1928

Glyptopleurina pasinii Crasquin n. sp.

Pl. 1, figs 4-5

?1981: *Glyptopleurina* (?) sp. A – Pasini, p. 10-12, pl. 3, figs 1-11.

Derivation of name. Dedicated to Prof. Mario Pasini who described the first Late Permian ostracods from the Southern Alps.

Holotype. One complete carapace figured Pl. 1, fig. 4; collection number P6M2233.

Paratype. One complete carapace figured Pl. 1, fig. 5, collection number P6M2234.

Type-level. Sample 05BU05, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., Changhsingian; Late Permian.

Material. 2 carapaces, 1 isolated valve and several fragments.

Diagnosis. A species of *Glyptopleurina* with two parallel ridges on L2, important flattening of posterior part of the carapace and large reticulation.

Description. Carapace of heavy aspect; DB straight; AB with small radius of curvature, with maximum of convexity located in the lower 1/3 of height; VB long and nearly straight; PB with small radius of curvature and maximum of curvature located high; L2 and S2 well developed; S1 observable on some specimens (Pasini 1981; Pl. 3, fig. 1); L2 elongated backward and subdivided in two parts by the presence of two parallel ridges, one in dorsal position and the other one in median position; dorsal ridge originates at S2 level close to the hinge and finishes at the upper extremity of L2, which is above the hingeline; the median ridge begins below S2, which is located at mid-height and mid-length, follows L2 and ends at its extremity; BP strongly compressed laterally back of L2, producing

a flattening along the BP which continues on the ventral part of the carapace; left valve overlaps right on free margins; surface with coarse reticulation; possible sexual dimorphism (with higher BP).

Remarks. It was not possible to find Pasini's original material. The figured specimens of *Glyptopleurina?* sp. A (Pasini 1981; Pl. 3, figs 1-11) may belong to our new species.

Size. L= 520-615 µm, H= 280-340 µm.

Stratigraphic and geographic distribution. Digenera and Rio Barbide (Pasini 1981); samples 05BU4A, 05BU5 and 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Genus *Knoxiella* Egorov, 1950

Type species: *Knoxiella semilukiana* Egorov, 1950

Knoxiella ventrospinosa Crasquin n. sp.

Pl. 1, figs 7-11

Derivation of name. From the presence of a spine located in the ventral part of the carapace.

Holotype. One complete carapace figured Pl. 1, figs 7 and 11; collection number P6M2236.

Paratype. One complete carapace figured Pl. 1, fig. 8, collection number P6M2237.

Type-level. Sample BU1A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., Changhsingian; Late Permian.

Material. More than 30 carapaces and several fragments.

Diagnosis. A species of *Knoxiella* with a small spine in the median part of the ventral border of the left valve.

Description. DB straight for both valves, AB rounded with maximum convexity located below mid-height; VB nearly straight on LV, slightly arched on RV; PB with small radius of convexity and maximum convexity located near the upper 1/3 of height; RV overlaps LV all around free margins with maximum on VB; S2 well developed; carapace laterally flattened on anterior and posterior parts; surface smooth.

Remarks. This species could be distinguished from other species of the genus, like *Knoxiella suboblunga* Wang, 1978 (Late Permian of Guizhou and Yunnan, South China; Wang 1978) or *Knoxiella infirma* Shi, 1982 (Wordian of Turkey; Crasquin-Soleau et al. 2004), Changhsingian of Hubei Province (Chen & Shi 1982) and Saudi Arabia (Crasquin-Soleau et al. 2005) by its ventral spine and its shallower S2.

Size. L= 440-635 µm, H= 240-355 µm.

Stratigraphic and geographic distribution. samples 05BUSC1, 05BU1A, 05BU1B, 05BU1C, 05BU03, 05BU09, 05BU10, 'Ostracod unit' and Bulla Mb., Bellerophon Fm., Lower Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Family Serenidae Rozhdvenskaya, 1972

Genus *Sargentina* Coryell & Johnson, 1939

Type species: *Sargentina allani* Coryell & Johnson, 1939

Sargentina postacuta (Zalányi, 1974)

Pl. 1, fig. 12-14

1974 *Hollinella permiana* sp. nov. Zalányi, p.108-109, pl.1, fig. 4; pl.14, figs 3a-d.

1974 *Hollinella postacuta* sp. nov. Zalányi, p.113-114, pl.1, figs 2a-d.

1974 *Hollinella visnyoensis* sp. nov. Zalányi, p.113-114, pl.1, figs 3a-c.

PLATE 1

All specimens are from the Bulla section, Southern Alps, Italy. Scale bar is 100 µm. All specimens are stored at the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

Figs. 1-2 - *Langdaia laolongdongensis* Crasquin-Soleau & Ker-shaw, 2005.

Fig. 1 - Collection number: P6M2230, left lateral view of complete carapace, sample number 05BU05; fig. 2 - Collection number P6M2231, left lateral view of complete carapace; sample number 05BU05.

Fig. 3 - *Langdaia suboblunga* Wang, 1978. Collection number: P6M2232, left lateral view of complete carapace, sample 05BU19.

Figs 4-5 - *Glyptopleurina pasinii* Crasquin n. sp.

Fig. 4 - Holotype, collection number: P6M2233, left lateral view of complete carapace, sample 05BU05; fig. 5 - Paratype, collection number P6M2234, right lateral view of complete carapace, sample 05BU7A.

Fig. 6 - *Geffenina?* sp. 1. Collection number: P6M2235, left lateral view of complete carapace, sample 05BU7A.

Figs 7-11 - *Knoxiella ventrospinosa* Crasquin n. sp.

Fig. 7 - Holotype, collection number: P6M2236, left lateral view of complete carapace. sample 05BU1A; fig. 8 - Paratype, collection number P6M2237, left lateral view of complete carapace, sample 05BU1A; fig. 9 - collection number: P6M2238, left lateral view of complete carapace, sample number 05BU1A; fig. 10 - collection number: P6M2239, right lateral view of complete carapace, sample number 05BU1A; fig. 11 - enlargement of fig. 7. Detail of the ventral spine.

Figs 12-14 - *Sargentina postacuta* (Zalányi, 1974).

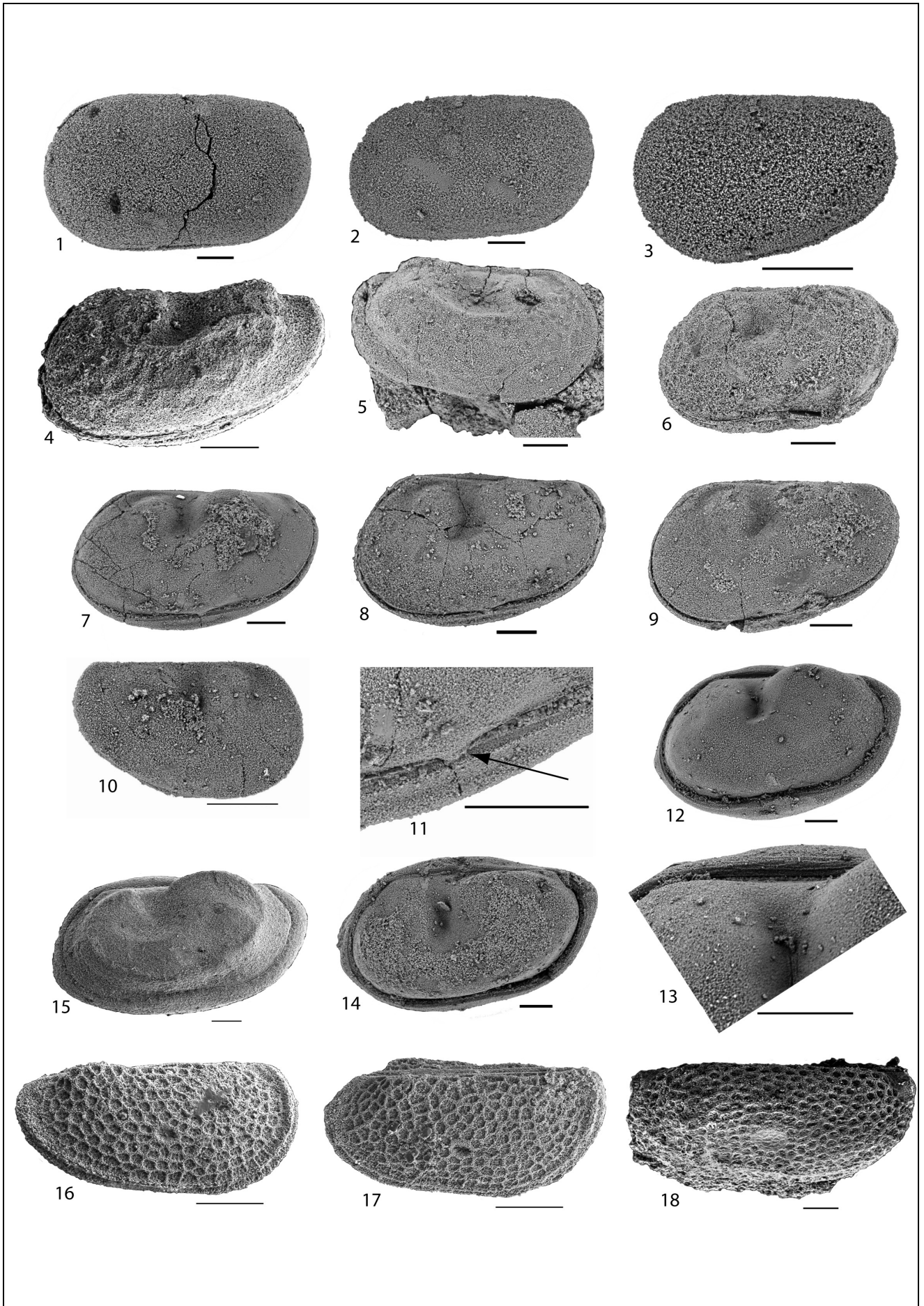
Fig. 12 - Collection number P6M2240, left lateral view of complete carapace, sample number 05BU1A; fig. 13 - Detail of complete carapace of figure 12; fig. 14 - Collection number P6M2241, left lateral view of complete carapace, sample number 05BU1A

Fig. 15 - *Sargentina* n. sp. A. Collection number P6M2242, left lateral view of a complete carapace, sample 05BU03.

Figs 16-17 - *Knighitina bullaensis* Crasquin n. sp.

Fig. 16 - Holotype, Collection number P6M2243, right lateral view of complete carapace, sample 05BU05; fig. 17. Paratype, Collection number P6M2244, right lateral view of complete carapace, sample 05BU05.

Fig. 18 - *Kirkbya* cf. *buekkensis* Kozur 1985. Collection number P6M2245, right lateral view of complete carapace, sample number 05BU4A.



1981 *Sargentina dolomitica* sp. n. Pasini, p.7-9, pl.1, figs 5-7; pl.2, figs 1-13; fig.2.

Revised diagnosis. A species of *Sargentina* with AB and PB angular at RV; striation parallel to the margins and present all around the overlap of RV on LV.

Discussion. Zalányi (1974) described 3 new species from the Late Permian of the Bükk Mountains, Hungary. These three species are here considered to be synonyms; similar salient intraspecific variation is apparent also in Pasini's (1981) Italian material as well as in our material. Of the three species names used by Zalányi (1974), the second (*postacuta*) is selected because of overuse of "*permiana*" as a species name.

Stratigraphic and geographic distribution. Late Permian, Bükk Mountains, Hungary (Zalányi 1974); Trento (northern Italy), late Changhsingian; Digonera and Vigo di Fassa, Trento (northern Italy), Late Bellerophon Fm., late Changhsingian (Pasini 1981); samples 05BU1A, 05BU1B, 05BU2A, 05BU9 and 05BU12, 'Ostracod unit', Bellerophon Fm., Lower Tesero Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Sargentina n. sp. A

Pl. 1, fig. 15

Remarks. This species is characterized by an important ridge which begins on the upper part of S2, winds round S2, runs parallel to VB and follows the external part of L3. There is also a small horizontal ridge below S2. This species is very characteristic and different from other representative of the genus, but unfortunately we found only one specimen.

Stratigraphic and geographic distribution. Sample 05BU03, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Suborder **Kirkbyocopina** Gründel, 1969

Superfamily Kirkbyoidea Ulrich & Bassler, 1906

Family Kirkbyidae Ulrich & Bassler, 1906

Genus *Knightina* Kellett, 1933

Type species: *Amphissites allorismoides* Knight, 1928

Knightina bullaensis Crasquin n. sp.

Pl. 1, figs 16-17

Derivation of name. From Bulla, the name of the type section.

Holotype. One complete carapace figured Pl. 1, fig. 16, collection number P6M2243.

Paratype. One complete carapace figured Pl. 1, fig. 17, collection number P6M2244.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., Changhsingian; Late Permian.

Material. 2 carapaces and several fragments.

Diagnosis. A species of *Knightina* with elongated carapace and with reticulation on marginal surface.

Description. Subrectangular carapace with long straight DB; AB with small radius of curvature, and maximum curvature located close to DB; VB long and straight; PB with small radius of curvature; all surface covered by large anastomosing reticulation and particularly on the marginal surface where reticulation is perpendicular to the free borders; kirkbyan pit clear, located in central part of the carapace just below mid-height; posterior shoulder clear but not overhanging the hinge line.

Remarks. *Knightina bullaensis* n. sp. can be compared to *K. hungarica* Kozur, 1985a from the early Wuchiapingian of Bükk Mountains (Hungary) (Kozur 1985) but the reticulation is larger and finer and is present on the marginal surface of the present material.

Size. L= 400-415 µm, H= 190-200 µm.

Stratigraphic and geographic distribution. Sample 05BU05, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Suborder **Beyrichicopina** Scott, 1961

Superfamily Kirkbyoidea (Ulrich & Bassler, 1906)

Family Kirkbyidae Ulrich & Bassler, 1906

Genus *Parahollinella* Zalányi, 1974 emend. Kozur, 1985

Type species: *Parahollinella hungarica* Zalányi, 1974

Parahollinella visnyoensis Kozur, 1985

Pl. 2, fig. 4

1985a *Parahollinella visnyoensis* n. sp. Kozur, p. 32-33, pl. 7, figs 8-9.

1985a *Kegelites visnyoensis* n. sp. Kozur, p. 117.

1985b *Parahollinella visnyoensis* - Kozur, pl. 4, fig. 3.

Stratigraphic and geographic distribution. Wuchiapingian (Abadehian) of Bükk Mountains, Hungary (Kozur 1985a); samples 05BU6 and 05BU7A, Bulla Mb., Bellerophon Fm., Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Family Beyrichiidae Matthew, 1886

Genus *Neoulrichia* Kozur, 1981

Type species: *Neoulrichia pulchra* Kozur, 1981

Neoulrichia pulchra Kozur, 1981

Pl. 2, figs 8-9

?1981 Drepanellacea (?) - Pasini, pl. 1, figs 2-3.

1981 *Neoulrichia pulchra* n. gen. n. sp. Kozur, p. 201, pl. 1, fig. 1.

1985b *Neoulrichia pulchra* Kozur 1981 - Kozur, pl. 10, fig. 3.

Stratigraphic and geographic distribution. Basal Dzulfian (early Wuchiapingian) of the Bükk Mountains, Hungary (Kozur 1981, 1985b); Rio Barbide and Digonera sections, northern Italy (Pasini 1981); samples 05BU1A, 05BU1B, 'Ostracod unit', Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Order **Podocopida** Müller, 1894

Suborder **Podocopina** Sars, 1866

Superfamily **Bairdioidea** Sars, 1888

Family **Bairdiidae** Sars, 1888

Genus *Bairdia* McCoy, 1844

Type species: *Bairdia curta* McCoy, 1844

Bairdia ortiseiensis Crasquin n. sp.

Pl. 2, figs 13-18

Derivation of name. From Ortisei town, northern Italy, close to the Bulla section.

Holotype. One complete carapace figured Pl. 2, fig. 13, collection number P6M2259.

Paratype. One complete carapace figured Pl. 2, fig. 14, collection number P6M2261.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian.

Material. 48 carapaces and numerous fragments

Diagnosis. A species of the *Bairdia* with AVB and PVB flattened and reticulated carapace, the reticulation is elongate, paralleling the margins.

Description. Carapace with huge frame; BD recitilinear on LV and arched on RV; AB with small radius of convexity and at right angles to DB in adults (more rounded in small forms); VB nearly linear or gently concave on RV, concave on LV; PB with small radius of convexity; AB and PB strongly flattened laterally; PDB nearly straight on both valves; carapace thick with maximum thickness around mid-length; RV overlaps LV all around the borders with maximum overlap on dorsal borders; surface reticulated; reticulation elongate and arranged parallel to margins; central part of the carapace smoother.

Remarks. *Bairdia ortiseiensis* n. sp. does not closely resemble other species of the genus.

Size. L= 370-990 µm, H= 235-620 µm.

Stratigraphic and geographic distribution. Samples 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., Lower Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Bairdia cheni Crasquin n.sp.

Pl. 3, figs 1-3

Derivation of name. Dedicated to Dr. Chen T.C., Nanjing, who described many species from Permian strata of South China.

Holotype. One complete carapace figured Pl. 3, fig. 1, collection number P6M2265.

Paratype. One complete carapace figured Pl. 3, fig. 2, collection number P6M2267.

Type-level. Sample 05BU4A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. 6 carapaces.

Diagnosis. A species of *Bairdia* with elongated carapace, DB, ADB and PDB straight, with sharp angles between ADB-DB and PDB on RV; BD regularly arched on LV.

Description. Carapace elongate; PDB, DB and ADB straight on LV; angles between PDB and DB and between DB and ADB sharp on LV; angle between PDB and DB 130-140°; angle between DB and ADB 15-45-150°; ADB and PDB nearly straight on RV; DB regularly arched on RV; AB with small radius of convexity and maximum curvature located high; VB straight to convex on LV, concave on RV; PB with very small radius of curvature and maximum convexity located low; LV overlaps RV, maximum on DB and VB; carapace smooth; small shouldering of DB on RV.

Remarks. *Bairdia cheni* n. sp. is very close from *B. cf. trianguliformis* Chen, 1958 *sensu* Shi & Chen, 1987 from the Late Permian of the Meishan section, South China. The overlap in our material is more important and the carapace is more asymmetric from the AB to PB, with maximum height located in the first 1/3 of length; the BP has a smaller radius of curvature. *B. cheni* n. sp. can be compared with three species described by (Chen 1958) from the Early Permian of Lungtan (South China): *B. beedei* Ulrich & Bassler, 1906, *B. piscariformis* Chen, 1958 and *B. lungtanensis* Chen, 1958. These three species may be synonyms. With our material, the AB has smaller radius of curvature and the carapace is more elongate.

Size. L= 600-1150 µm, H= 285-590 µm.

Stratigraphic and geographic distribution. Samples 05BU3, 05BU4A, 05BU5, Bulla Mb., Bellerophon Fm., Bulla section, late Changhsingian, Late Permian; Southern Alps, northern Italy (see Tab. 1).

Bairdia galei Croneis & Thurman 1939 *sensu*

Shi & Chen, 1987

Pl. 2, figs 11-12

2002 *Bairdia galei* Geis - Shi & Chen, p. 64, pl. 2, figs 13-16

Remarks. Our material appears to be conspecific with the species figured by Shi & Chen (2002) under the name *B. galei*, but it differs from *B. galei* described originally from the Early Carboniferous of the North American Platform (Geis 1932).

Stratigraphic and geographic distribution. Late Permian of Heshan and Yishan, Guangxi Province, South China (Shi and Chen 2002); Samples 05BU5,

05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Bairdia (Rectobairdia) kershawi Crasquin n. sp.

Pl. 4, figs 18-19

1987 *Rectobairdia tantilla* (Kummerow) - Shi & Chen, p. 41-42, pl. 5, figs 3-10.

2002 *Rectobairdia tantilla* (Kummerow) - Shi & Chen, p. 71-72, pl. 8, figs 5-7, pl. 9, figs 6-9.

Derivation of name. Dedicated to Dr. Steve Kershaw, Brunel University, Uxbridge, UK.

Holotype. One complete carapace figured Pl. 4, fig. 18, collection number P6M2304.

Paratype. One complete carapace figured Pl. 4, fig. 19, collection number P6M2305.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. 10 carapaces and numerous fragments.

Diagnosis. A species of *Bairdia* (*Rectobairdia*) with elongated carapace, height almost constant along its length, AB with a large radius of curvature.

Description. Carapace elongated, H/L= 0.45, DB long (+/- half of length), straight on both valves, could be slightly concave on LV in its medium part; AB with large radius of curvature and maximum of convexity located at mid-height or above; VB concave on both valves, PB with small radius of curvature, maximum of convexity located in lower 1/3 of height: overlap moderate with maximum dorsally; surface smooth.

Remarks. Shi & Chen (1987, 2002) ascribed specimens from Late Permian of Meishan section (Zhejiang Province) and of Heshan and Yishan areas (Guangxi Province, South China) to *Rectobairdia tantilla* (Kummerow 1953) from the Middle Devonian of Poland and Germany. The two species are close but the AB of *R. tantilla* has a greater radius of curvature and the ADB is more horizontal.

Size. L= 850-1020 µm, H= 400-450 µm.

Stratigraphic and geographic distribution. Heshan and Yishan areas, Guangxi province, Meishan, Zhejiang Province, South China, late Changhsingian, Late Permian. Samples, 05BU5, 05BU6, Bulla Mb., Bellerophon Fm., Bulla section, late Changhsingian, Late Permian; Southern Alps, northern Italy (see Tab. 1).

Genus *Bairdiacratia* Crasquin gen. n.

Derivation of name. From being intermediate between the genera *Bairdia* and *Acratia*

Type species. *Bairdiacratia qinglaili* Crasquin n. sp. (Pl. 3, figs 13-16).

Type horizon. Sample 05BU7A, Bulla Mb., Bellerophon Fm.; late Changhsingian; Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy.

Diagnosis. A new genus with AB characteristic of the genus *Acratia* (acratian beak) and PB characteristic of *Bairdia*, AB and PB flattened.

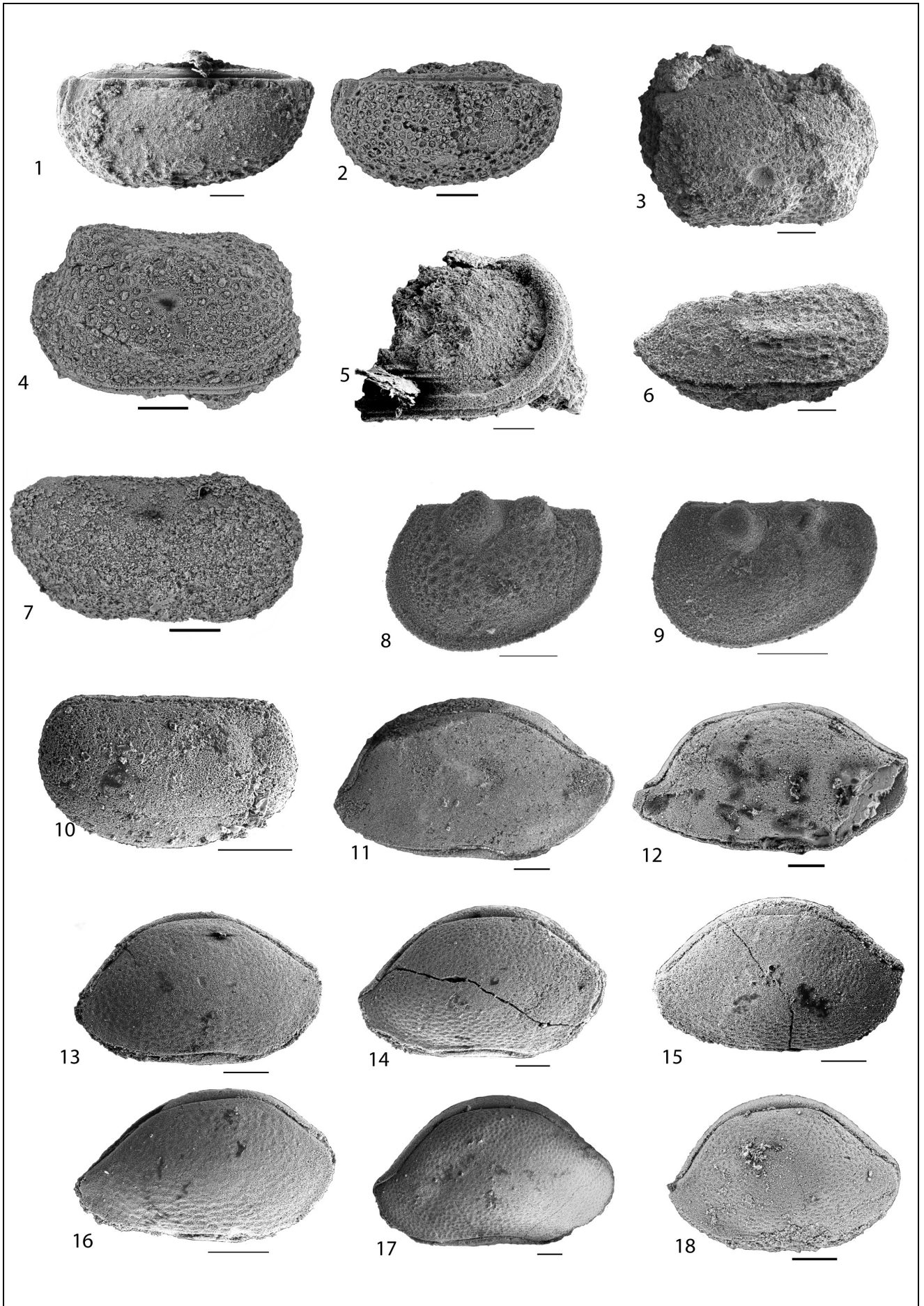
Remarks. *Bairdiacratia* n. gen. resembles *Lobobairdia* Kollman, 1963 from the Late Triassic (Kollmann 1963) in general outline, but our material lacks a groove on AB and PB.

Distribution. Late Changhsingian, Late Permian, Southern Alps, northern Italy; Dajiang section, Guizhou Province, Meishan section, Zhejiang Province, Jiangsu section, Hubei Province, South China.

PLATE 2

All specimens are from Bulla section, Southern Alps. Scale bar is 100 µm. All specimens are stored in the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

- Figs 1-2 - *Kirkbyia* sp. 1.
Fig. 1 - Collection number P6M2246, left lateral view of complete carapace, sample number 05BU05; fig. 2 - Collection number P6M2247, left lateral view of complete carapace, sample number 05BU7A.
- Fig. 3 - cf. *Shleesha pinguis* (Ulrich & Bassler, 1906). Collection number P6M2248, right lateral view of complete carapace, sample number 05BU05.
- Fig. 4 - *Parabollinella visnyoensis* Kozur, 1985. Collection number P6M2249, right lateral view of right valve, sample number 05BU06.
- Fig. 5 - Kirkbyidae sp. 1. Collection number P6M2250, right lateral view of right valve, sample 05BU05.
- Fig. 6 - Kirkbyidae sp. 2. Collection number P6M2251, right lateral view of right valve, sample 05BU05.
- Fig. 7 - Kirkbyidae sp. 3. Collection number P6M2253, right lateral view of right valve, sample 05BU17.
- Figs 8-9 - *Neoulrichia pulchra* Kozur, 1981.
Fig. 8 - Collection number P6M2254, left lateral view of complete carapace, sample number 05BU1A; fig. 9 - Collection number P6M2255, left lateral view of complete carapace, sample number 05BU1A.
- Fig. 10 - *Paraparchites* sp. 1. Collection number P6M2256, left lateral view of complete carapace, sample number 05BU05.
- Figs 11-12 - *Bairdia galei* Croneis & Thurman 1939 *sensu* Shi & Chen, 1987.
Fig. 11 - Collection number P6M2257, right lateral view of complete carapace, sample number 05BU05; fig. 12 - Collection number P6M2258, right lateral view of complete carapace, sample number 05BU4A.
- Figs 13-18 - *Bairdia ortiseiensis* Crasquin n. sp.
Fig. 13 - Holotype, collection number: P6M2259, right lateral view of complete carapace, sample 05BU05; fig. 14 - Collection number: P6M2260, right lateral view of complete carapace, sample 05BU05; fig. 15 - Paratype, collection number P6M2261, right lateral view of complete carapace, sample number 05BU05; fig. 16 - Collection number: P6M2262, right lateral view of complete carapace, sample number 05BU05; fig. 17 - Collection number: P6M2263, right lateral view of complete carapace, sample number 05BU05; fig. 18 - Collection number: P6M2264, right lateral view of complete carapace, sample number 05BU7A.



Species included in *Bairdiacratia* Crasquin

gen. n.

Bairdiacratia qinglaii Crasquin n. sp.*Bairdiacratia tergilata* Crasquin n. sp.*Bairdiacratia* n. sp. 1*Bairdiacratia* n. sp. 2*Bairdiacratia* n. sp. 3*Lobobairdia rostriformis* Chen, 1982 (in Chen & Shi 1982)***Bairdiacratia qinglaii* Crasquin n. gen. n. sp.**

Pl. 3, figs 13-16

Derivation of name. Dedicated to Prof. Feng Qinglai, Chinese University of Geosciences, Wuhan, China**Holotype.** One complete carapace figured Pl. 3, fig. 13; collection number P6M2277.**Paratype.** One complete carapace figured Pl. 3, fig. 14, collection number P6M22279.**Type-level.** Sample 05BU7A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.**Material.** Fifteen carapaces and numerous fragments.**Diagnosis.** A species of *Bairdiacratia* Crasquin gen. n. with short carapace, AB relatively large, and AB and PB strongly compressed laterally.**Description.** Short ($0.60 < H/L < 0.70$) and thick carapace; PDB and ADB straight on both valves; DB straight on RV and gently convex on LV; AB characterized by typical "acratian beak", VB straight on LV and gently concave on RV; typical "bairdian" PB; AB and PB strongly compressed laterally; maximum of height located in front of mid-length; LV overlaps RV all around the carapace, with maximum on dorsal part; carapace could be ornamented by reticulation parallel to margins (Pl. 3, fig. 16).**Size.** L= 490-920 μ m, H= 340-565 μ m.**Stratigraphic and geographic distribution.** Samples 05BU3, 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).***Bairdiacratia tergilata* Crasquin n. gen. n. sp.**

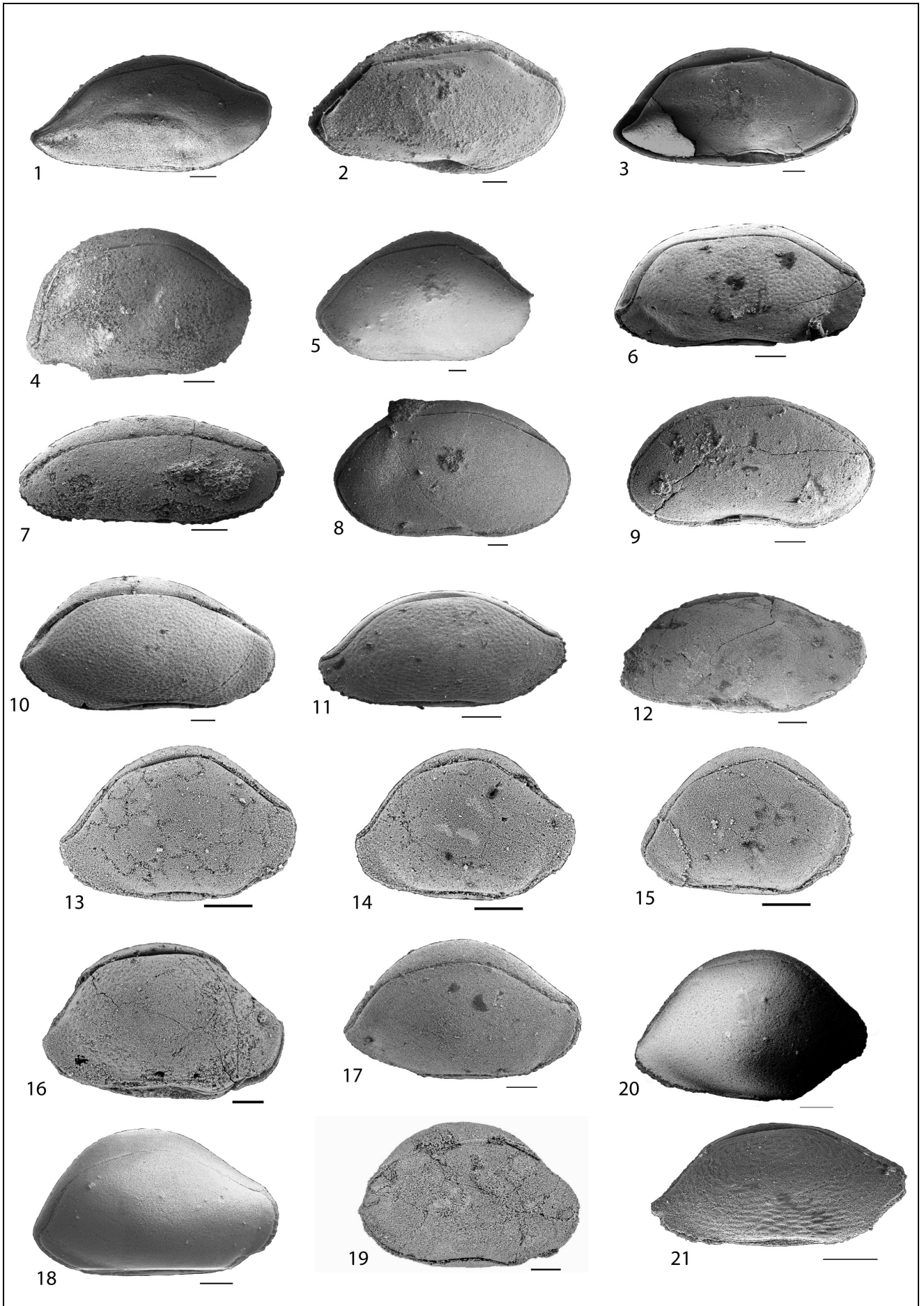
Pl. 3, figs 17-18

Derivation of name. From Latin *tergum-i*: back and *latus-um*: large.**Holotype.** One complete carapace figured Pl. 3, fig. 18, collection number P6M2281.**Paratype.** One complete carapace figured Pl. 3, fig. 17, collection number P6M2282.**Type-level.** Sample 05BU3, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.**Material.** Six carapaces and numerous fragments.**Diagnosis.** A species of *Bairdiacratia* Crasquin gen. n. with very important overlap of LV on RV on all dorsal margins.

PLATE 3

Except figs 19 and 20 which come from South China, all specimens are from Bulla section, Southern Alps. Scale bar is 100 μ m. All specimens are housed in the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

- Figs 1-3 - *Bairdia cheni* Crasquin n. sp.
 Fig. 1 - Holotype, Collection number: P6M2265, right lateral view of complete carapace, sample 05BU4A; fig. 2 - Collection number: P6M2266, right lateral view of complete carapace, sample 05BU05; fig. 3 - Paratype, Collection number: P6M2267, right lateral view of complete carapace, sample number 05BU4A.
- Fig. 4 - *Bairdia* sp. 4. Collection number: P6M2268, right lateral view of complete carapace, sample 05BU05.
- Fig. 5 - *Bairdia* sp. 5. Collection number: P6M2269, right lateral view of complete carapace, sample 05BU05.
- Fig. 6 - *Bairdia* sp. 1. Collection number: P6M2270, right lateral view of complete carapace, sample 05BU03.
- Fig. 7 - *Bairdia* sp. 2. Collection number: P6M2271, right lateral view of complete carapace, sample 05BU03.
- Figs 8-9 - *Bairdia* sp. 3.
 Fig. 8 - Collection number: P6M2272, right lateral view of complete carapace, sample 05BU05; fig. 9 - Collection number: P6M2273, right lateral view of complete carapace, sample 05BU05.
- Fig. 10 - *Bairdia* sp. 6. Collection number: P6M2274, right lateral view of complete carapace, sample 05BU4A.
- Fig. 11 - *Bairdia* sp. 7. Collection number: P6M2275, right lateral view of complete carapace, sample 05BU03.
- Fig. 12 - *Bairdia* cf. *subcontracta* Chen, 1987. Collection number: P6M2276, right lateral view of complete carapace, sample number 05BU03.
- Figs 13-16 - *Bairdiacratia qinglaii* Crasquin n. gen. n. sp.
 Fig. 13 - Holotype, Collection number: P6M2274, right lateral view of complete carapace, sample 05BU7A; fig. 14 - Collection number: P6M2278, right lateral view of complete carapace, sample 05BU7A; fig. 15 - Paratype, Collection number: P6M2279, right lateral view of complete carapace, sample number 05BU7A; fig. 16 - Collection number: P6M2280, right lateral view of complete carapace, sample number 05BU7A.
- Figs 17-18 - *Bairdiacratia tergilata* Crasquin n. gen. n. sp.
 Fig. 17 - Paratype, Collection number: P6M2282, right lateral view of complete carapace, sample 05BU03; fig. 18 - Holotype, Collection number: P6M2281, right lateral view of complete carapace, sample 05BU03.
- Fig. 19 - *Bairdiacratia* n. gen. n. sp. 3. Collection number: P6M2284, right lateral view of complete carapace from Dajiang section, Guizhou Province, South China, sample 05PAJ22, Dajiang section, Guizhou Province, China (location in Forel et al. 2009).
- Fig. 20 - *Bairdiacratia* n. gen. n. sp. 1. Collection number: P6M2285, right lateral view of complete carapace from Meishan section, Feijiang Province, South China, sample 04C16.3, Meishan section, Zhejiang Province, China.
- Fig. 21 - *Bairdiacratia* n. gen. n. sp. 2. Collection number: P6M2286, right lateral view of complete carapace, sample 05BU05.



Description. Carapace thick with DB slightly convex on RV and arched on LV; ADB and PDB nearly straight; AB with typical “acratian beak” in its ventral part; VB nearly straight on LV, slightly concave on RV; PB with typical *Bairdia* shape; AB compressed laterally; PB compressed laterally but only in its ventral part; LV overlaps RV all around the carapace; very important overlap on dorsal parts of the carapace; surface smooth.

Remarks. *Bairdiacratia tergilata* Crasquin n. gen. n. sp. differs from *B. qinglaili* Crasquin n. gen. n. sp. by its important overlap in the dorsal part of the carapace, its longer carapace and more tapering PB.

Size. L= 680-800 µm, H= 450-470 µm.

Stratigraphic and geographic distribution. Samples 05BU3 and 05BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

***Bairdiacratia* n. gen. n. sp. 1**

Pl. 3, fig. 20

Remarks. This specimen is reported from the Permian-Triassic boundary stratotype at Meishan, South China. It presents an AB with small radius of convexity and maximum of curvature located high, BP tapering, PDB, DB and ADB straight on RV, overlap of LV on RV moderate. Revision of the Meishan ostracods is in progress.

Stratigraphic and geographic distribution. Sample 04C16.3, Baoqing Mb., Changxing Fm., late Changhsingian, Late Permian; Meishan section, Zhejiang Province, South China (Crasquin et al. in progress).

***Bairdiacratia* n. gen. n. sp. 2**

Pl. 3, fig. 21

Remarks. This specimen of *Bairdiacratia* gen. n. is very elongate, AB with very small radius of convexity and maximum of convexity located high. The carapace is reticulate; the reticulation is elongate, parallel to the margins. This species is new but we found only one specimen.

Stratigraphic and geographic distribution. Sample 05BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

***Bairdiacratia* n. gen. n. sp. 3**

Pl. 3, fig. 19

Remarks. This specimen comes from the Permian-Triassic boundary at the Dajiang section in Guizhou Province, South China (Forel et al. 2009). This specimen is poorly preserved but has characteristics of

Bairdiacratia. It is close to *B. tergilata* n. gen. n. sp. with a larger PB but the preservation doesn't allow specific attribution. The publication of the Dajiang ostracods is in progress.

Stratigraphic and geographic distribution. Samples 05PAJ22, Wujiaping Fm., late Changhsingian, Late Permian; Dajiang section, Guizhou Province, South China (Forel et al. 2009).

Genus *Bairdiacypris* Bradfield, 1935

Type species: *Bairdiacypris deloi* Bradfield, 1935

***Bairdiacypris longirobusta* Chen, 1958**

Pl. 4, fig. 1-2

1958 *Bairdiacypris longirobusta* Chen (sp. nov.), p. 232, 255, pl. 7, figs 1-3.

1978 *Bairdiacypris longirobusta* Chen - Guan, p.157, pl. 40, figs 7-8.

1982 *Bairdiacypris longirobusta* Chen - Chen & Shi, p. 136, pl. 10, figs 12-18.

1987 *Bairdiacypris longirobusta* Chen - Shi & Chen, p. 50, pl. 12, figs 21-22, pl. 16, figs 14-15.

2002 *Bairdiacypris longirobusta* Chen - Shi & Chen, p. 83, pl. 21, figs 4-7.

Stratigraphic and geographic distribution. Early Permian of Lungtan (Chen 1958); Late Permian of Nantong, Jiangsu Province and Mianyang, Hubei Province (Chen & Shi 1982); Meishan section, Zhejiang Province, South China (Shi & Chen 1987) and Heishan and Yishan in Guangxi Province, Changhsingian (Shi & Chen 2002). Sample 05BU6, Bulla Mb., Bellerophon Fm., sample 05BU7B, lower Tesero Mb., Werfen Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

***Bairdiacypris? caeca* Shi, 1987**

Pl. 4, figs 4-5

1987 *Bairdiacypris? caeca* Shi sp. nov. (in Shi & Chen 1987), 52, pl. 13, figs 1-6.

2002 *Bairdiacypris? caeca* Shi - Shi & Chen, p.86, pl. 22, figs 12-19.

Stratigraphic and geographic distribution. Changhsingian of Meishan section, Zhejiang Province, South China (Shi & Chen 1987) and Heishan and Yishan in Guangxi Province (Shi & Chen 2002). Sample 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

***Bairdiacypris wangi* Kozur, 1985**

Pl. 4, fig. 6

1985a *Bairdiacypris wangi* n. sp. Kozur, p. 80-81, pl. 17, figs 5-6.

Stratigraphic and geographic distribution. Wuchiapingian (Abadehian), Bükk Mountains, Hungary. Sample 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Liuzhinia* Zheng, 1976

Type species: *Liuzhinia subovata* Zheng, 1976

Liuzhinia antalyaensis Crasquin-Soleau, 2004

Pl. 4, figs 9-10

2004 *Liuzhinia antalyaensis* Crasquin-Soleau n. sp. (in Crasquin-Soleau et al.), p. 286, pl. 3, figs 6-13.

2006 *Liuzhinia antalyaensis* Crasquin-Soleau, 2004 - Crasquin-Soleau et al., p. 62, pl. 3, figs 12-13.

Stratigraphic and geographic distribution. Çürük dag section, western Taurus, Turkey, Early Triassic (Crasquin-Soleau et al. 2004); Fengshan area, Guangxi Province, South China, Griesbachian, Early Triassic (Crasquin-Soleau et al. 2006). Sample 05BU14, 05BU17, 05BU18, 05BU21, Lower and Upper Mazzin Mbs, Werfen Fm., Induan, Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Paracypris* Sars, 1866

Type species: *Paracypris polita* Sars, 1866

Paracypris gaetanii Crasquin-Soleau, 2006

Pl. 4, fig. 12

2006 *Paracypris gaetanii* Crasquin-Soleau n. sp. (in Crasquin-Soleau et al.), p. 64, pl.4, figs 1-4.

Stratigraphic and geographic distribution. Fengshan area, Guangxi Province, South China, Griesbachian, Early Triassic (Crasquin-Soleau et al. 2006). Sample 05BU24, Upper Mazzin Mb., Werfen Fm., Induan, Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Paramacrocypris*

Type species: *Paramacrocypris schallreuteri* Kozur, 1985

Paramacrocypris schallreuteri Kozur, 1985

Pl. 4, figs 13-14

1985a *Paramacrocypris schallreuteri* n. gen. n. sp. Kozur, p. 109-110, pl. 21, fig. 9.

Stratigraphic and geographic distribution. Wuchiapingian (Dzulfian), early Late Permian, Bükk Mountains, Hungary (Kozur 1985a). Samples 05BU3,

05BU4A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Petasobairdia* Chen, 1982

Type species: *Petasobairdia bicornuta* Chen, 1982

Petasobairdia nantongensis Chen, 1982

Pl. 4, figs 16-17

1982 *Petasobairdia nantongensis* Chen gen. et sp. nov. (in Chen & Shi), p. 130-131, pl. 4, figs 1-9.

1987 *Petasobairdia nantongensis* Chen - Shi & Chen, p. 47, pl. 7, figs 12-16, pl.19, figs 1-4.

2002 *Petasobairdia nantongensis* Chen - Shi & Chen, p. 75, pl. 17, figs 7-9.

Stratigraphic and geographic distribution. Late Permian of Jiangsu and Hubei Provinces (Chen & Shi 1982), of Meishan section, Zhejiang Province (Shi & Chen 1987) and of Guangxi Province (Shi & Chen, 2002), South China. Samples 05BU05, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Family Microcheilinellidae Gramm, 1975

Genus *Microcheilinella* Geis, 1933

Type species: *Microcheilus distortus* Geis, 1932

Microcheilinella lata Crasquin n. sp.

Pl. 5, figs 1-4

Derivation of name. From latin *latus*, *a*, *um*: large, plump.

Holotype. One complete carapace figured Pl. 5, fig. 1, collection number P6M2306.

Paratype. One complete carapace figured Pl. 5, fig. 2, collection number P6M2307.

Type-level. Sample 05BU6, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. Ten carapaces and several fragments.

Diagnosis. A species of *Microcheilinella* with DB slightly concave on RV, VB nearly straight on RV, hinge short and invaginated, maximum of overlap on PB and PDB and minimum overlapping in PVB.

Description. Carapace with rounded form; H/L = 0.55.

RV: DB straight, with short and invaginated hinge; AB rounded with large radius of convexity, maximum of convexity located in the lower 1/3 of height; VB nearly straight; PB with maximum of convexity located close to VB; LV outline regularly rounded, PVB slightly truncated; LV strongly overlaps RV around all margins; minimum of overlap on PVB; in dorsal view,

carapace thin for the genus, with maximum thickness located behind mid-length; thickness equivalent to height.

Remarks. *Microcheilinella lata* n. sp. is very close from *M. sp. sensu* Crasquin-Soleau et al. 2004 from the late Middle Permian of Turkey. This last species is shorter but presents the same type of outline and overlap.

Size. L= 332-545 µm, H= 180-300 µm.

Stratigraphic and geographic distribution. Samples 05BU6 and 06BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Microcheilinella peraxilis Shi, 1987

Pl. 5, fig. 6

1987 *Microcheilinella peraxilis* Shi sp. nov. (in Shi & Chen), p. 62, pl. 14, figs 23-27.

Stratigraphic and geographic distribution. Sample 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1); Late Permian, Meishan section, Zhejiang Province, South China.

Family Acratiidae Gründel, 1962

Genus *Acratia* Delo, 1930

Type species: *Acratia typica* Delo, 1930

Acratia zhongyingensis Wang, 1978

Pl. 5, figs 10-12

1978 *Acratia zhongyingensis* sp. nov. Wang, p. 295, pl. 4, figs 5-6.

2002 *Acratia zhongyingensis* Wang - Shi & Chen, p. 82-83, pl. 20, figs 25-26.

Stratigraphic and geographic distribution. Late Permian of Western Guizhou province (Wang 1978) and Meishan section, Zhejiang Province, South China (Shi & Chen 2002); Samples 05BU1A, 05BU1B, 05BU9, 'Ostracod unit', Bellerophon Fm. and Lower Tesero Mb., Werfen Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy.

Family Geroidae Gründel, 1962

Genus *Pseudacanthoscapha* Kozur, 1985

Type species *Acratia? striatula* Shi, 1982

Pseudacanthoscapha striatula (Shi, 1982)

Pl. 5, fig. 22

1982 *Acratia? striatula* Shi sp. nov. (in Chen & Shi), p. 139, pl. 11, figs 9-11.

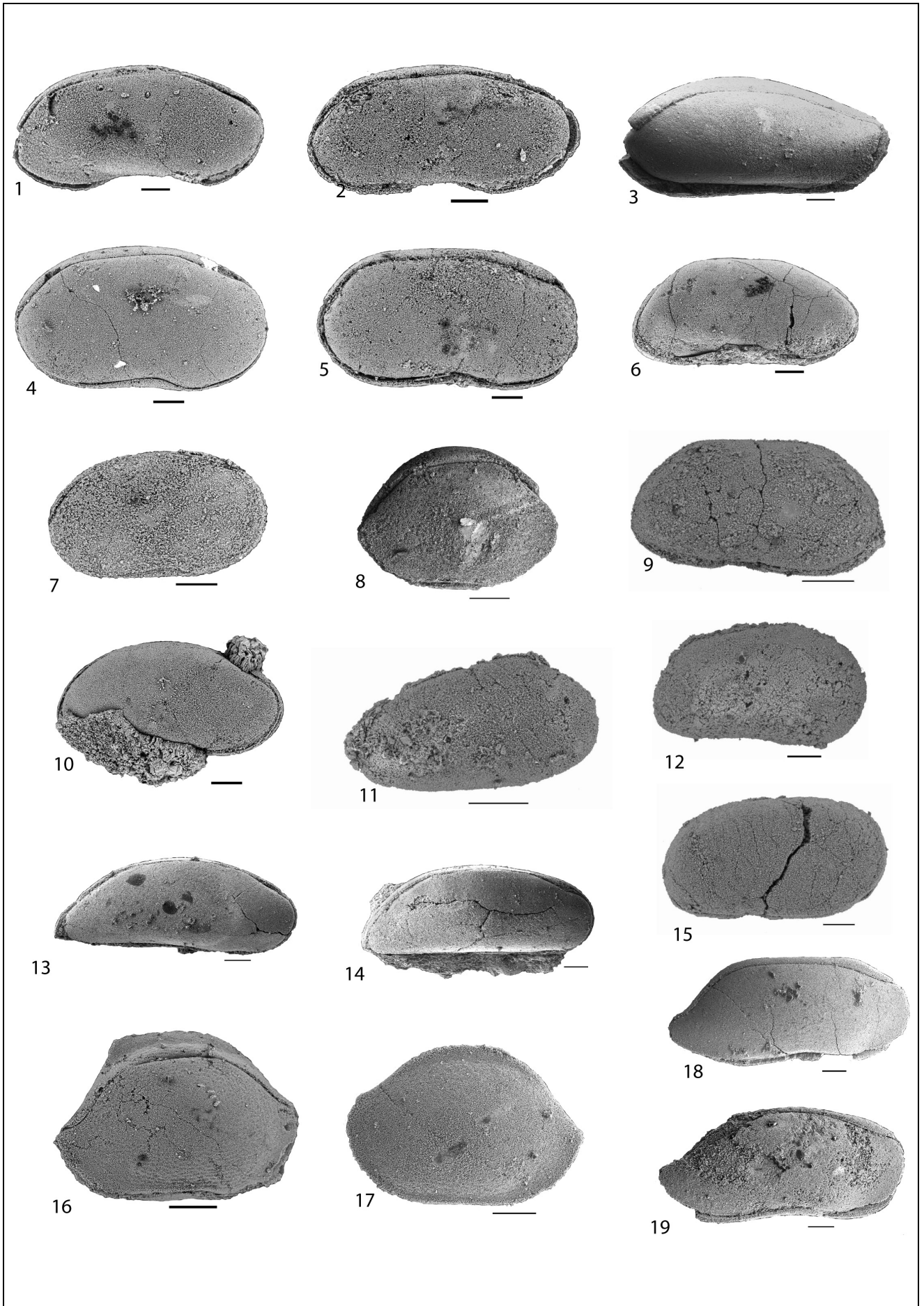
1985a *Pseudacanthoscapha beckeri* n. gen. n. sp. - Kozur, p. 110, pl. 18, fig. 9.

1987 *Acratia striatula* Shi - Shi & Chen, p.49, pl. 11, figs 13-18, pl. 17, figs 1-4.

PLATE 4

All specimens are from Bulla section, Southern Alps. Scale bar is 100 µm. All the specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), undernumbers P6M.

- Figs 1-2 - *Bairdiacypris longirobusta* Chen, 1958.
Fig. 1 - Collection number: P6M2287, right lateral view of complete carapace, sample 05BU06; fig. 2 - Collection number: P6M2266, right lateral view of complete carapace, sample 05BU06.
- Fig. 3 - *Bairdiacypris* sp.1. Collection number: P6M2289, right lateral view of complete carapace, sample 05BU03.
- Figs 4-5 - *Bairdiacypris? caeca* Shi, 1987.
Fig. 4 - Collection number: P6M2290, right lateral view of complete carapace, sample number 05BU7A; fig. 5 - Collection number: P6M2291, right lateral view of complete carapace, sample number 05BU7A.
- Fig. 6 - *Bairdiacypris wangi* Kozur, 1985. Collection number: P6M2292, right lateral view of complete carapace, sample 05BU06.
- Fig. 7 - *Fabalitycypris* cf. *vinsyoensis* Kozur, 1985. Collection number: P6M2293, right lateral view of complete carapace, sample 05BU7A.
- Fig. 8 - *Cryptobairdia* cf. *postilonga* Chen, 2002. Collection number: P6M2294, right lateral view of complete carapace, sample 05BU05.
- Figs 9, 12 - *Liuzhinia antalyaensis* Crasquin-Soleau, 2004.
Fig. 9 - Collection number: P6M2295, right lateral view of complete carapace, sample number 05BU18; fig. 12 - Collection number: P6M2296, right lateral view of complete carapace, sample number 05BU17.
- Fig. 10 - *Macrocypris* sp.1. Collection number: P6M2297, right lateral view of complete carapace, sample 05BU11.
- Fig. 11 - *Paracypris gaetani* Crasquin-Soleau, 2006. Collection number: P6M2298, right lateral view of complete carapace, sample 05BU24.
- Figs 13-14 - *Paramacrocypris schallreuteri* Kozur, 1985.
Fig. 13 - Collection number: P6M2299, right lateral view of complete carapace, sample number 05BU03; fig. 14 - Collection number: P6M2300, right lateral view of complete carapace, sample number 05BU03
- Fig. 15 - *Paracypris* sp. 1. Collection number: P6M2301, right lateral view of complete carapace, sample 05BU23.
- Figs 16-17 - *Petasobairdia nantongensis* Chen, 1982.
Fig. 16 - Collection number: P6M2302, right lateral view of complete carapace, sample number 05BU7A; fig. 17 - Collection number: P6M2303, left lateral view of complete carapace, sample number 05BU05.
- Figs 18-19 - *Bairdia (Rectobairdia) kershawii* Crasquin n. sp.
Fig. 18 - Holotype, Collection number: P6M2304, right lateral view of complete carapace, sample 05BU5; fig. 19. Paratype, Collection number: P6M2305, right lateral view of complete carapace, sample 05BU5.



Stratigraphic and geographic distribution. Basal Dzulfian (early Wuchiapingian) of Bükk Mountains (Hungary; Kozur 1985a), Changhsingian of Meishan section, Zhejiang (Shi & Chen 1987) and Mianyuangi, Hubei (Chen & Shi 1982); sample 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Superfamily Cytheroidea Baird, 1850

Family Bythocytheridae Sars, 1928

Genus *Parabythocythere* Kozur, 1981

Type species: *Parabythocythere permica* Kozur, 1981

***Parabythocythere? chongpani* Crasquin n. sp.**

Pl. 5, figs 13-16

Derivation of name. Dedicated to Prof. Chongpan Chonglakmani from Suranaree University of Technology, Nakhon Ratcharisma, Thailand.

Holotype. One complete carapace figured Pl. 5, fig. 14, collection number P6M2319.

Paratype. One complete carapace figured Pl. 5, fig. 13, collection number P6M2318.

Type-level. Sample 05BU3, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. Five carapaces and several fragments.

Diagnosis. A species doubtfully attributed to the genus *Parabythocythere* with very delicate reticulation parallel to its free margins.

Description. Carapace with straight DB; AB with small radius of curvature and maximum of convexity located at mid-height; VB convex with maximum of height located in front of mid-length; PB with small radius of curvature and maximum of convexity located around upper 1/3 of height; BP compressed laterally; RV overlaps LV; primary ornament difficult to observe (only a shallow S2 on some carapaces); reticulation very delicate like fingerprints, parallel to free margins; dorsal view biconvex with maximum thickness posteriorly, BP strongly compressed.

Remarks. *Parabythocythere? chongpani* Crasquin n. sp. differs from *P. permica permica* Kozur, 1981 from the Late Permian of the Bükk Mountains, Hungary, and the Meishan section in South China and from *P. permiana reticulata* Kozur, 1985 from the Middle Permian of the Bükk Mountains, by its more tumid and fine ornament. The doubt as to generic attribution comes from the fact that the primary lobation is totally absent.

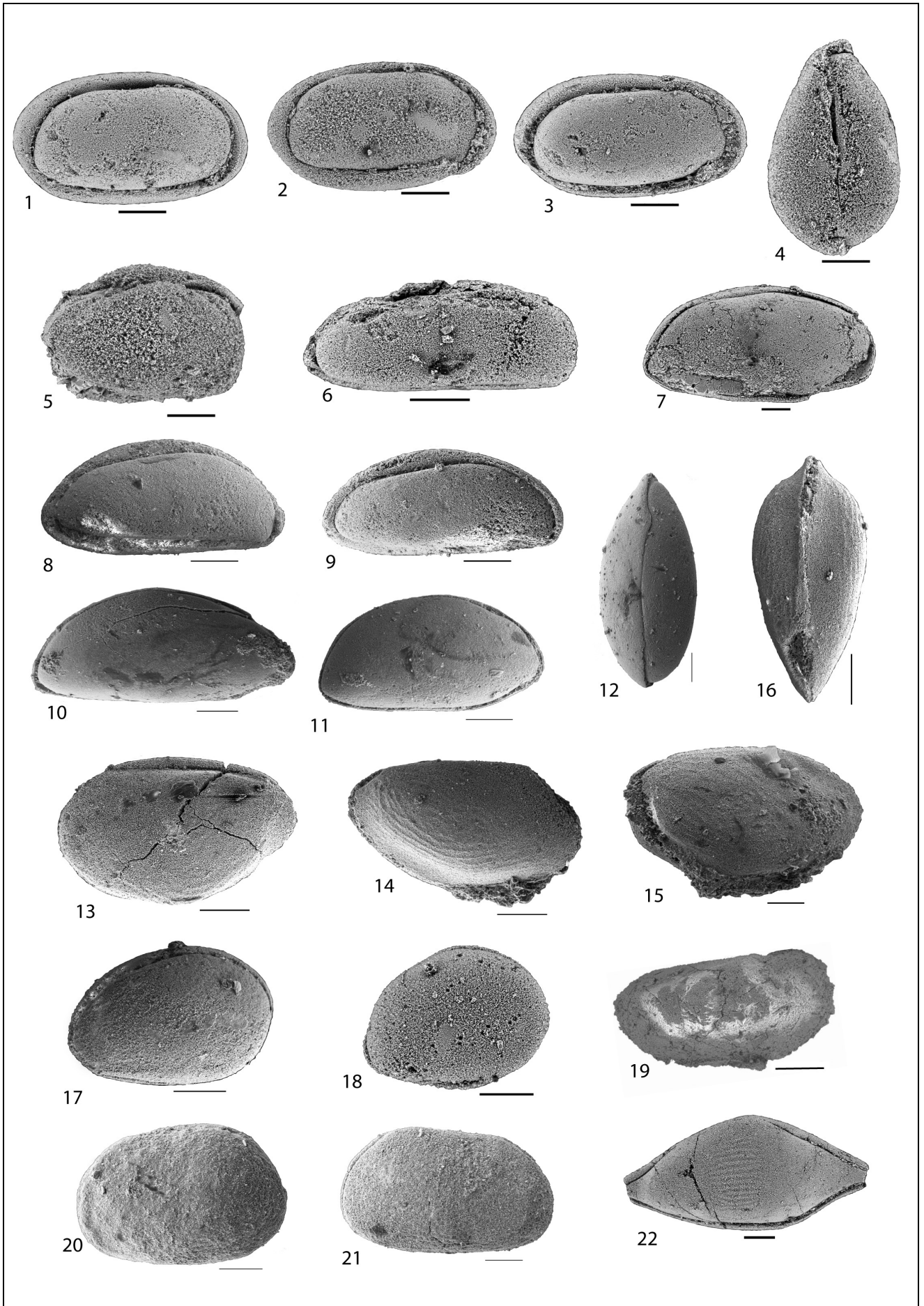
Size. L= 450-634 µm, H= 225-400 µm.

Stratigraphic and geographic distribution. Samples 05BU3 and 06BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

PLATE 5

All specimens are from the Bulla section, Southern Alps. Scale bar is 100 µm. All the specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), under numbers P6M.

- Figs 1-4 - *Microcheilinella lata* Crasquin n. sp.
 Fig. 1 - Holotype, Collection number: P6M2306, right lateral view of complete carapace, sample 05BU06; fig. 2. Paratype, Collection number: P6M2307, right lateral view of complete carapace, sample 05BU06; fig. 3. Collection number: P6M2308, right lateral view of complete carapace, sample number 05BU06; fig. 4 - Collection number: P6M2309, dorsal view of complete carapace, sample number 05BU09.
- Fig. 5 - *Microcheilinella* sp. 2. Collection number: P6M2310, right lateral view of broken carapace, sample 05BU7A.
- Fig. 6 - *Microcheilinella peraxilis* Shi, 1987. Collection number: P6M2311, right lateral view of complete carapace, sample 05BU06.
- Fig. 7 - *Acratia* sp. 1. Collection number: P6M2312, right lateral view of complete carapace, sample 05BU06.
- Figs 8-9 - *Acratia* sp. 2.
 Fig. 8 - Collection number: P6M2313, right lateral view of complete carapace, sample number 05BU05; fig. 9 - Collection number: P6M2314, right lateral view of complete carapace, sample number 05BU05.
- Figs 10-12 - *Acratia zhongyingensis* Wang, 1978.
 Fig. 10 - Collection number: P6M2315, right lateral view of complete carapace, sample number 05BU1A; fig. 11 - Collection number: P6M2316, right lateral view of complete carapace, sample number 05BU1A; fig. 12 - Collection number: P6M2317, dorsal view of complete carapace, sample number 05BU1A.
- Figs 13-16 - *Parabythocythere? chongpani* Crasquin n. sp.
 Fig. 13 - Paratype, Collection number: P6M2318, right lateral view of complete carapace, sample 05BU03; fig. 14 - Holotype, Collection number: P6M2319, right lateral view of complete carapace, sample 05BU03; fig. 15 - Collection number: P6M2320, right lateral view of complete carapace, sample number 05BU05; fig. 16 - Collection number: P6M2321, dorsal view of complete carapace, sample number 05BU05.
- Figs 17-18 - *Basslerella obesa* Kellett, 1935 *sensu* Chen & Shi, 1982.
 Fig. 17 - Collection number: P6M2322, right lateral view of complete carapace, sample number 05BU05; fig. 18 - Collection number: P6M2323, right lateral view of complete carapace, sample number 05BU06.
- Fig. 19 - *Kerocythere?* sp. 1. Collection number: P6M2324, right lateral view of right valve, sample 05BU23.
- Figs 20-21 - *Callicythere mazurensis* (Styk, 1972).
 Fig. 20 - Collection number: P6M2325, right lateral view of complete carapace, sample 05BU1C; fig. 21 - Collection number: P6M2326, left lateral view of complete carapace, sample 05BU1C.
- Fig. 22 - *Pseudacanthoscapha striatula* (Shi, 1982). Collection number: P6M2327, right lateral view of complete carapace, sample 05BU7A.



Family Cytherideidae Sars, 1925

Genus *Basslerella* Kellett, 1935

Type species: *Basslerella crassa* Kellett, 1935

***Basslerella obesa* Kellett, 1935 sensu Chen & Shi, 1982**

Pl. 5, figs 17-18

non 1935 *Basslerella obesa* Kellett, p. 156, pl. 17, fig. 6

1982 *Basslerella obesa* Kellett, 1935 in Chen & Shi, p.140, fig. 11, figs 12-25

1987 *Basslerella obesa* Kellett - Shi & Chen, p. 54, pl. 13, figs 24-27

1992 *Basslerella obesa* Kellett - Yi, pl. 2, fig.3

2002 *Basslerella obesa* Kellett - Shi & Chen, p. 88, pl. 23, figs 26-35

Remarks. The form here reported conforms with the species described by Chinese authors from the Late Permian of Hubei Province (Chen & Shi 1982), the Late Permian of Meishan, Zhejiang Province (Shi & Chen 1987, 2002), and Datian, Fujian Province (Yi 1992) in South China but it is not the species *B. obesa* originally described by (Kellett 1935) from the Late Pennsylvanian? - Early Permian of Kansas. The specimens discovered here are more elongate and probably belongs to another genus which is not possible to precise for the time being. A new species should be described in the future when more material will be available.

Stratigraphic and geographic distribution.

Early to Late Permian of Guangxi Province, Zhejiang Province, Fujian Province, South China; Samples 05BU5 and 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (cf. Tab. 1).

Family Cytherissinellidae Kashevarova, 1958

Genus *Callicythere* Wei, 1981

Type species: *Callicythere emeiensis* Wei, 1981

***Callicythere mazurensis* (Styk, 1972)**

Pl. 5, figs 20-21

1972 *Lutkevichinella mazurensis* Styk n. sp. p.877, pl. 2, figs 9-12.

1985b *Callicythere mazurensis* (Styk, 1972) - Kozur, pl. 3, fig. 7

Stratigraphic and geographic distribution. Late Middle Permian (Kozur 1985b) - Early Triassic (Styk 1972) of the Bükk Mountains, Hungary; Sample 05BU1C, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Order **Platycopida** Sars, 1866

Suborder **Platycopina** Sars, 1866

Superfamily Cavellinoidea Egorov, 1950

Family Cavellinidae Egorov, 1950

Genus *Cavellina* Coryell, 1928

Type species: *Cavellina puchella* Coryell, 1928

***Cavellina bellerophonella* Crasquin n. sp.**

Pl. 6, figs 3-7

Derivation of name. From the Bellerophon Formation, the type level.

Holotype. One complete carapace figured Pl. 6, fig. 3, collection number P6M2330.

Paratype. One complete carapace figured Pl. 6, fig. 4, collection number P6M2331.

Type-level. Sample 05BU1A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., late Changhsingian; Late Permian.

Material. 150 carapaces and numerous fragments.

Diagnosis. A species of *Cavellina* with elongate carapace, PB and AB with small radius of curvature.

Description. Carapace elongated ($0.55 < H/L < 0.60$); anterior and posterior parts of DB rectilinear on RV, regularly arched on LV; AB with small radius of curvature; maximum of curvature located above mid-height, maximum of curvature on LV located higher than on RV; ABV rounded on LV and truncated on RV; VB straight on RV, nearly straight to slightly convex on LV; PB with small radius of curvature, maximum of convexity located at or below mid-height; LV overlaps carapace flattened on all the free margins, flattening underlined by a small sulcus; RV all around the carapace, maximum of overlap at ADB and AB; dorsal view biconvex; surface smooth.

Remarks. The genus *Cavellina* is abundant in the Middle Permian, for example in the Bükk Mountains (Kozur 1985a) and in Oman (Crasquin-Soleau et al. 1999), but occurrences in the Late Permian are rare. Shi & Chen (1987) show two species of *Cavellina* in the late Changhsingian of Meishan section (South China) but the figured specimens belong to the genus *Sulcella* (presence of posteroventral sulcus).

Cavellina bellerophonella n. sp. may be compared to *C. boomeri* Crasquin-Soleau, 1999 from the Wordian of Oman (Crasquin-Soleau et al. 1999) and to *C. visnyoensis* Kozur, 1985 from late Middle Permian of the Bükk Mountains (Kozur 1985a). *C. boomeri* has a more rounded and larger AB. *C. visnyoensis* has a greater H/L ratio, a larger PB and a flattening of the carapace in the postero-dorsal area. *C. alpina* n. sp. is shorter; *C. triasica* Crasquin n. sp. is more square.

Size. L= 515-765 µm, H= 335-485 µm.

Stratigraphic and geographic distribution. Samples 05BUSC1, 05BUSC2, 05BU1A, 05BU1B, 'Ostra-

cod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina alpina Crasquin n. sp.

Pl. 6, figs 8-10

Derivation of name. From the Alps, area of discovery.

Holotype. One complete carapace figured Pl. 6, fig. 8, collection number P6M2336.

Paratype. One complete carapace figured Pl. 6, fig. 9, collection number P6M2335.

Type-level. Sample 05BUSC1, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., late Changhsingian; Late Permian.

Material. Fifteen carapaces and numerous fragments.

Diagnosis. A species of *Cavellina* with square carapace and BP with a large radius of curvature.

Description. Carapace stocky ($0.62 < H/L < 0.69$), high, BD regularly arched on both valves, AB and PB with large radius of curvature, maximum of curvature of AB located above mid-height and of PB below; VB nearly straight or slightly convex; LV overlaps RV all around the carapace; the overlap is fine; presence of the thin sulcus all around free margins; carapace smooth; carapace biconvex in dorsal view, compressed at extremities.

Remarks. *Cavellina alpina* Crasquin n. sp. is shorter than other species of the genus (see above)

Size. L= 480-720 µm, H= 235-450 µm.

Stratigraphic and geographic distribution. Sample 05BUSC1, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina triassica Crasquin n. sp.

Pl. 6, figs 13-14

Derivation of name. From the Triassic period.

Holotype. One complete carapace figured Pl. 6, fig. 14, collection number P6M2340.

Paratype. One complete carapace figured Pl. 6, fig. 13, collection number P6M2341.

Type-level. Sample 05BUSC24, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Upper Mazzin Mb., Werfen Fm., Induan, Early Triassic.

Material. Fifteen carapaces and fragments.

Diagnosis. A species of *Cavellina* with rectangular carapace; AB and PB with large radius of curvature and very small overlap of LV on RV.

Description. Carapace rectangular; DB regularly arched on both valves; AB with large radius of curvature, maximum of convexity located above mid-height; VB sub-rectilinear; BP largely arched with maximum of convexity located at mid-height, radius of curvature equivalent to AB; LV overlaps RV slightly and the over-

lap is the same all around the carapace; carapace smooth.

Remarks. *Cavellina triassica* n. sp. differs from other species of the genus by its rectangular outline. This is the first species of the genus described in the Triassic.

Size. L= 495-570 µm, H= 320-350 µm.

Stratigraphic and geographic distribution. Samples 05BU19A, 05BU24, Upper Mazzin Mb., Werfen Fm., Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina visnyoensis Kozur, 1985

Pl. 6, figs 11-12

1985a *Cavellina visnyoensis* n. sp., Kozur, p. 21, pl. 4, fig. 10, pl. 5, figs 1-2

Stratigraphic and geographic distribution.

Early Late Permian, Bükk Mountains, Hungary (Kozur 1985a); sample 05BU1A, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Sulcella* Coryell & Sample, 1932

Type species: *Sulcella sulcata* Coryell & Sample, 1932

Sulcella suprapermiana Kozur, 1985

Pl. 6, figs 1-2

1985a *Sulcella suprapermiana* Kozur, p. 22, pl. 5, figs 6, 8.

1998 *Sulcella suprapermiana* Kozur, 1985 - Crasquin-Soleau & Baud, p. 134, pl. 4, figs 1-3.

1999 *Sulcella suprapermiana* Kozur, 1985 - Crasquin-Soleau et al., p. 169, 190, pl. 4, fig. 15.

Stratigraphic and geographic distribution. Late Permian, Bükk Mountains, Hungary (Kozur 1985a); late Middle Permian-early Late Permian, Hydra Island, Greece (Crasquin-Soleau & Baud 1998); Middle Permian of the Sultanate of Oman (Crasquin-Soleau, Brouin et al. 1999); samples 05BU3, 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Palaeocological inferences

Ostracods are predominantly benthic inhabitants and, therefore, reflect sea-floor conditions. Different families and /or superfamilies had specific palaeoecological preferences. Such preferences of Late Palaeozoic-Early Triassic ostracod families/superfamilies may be summarized as follow (Lethiers 1982; Melnyk & Maddocks 1988). The Bairdioidea are present in shallow to

deep, open carbonate environments with normal salinity. The Kloedenellidae characterize very shallow, euryhaline environments, whereas the Cavellinidea, Beyrichiidae and Paraparchitidae are adapted to euryhaline environments in shallow to very shallow waters. The Sansabellidae occur in shallow normal marine environments, and the Kirkbyidae in sublittoral, normal marine environments. The Cytherelloidea recorded here are inhabitants of open marine environments. All ostracods reported here are typical of tropical warm waters. Almost all specimens are represented by closed carapaces. This indicates limited transport and/or burying in a soft substratum (Oertli 1971). The number of specimens per sample varied greatly, from 0 to more than 950 (Fig. 4).

1. 'Ostracod unit' (samples BUSC1 to BU1C – figs 3 to 5)

This lower unit of the Bulla section is characterised by relative low diversity (2 to 5 species) and high numbers of specimens: 63 for sample 05BU1C, 160 for samples 05BUSC1 and 05BUSC2, and more than 950 for sample 05BU1A. In the lower samples (05BUSC1 and 05BUSC2), the ostracod assemblages represent normal marine conditions in a shallow environment. In the upper part, sample 05BUSC1 is unusual in composition, having a very high number of specimens (more than 950) for 5 species. *Cavellina bellerophonella* n. sp. and *Sargentina postacuta* represent about 92% of the specimens obtained, *S. postacuta* aggregating 730 specimens. Such proliferation of one or two species indicates a stressed environment where a limited number of species are capable of adaptation and thus flourishing. The stress could be due to modification of the salinity and/or oxygenation associated with reduction in bathymetry. Sample 05BUSC2 has the same 5 species but with fewer specimens and more even representation of them. This could indicate a return to more normal marine conditions. Sample 05BU1C, with 63 specimens belonging mainly to *Knoxiella ventrospinosa* n. sp. accords with this trend.

The unconformity-paraconformity U1 (Farabegoli et al. 2007 and references therein) marks the limit between the 'Ostracod unit' and the Bulla Mb. and is attributed to a rapid sea-level fall. It is reflected in the ostracod assemblage more by a change in composition than by significant extinctions despite their being decreased taxonomic diversity and a decrease in number of specimens.

2. The Bulla Member (samples 05BU2 to 05BU7A – Figs 3 to 5)

This member displays the most diverse ostracod assemblages in the Bulla section with 48 species occurring in this interval.

The basal sample (05BU2), containing only 8 specimens of a single species, is insufficient for palaeoecologic interpretation. We observed an important increase in specimen numbers from sample 05BU2A to 05BU6 (Tab. 1 and Fig.3). There is a drop in specimen numbers in sample 05BU7A but the diversity is still high. The

PLATE 6

All specimens are from the Bulla section, Southern Alps. Scale bar is 100 µm. All specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), under numbers P6M.

- Figs 1-2 - *Sulcella suprapermiana* Kozur, 1985.
Fig. 1 - Collection number: P6M2328, left lateral view of complete carapace, sample number 05BU06; fig. 2 - Collection number: P6M2329, right lateral view of complete carapace, sample number 05BU7A.
- Figs 3-7 - *Cavellina bellerophonella* Crasquin n. sp.
Fig. 3 - Holotype, Collection number: P6M2330, left lateral view of complete carapace, sample 05BU1A; fig. 4. Paratype, Collection number: P6M2331, left lateral view of complete ♀ carapace, sample 05BU1A; fig. 5 - Collection number: P6M2332, dorsal view of complete ♂ carapace, sample number 05BU1A; fig. 6 - Collection number: P6M2333, left lateral view of complete ♂ carapace, sample number 05BU1A; fig. 7 - Collection number: P6M2334, dorsal view of complete ♀ carapace, sample number 05BU1A.
- Figs 8-10 - *Cavellina alpina* Crasquin n. sp.
Fig. 8 - Paratype, Collection number: P6M2335, left lateral view of complete carapace, sample 05BUSC1; fig. 9 - Holotype, Collection number: P6M2336, left lateral view of complete carapace, sample 05BUSC1; fig. 10 - Collection number: P6M2337, dorsal view of complete carapace, sample number 05BUSC1.
- Figs 11-12 - *Cavellina visnyoensis* Kozur, 1985.
Fig. 11 - Collection number: P6M2338, left lateral view of complete carapace, sample 05BU1A; fig. 12 - Collection number: P6M2339, dorsal view of complete carapace, sample 05BU1A.
- Figs 13-14 - *Cavellina triassica* Crasquin n. sp.
Fig. 13 - Paratype, Collection number: P6M2340, left lateral view of complete carapace, sample 05BU19A; fig. 14. Holotype, Collection number: P6M2341, left lateral view of complete carapace, sample 05BU24.
- Figs 15-16 - *Fabalicypriis?* sp. A.
Fig. 15 - Collection number: P6M2342, left lateral view of complete carapace, sample number 05BU02; fig. 14 - Collection number: P6M2343, left lateral view of complete carapace, sample number 05BU04.
- Figs 17-19 - *Arqoviella* sp.1
Fig. 17 - Collection number: P6M2344, right lateral view of complete carapace, sample number 05BUSC2; fig. 18 - Collection number: P6M2345, left lateral view of complete carapace, sample number 05BUSC2; fig. 19 - Collection number: P6M2346, dorsal view of complete carapace, sample number 05BUSC2.

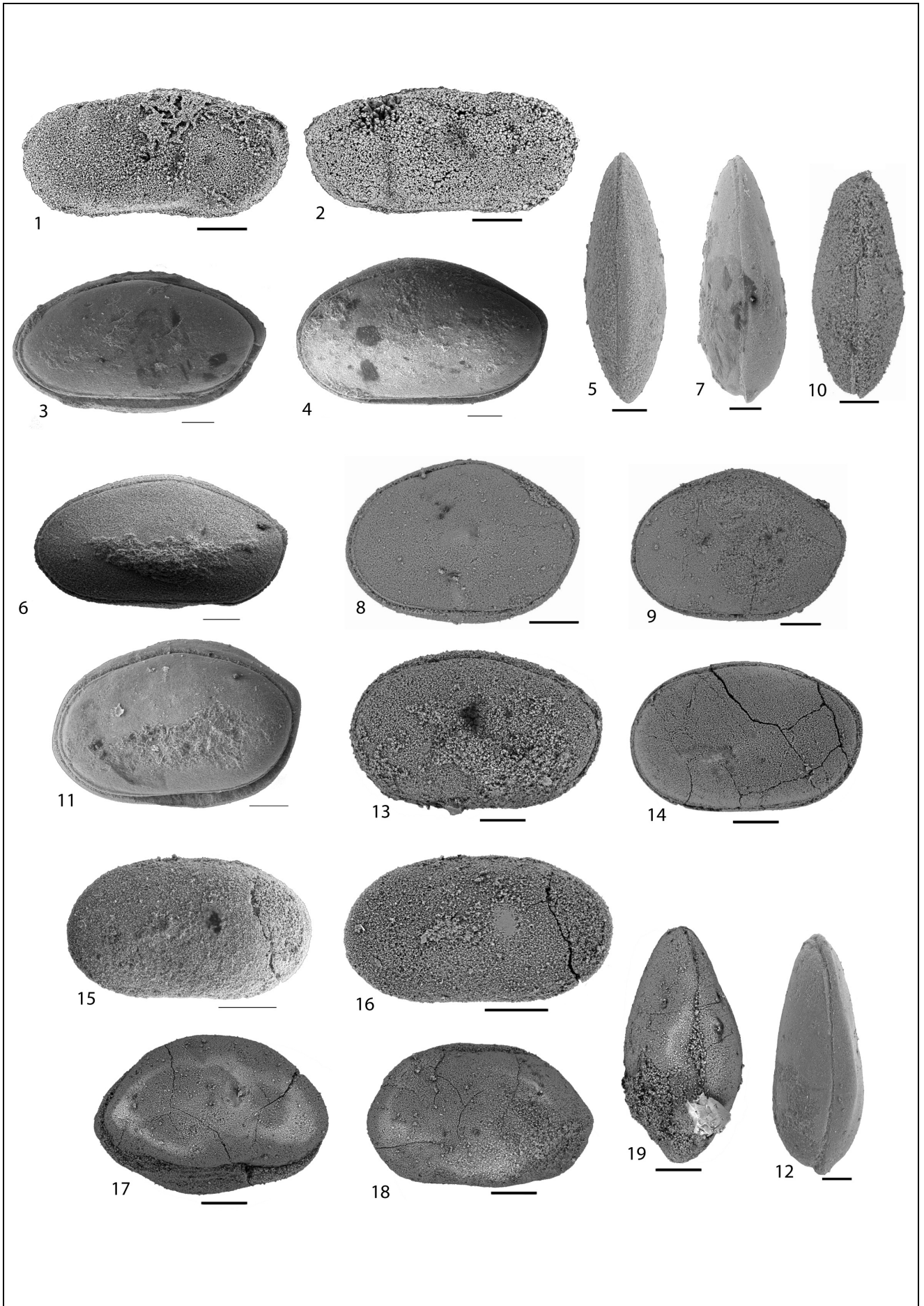
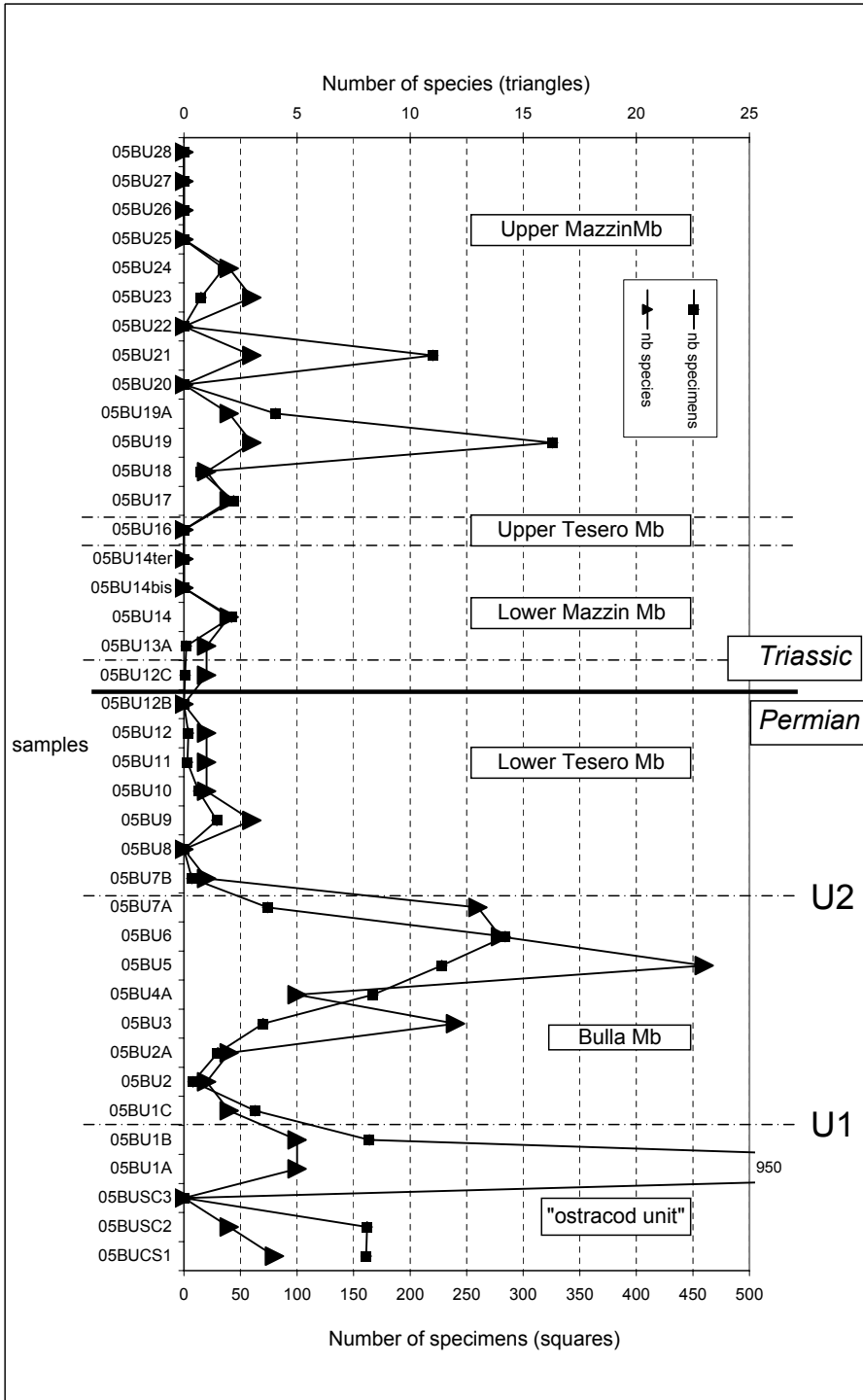


Fig. 4 - Number of species and specimens per sample.



first Bairdioidea appear in sample 05BU7A indicating a more open marine environment. They dominate the ostracod assemblages in all of the Bulla Mb. Except *K. ventrospinosa* n. sp., *Sargentina postacuta* and *Arqoviella* sp.1, all ostracod species present in Bulla Mb. are absent from the 'Ostracod unit'. Therefore, the possibility of reworking of fossils from the 'Ostracod unit' is not supported here. The abundant and diverse ostracod faunas, particularly in samples 05BU3, 5, 6 and 7A, are accord with the return of normal marine open condi-

tions connected with a transgressive phase. The peak of diversity and abundance occurred in sample 05BU6.

A drastic drop in the ostracod community occurred between samples 05BU7A and 05BU7B with a loss of 12 species. This break corresponds with unconformity U2 of Farabegoli et al. (2007), interpreted as a rapid sea-level fall.

3. The Lower Tesero Member (samples 05BU7B to 05BU12D – Figs 3 to 5)

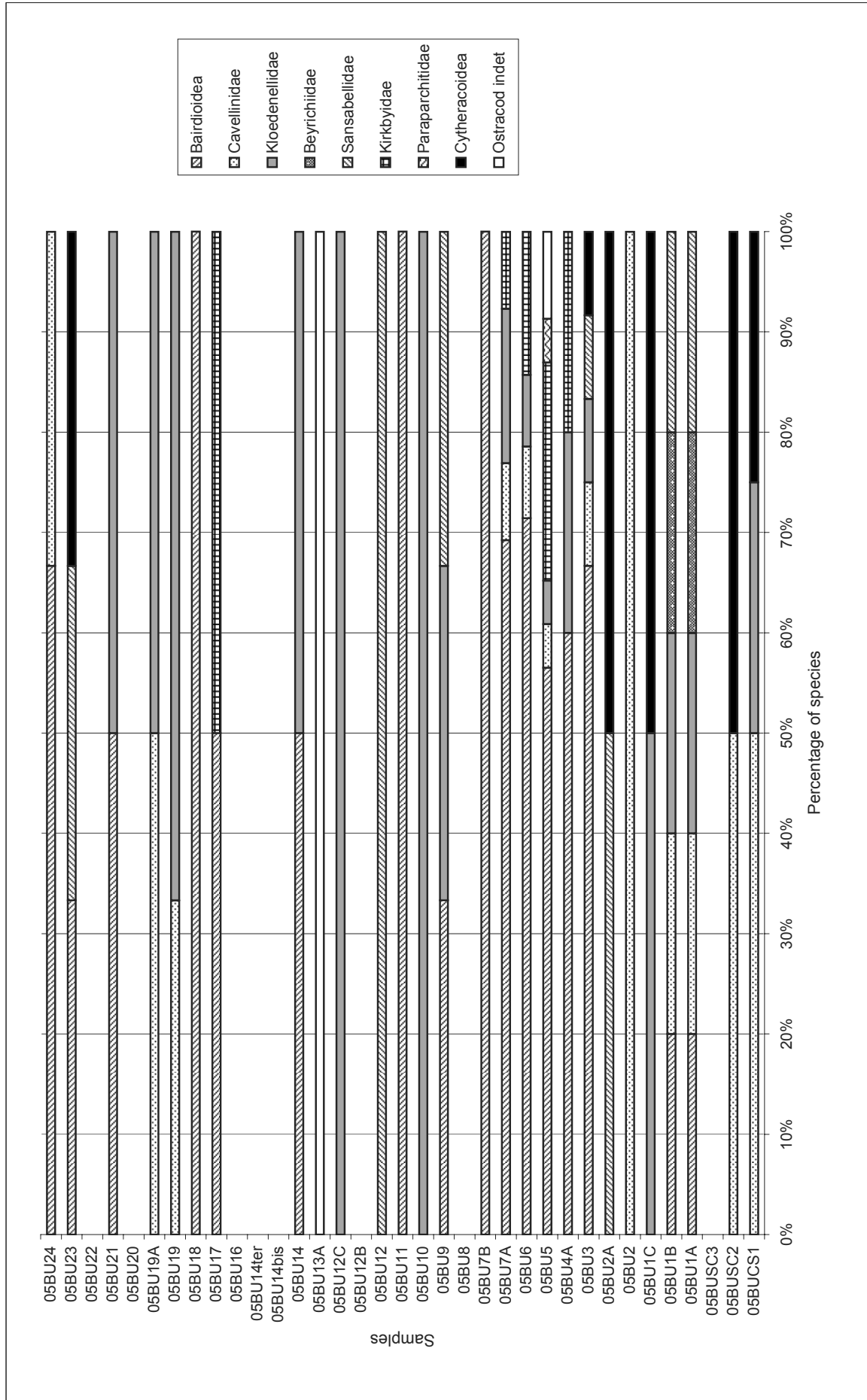


Fig. 5 - Distribution of ostracod families or superfamilies in the Bulla section (as percentages of species).

Diversities and abundances are very low for the entire member; they follow the main extinction event. The basal sample 05BU7B, having only one species represented by only seven specimens, is clearly not significant. The succeeding sample 05BU8 proved barren. Samples 05BU9 and 10 are characterized by species which appeared in the 'Ostracod unit' and are absent in the Bulla Mb. Sample 05BU9 is more diverse (3 species) and could represent a shallow marine environment. *Knoxiella ventrospinosa* n. sp. in sample 05BU10 belongs to Kloedenellidae, a family adapted to restricted environments such as low oxygen concentrations associated with microbialite deposition. For the rest of the Lower Tesero Mb., ostracod assemblages are absent or poorly represented and not of value for palaeoecologic interpretation. This paucity phase includes the Permian-Triassic boundary at 05BU12B level.

4. Lower Mazzin Member and Upper Tesero Member (samples 05BU13A to 05BU16 – Figs 3 to 5)

The paucity phase continues in these two members; samples proved barren or produced very rare ostracod assemblages.

5. Upper Mazzin Member (samples 05BU17 to 05BU33 – Figs 3 to 5)

An sharp increase of diversity with some peaks separated by barren samples occurs in this upper part of the section. Samples 05BU17, 18, 19, 19A, 21, 23 and 24 have associations with different percentages of Bairdioidea, Cavellinidae and Kloedenellidae which could be interpreted as shallow marine environments, with a more open marine location for samples 05BU18, 23 and 24. All samples after 05BU24 proved barren.

Conclusion

– This study presents for the first time the ostracod fauna of the Bulla section, parastratotype of the

Permian-Triassic boundary. Sixty-two species, belonging to 31 genera are discriminated and figured. One genus and 13 species are new.

– The 'Ostracod unit' has high diversity and great abundance of specimens characteristic of normal shallow marine conditions with a peak of stressed conditions.

– Unconformity-paraconformity U1, which marks the end of the 'Ostracod unit', is not clearly identified in itself in the ostracod assemblages. The top of 'Ostracod unit' and U1 are marked by a drop in diversity and abundance of specimens (Fig. 4) and is followed by a change in the ostracod faunal composition and a drop of species number (Fig. 3A).

– The Bulla Member displays maximum ostracod diversity and abundance linked with the transgressive trend reported for this period.

– Unconformity-paraconformity U2, at the boundary between the Bellerophon and Werfen formations (Bulla and Lower Tesero members) is the main extinction level for ostracods, as it is for all other groups.

– The Lower Tesero, Lower Mazzin and Upper Tesero members have very rare faunas.

– The lower part of the Upper Mazzin Mb. is characterized by an uneven burst of diversity before the great period of taxonomic paucity observed during the late Griesbachian all over the world (Crasquin et al. 2007).

Acknowledgements. We acknowledge with pleasure the sedimentary framework, generated largely by our colleague and friend Prof. Enzo Farabegoli, that has provided the context within which we have been able to place the ostracod faunas considered here.

Dr. Stephen Kershaw (Brunel University, Uxbridge, GB) and Dr. Avi Honigstein (Jerusalem, Israel Geological Survey) provided detailed and constructive reviews of our paper. We are most grateful to them. We also thank Maurizio Gaetani for his precise work on the manuscript.

The field work in Italy was supported by ECLIPSE2 and PICS CNRS 3361 research programs.

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OSTRACODS ACROSS THE PERMIAN-TRIASSIC BOUNDARY IN WESTERN TETHYS: THE BULLA PARASTROTOTYPE (SOUTHERN ALPS, ITALY)

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Received: February 27, 2008; accepted: May 26, 2008

Key words: Ostracods, Permian-Triassic boundary, Bulla section, Italy.

Abstract. Investigation of the ostracod fauna of the parastratotype of the Permian-Triassic boundary at Bulla in the Southern Alps produced 62 species belonging to 31 genera. They are all discussed and figured. This paper presents results of the first description of ostracods from this important site. One genus, *Bairdiacratia* n. gen., and 13 species are new: *Glyptopleurina pasinii* n. sp., *Knoxiella ventrospinosa* n. sp., *Knightina bullaensis* n. sp., *Bairdia ortiseiensis* n. sp., *B. cheni* n. sp., *B. (Rectobairdia) kershawi* n. sp., *Bairdiacratia qinglai* n. gen. n. sp., *B. tergilata* n. gen. n. sp., *Microcheilnella lata* n. sp., *Parabythocythere chongpani* n. sp., *Cavellina bellerophonella* n. sp., *C. alpina* n. sp. and *C. triassica* n. sp. The palaeoecological analysis of each unit is produced. The unconformity-paraconformity U1 is clearly reflected in the ostracod assemblages and is marked by a drop in diversity and abundance of specimens. It was followed by a change in the ostracod faunal composition. The Bulla Member displays maximum ostracod diversity and abundance linked with the transgressive trend reported for this period. The unconformity-paraconformity U2, at the boundary between the Bellerophon and Werfen formations (Bulla and Lower Tesero members) is the main extinction level for ostracods. The Lower Tesero, Lower Mazzin and Upper Tesero members have very poor faunas. The lower part of the Upper Mazzin Mb. is characterized by an uneven burst of diversity before the great period of taxonomic paucity observed during the late Griesbachian all over the world.

Riassunto. Per mezzo dell'analisi delle faune ad ostracodi del parastratotipo del limite Permiano-Triassico a Bulla (BZ) nelle Alpi Meridionali, sono state identificate 62 specie appartenenti a 31 generi. La loro discussione e documentazione iconografica è argomento di questo lavoro. Vengono descritti un nuovo genere, *Bairdiacratia* n. gen., e 13 nuove specie: *Glyptopleurina pasinii* n. sp., *Knoxiella ventrospinosa* n. sp., *Knightina bullaensis* n. sp., *Bairdia ortiseiensis* n. sp., *B. cheni* n. sp., *B. (Rectobairdia) kershawi* n. sp., *Bairdiacratia qinglai* n. gen. n. sp., *B.*

tergilata n. gen. n. sp., *Microcheilnella lata* n. sp., *Parabythocythere chongpani* n. sp., *Cavellina bellerophonella* n. sp., *C. alpina* n. sp. and *C. triassica* n. sp. Per ciascuna unità litostratigrafica viene riportata l'analisi paleoecologica. Le associazioni ad ostracodi riflettono in modo evidente la superficie di discontinuità U1 (unconformity-paraconformity 1) che separa l'Unità ad ostracodi (Ostracod and peritidal dolomite unit) e il Membro di Bulla (Bulla Mbr) della Formazione a Bellerophon, con un calo drastico in diversità e abbondanza. La maggiore diversità e abbondanza delle faune ad ostracodi è associata alla fase trasgressiva del Membro di Bulla. Il principale evento di estinzione ad ostracodi coincide con la superficie di discontinuità U2 (unconformity-paraconformity 2) posta in corrispondenza del limite formazionale fra la Formazione a Bellerophon e la Formazione di Werfen, fra i membri di Bulla e del Tesero Inferiore. I membri del Tesero Inferiore, Mazzin Inferiore e Tesero Superiore presentano una fauna ad ostracodi veramente povera. La parte inferiore del Membro del Mazzin Superiore è caratterizzata da un irregolare incremento di diversità che precede il periodo di scarsezza tassonomica osservato a livello mondiale durante il tardo Griesbachiano.

Introduction

The Bulla section in the Southern Alps is the parastratotype section for the Permian-Triassic (P-T) boundary. It was located at that time in western Tethys whereas the P-T stratotype at Meishan in China was located near the eastern border of Tethys. The Bulla section, well-known from many investigations, has been described in detail by Perri (1991), Farabegoli & Perri (1998), Perri & Farabegoli (2003) and Farabegoli et al. (2007 and references therein). Apart from a preliminary note (Pasini 1981) on ostracods from the upper part of the Bellerophon Formation at Digonera and Rio Bar-

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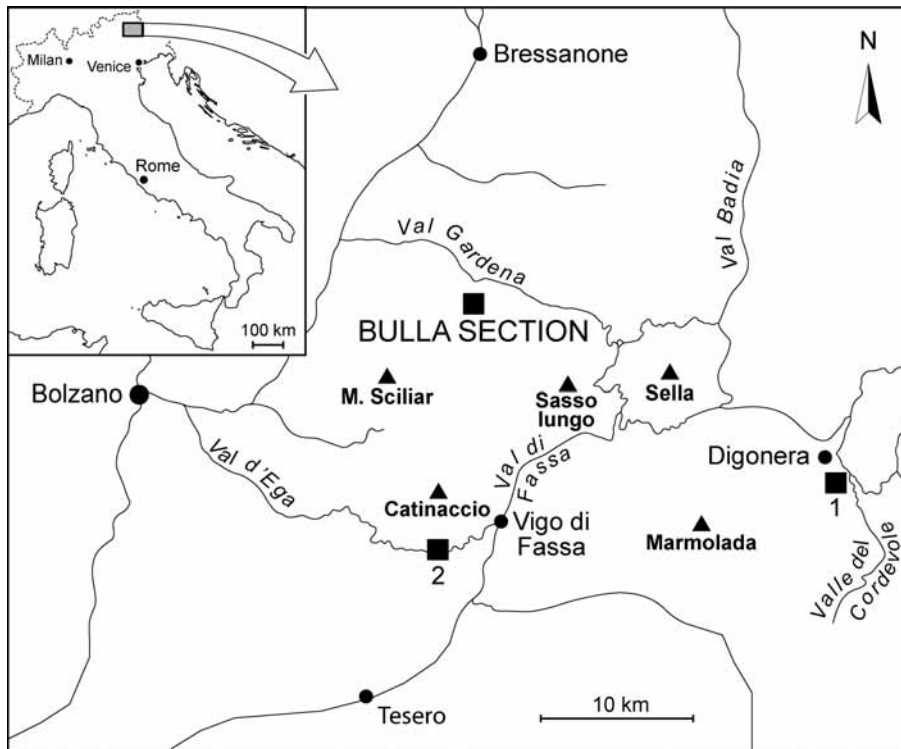


Fig. 1 - Location of the Bulla section, Bulla (Bolzano), Southern Alps, northern Italy, showing principal roads. Digonera (1) and Rio Barbide (2) are locations of Pasini's ostracod faunas.

bide (28 km SE and 16 km S of Bulla respectively; Fig. 1), ostracods from the P-T boundary interval in the Southern Alps have not been documented. Pasini (1981) described one new species, *Sargentina dolomitica*, here referred to the synonymy of *S. postacuta* Zálányi, 1974, one species in open nomenclature *Glyptopleurina* (?) sp. A (here referred to *G. pasinii* n. sp.) and figured a possible drepanellacean here attributed to *Neoulrichia pulchra* Kozur, 1981.

Of 47 samples processed by hot acetolysis (Lethiers & Crasquin-Soleau 1988; Crasquin-Soleau et al. 2005), 27 produced 62 species of ostracods referred to 31 genera; these are all figured.

Geological setting

This geological presentation is based on the publication of Farabegoli et al. (2007) and references therein. The Southern Alps Late Permian-Early Triassic succession is 40-600 m thick. On the new 1:50,000 Geologic Map of Italy, it is considered to consist of three informal units (Neri 2004): Val Gardena Sandstone (Lopingian), Bellerophon Formation (Lopingian) and Werfen Formation (latest Changhsingian-Olenekian). For this study, we sampled the upper part of the Bellerophon Fm. (Fig. 2) with its two units, the 'Ostracod unit' below and Bulla Mb. above, and the base of the Werfen Fm. with the interfingering succession of the Tesero and Mazzin members (see Farabegoli et al. 2007, Fig. 3).

Upper part of the Bellerophon Formation (Changhsingian):

- The 'Ostracod unit' (Changhsingian) is composed of grey silty dolomitic mudstone-wackestone alternating with subordinate grey to reddish shales (Fig. 2); thickness is ca 15 m. This unit was referred to mostly as the natural "regressive" fill over the previous algal shallow-marine environment (e.g. Massari et al. 1994). Only the upper 2 m were sampled for this study (samples 05BUSC1 to 05BU1B).

- The Bulla Mb. overlies the 'Ostracod unit' with an unconformable-paraconformable erosional surface, referred to as "U1" by Farabegoli et al. (2007). U1 documents a rapid sea-level fall, followed by a very short period of subaerial emersion that produced cementation of the old sea floor. The Bulla Mb. consists of 135 cm of dark grey to black fossiliferous limestone (packstone-wackestone) alternating with subordinate siltstone and marl (Perri & Farabegoli 2003). No conodonts have been found in this member in the Bulla section. It was deposited in shore-face to foreshore environments of an otherwise open shallow sea near the base of fair-weather waves (i.e. at a depth of 2-6 m). This event U1 and its related hiatus could correspond to the limit between sequences SQ2 and SQ3 of Zhang et al. (1996) in Meishan D section, i.e. to beds 24d-e because it contains "abraded bioclasts" caused by "short-term exposures on land" (Zhang et al. 1996; p.73-77). All members of this unit were sampled (samples 05BU1C to 05BU7A). Incidentally, the upper part of the Bulla Mb. produced the most diverse assemblage of foraminifers from the Bel-

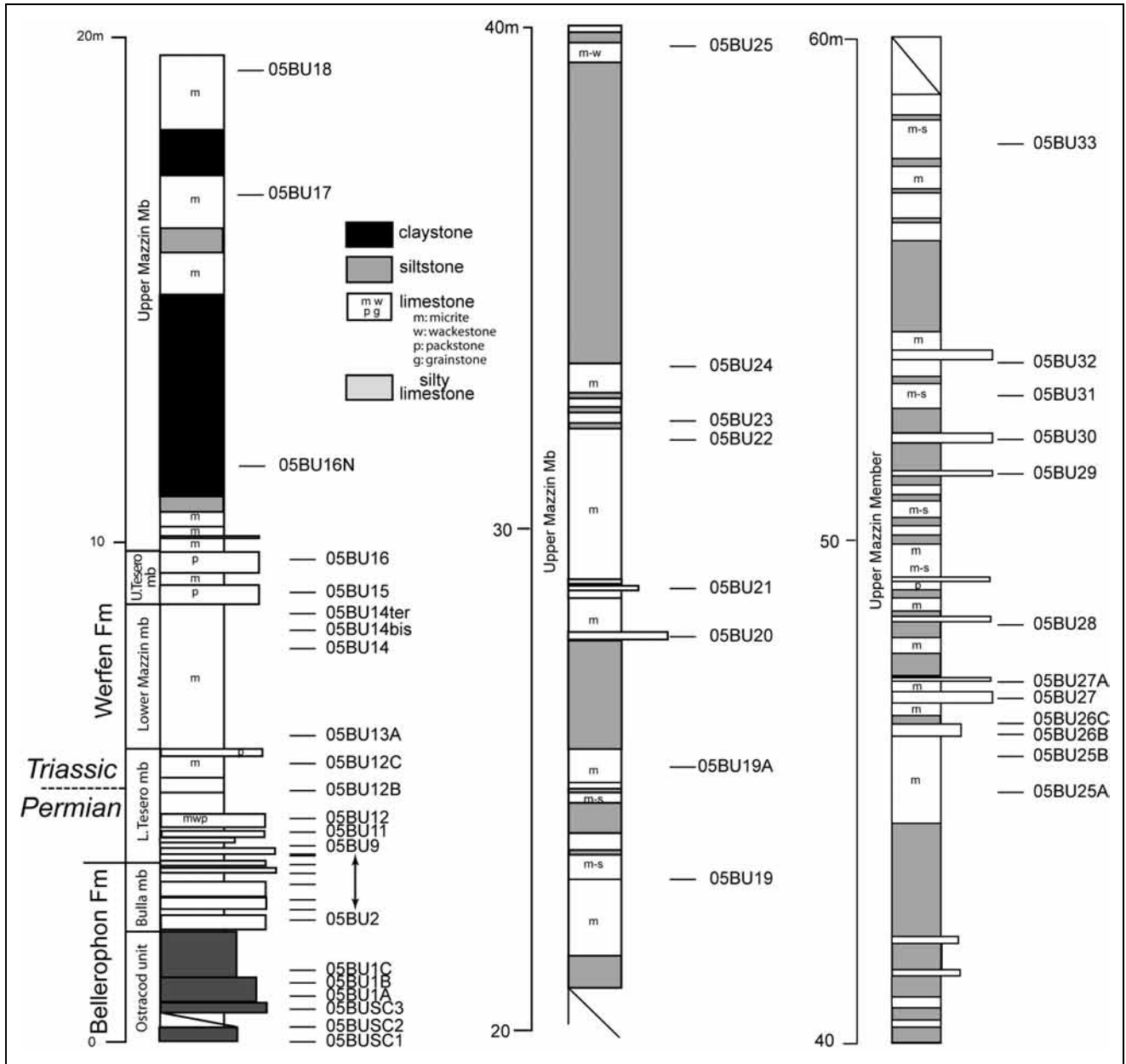


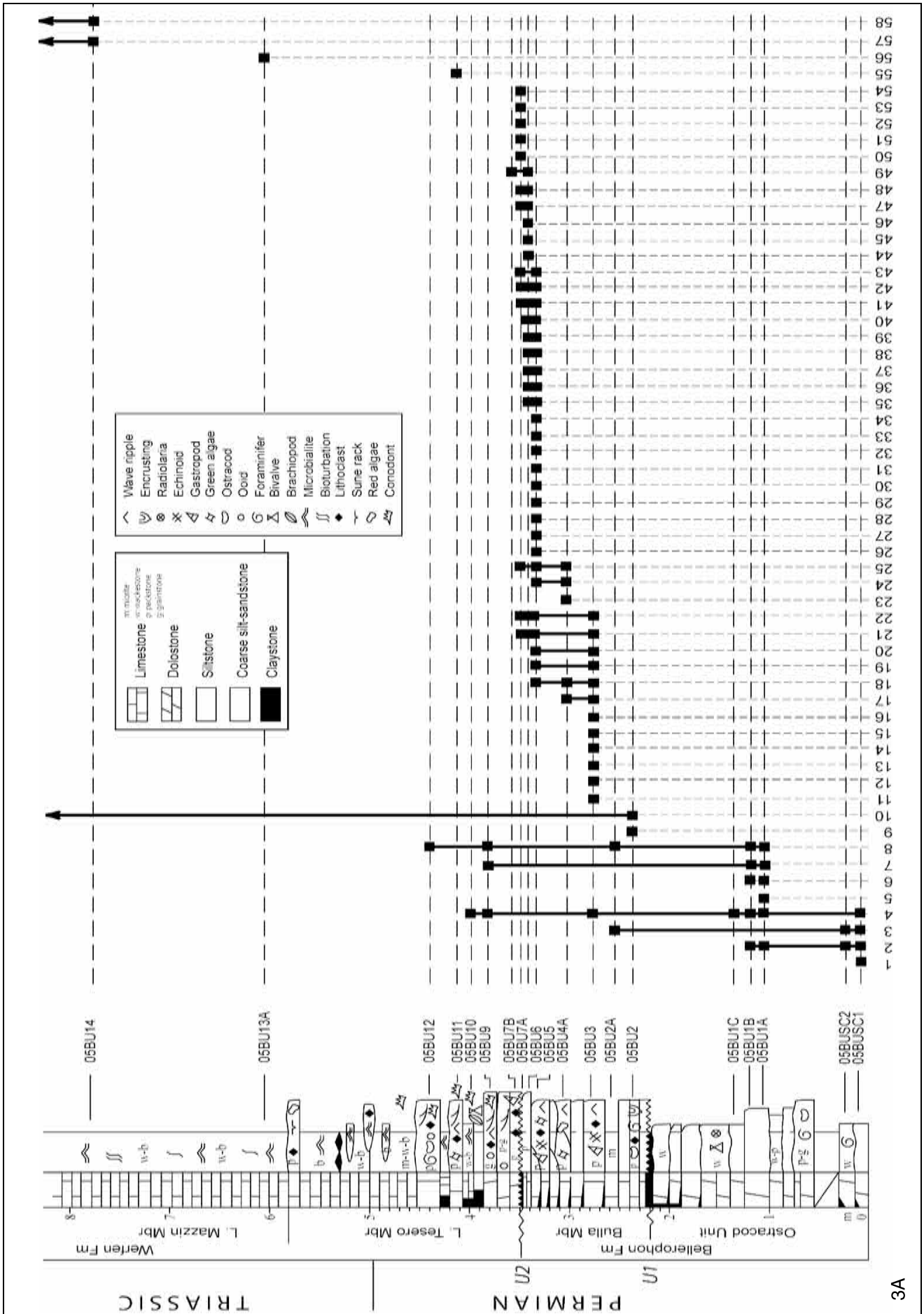
Fig. 2 - Stratigraphic columns of the Bulla section (from Farabegoli et al. 2007) with sample locations.

lerophon Fm. in the Southern Alps (Broglio Loriga et al. 1988).

- The boundary between the Bellerophon and Werfen formations is a sharp paraconformable – unconformable surface referred to as “U2” by Farabegoli et al. (2007) and interpreted as the boundary of a short-term sequence produced by a rapid sea-level fall, followed locally by a very short period of subaerial emersion. This E2 event could be correspond to Bed 26 in Meishan D section which is interpreted as representing a fall in sea-level and low-stand tract (Farabegoli et al. 2007; p. 123). The maximum of biodiversity decrease (“E1”) in the Southern Alps brackets U2 (Farabegoli et al. 2007).

Werfen Formation:

- The Lower Tesero Mb. (2.3 m, samples 05BU7B-05BU13) is mainly dark grey limestone with subordinate silty shale interbeds. The very base (samples 05BU7B-05BU8) is a 20 cm dark grey, mixed terrigenous-calcareous “layer” with hummocky cross-bedding and wave ripples. The next ca 80 cm (samples 05BU9-05BU12) consists of four bed/bedsets of oolitic grainstone-packstone with hummocky and wave ripples alternating with subordinate silty shale, pelletoid wackestone and subplanar to lenticular-columnar microbialitic layers. Sample 05BU10 has produced a few fish teeth and an abundant conodont fauna including *Hindeodus praeparvus*, *H. typicalis* and *Isarcicella prisca* associated



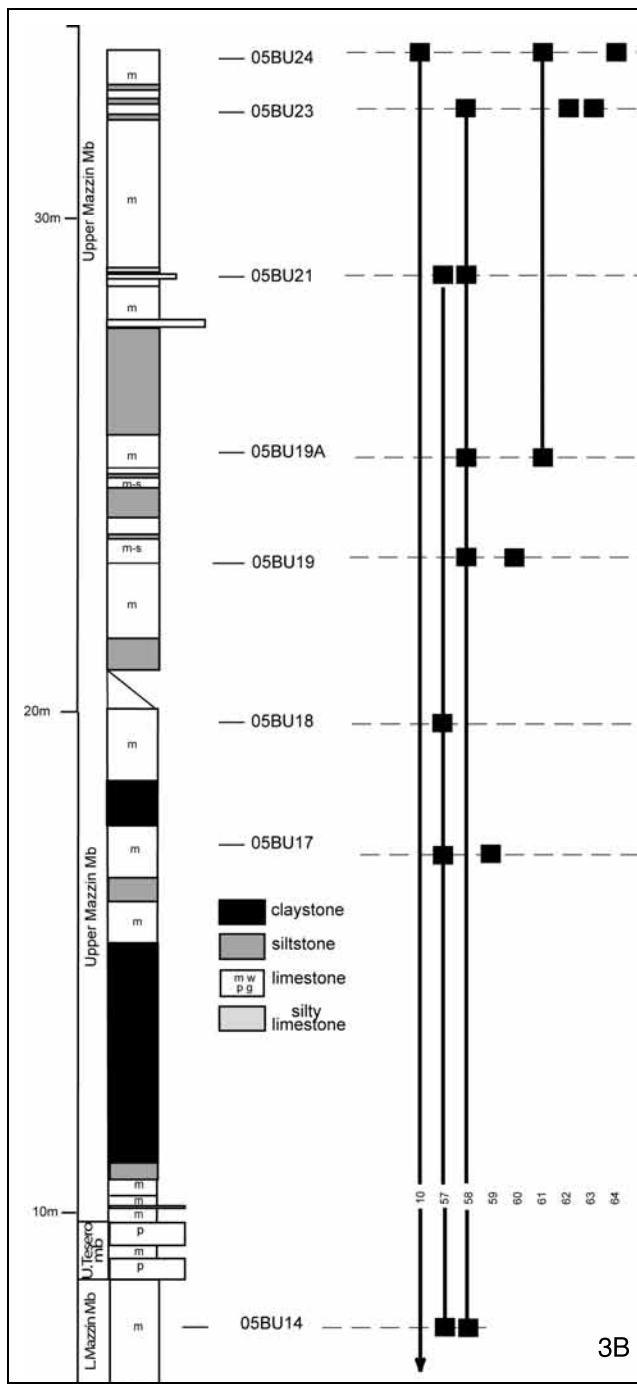


Fig. 3 - Stratigraphic columns of the Bulla section with vertical distributions of the ostracod faunas (for species names see Tab. 1). 3A: lower part; 3B: upper part.

with the entry of *I. peculiaris*. The following interval, samples 05BU11-05BU12, consists of two oolitic packstone layers containing reworked lithoclasts separated by a silty shale layer. Samples 05BU12A-05BU12B (ca 50 cm) consists of alternating cm-beds of pelletoidal wackestone, silty mudstone, siltstone and discontinuous, dome-shaped microbialites. Interval 05BU9-05BU12A has been referred to the late *praeparvus* Zone (late Changhsingian) (Perri & Farabegoli 2003).

The base of 05BU12B is the inferred P-T boundary in the Bulla section. *Hindeodus typicalis*, *H. pisai*, *Isarcicella prisca* and *I. turgida* occur in association with the index of the beginning of Triassic, *H. parvus*.

The interval top 05BU12B-top 05BU13 (ca 80 cm) consists of parallel-bedded and often lenticular, microbialitic layers. These pass laterally to silty marls and siltstones with wave ripples. It is referred to the *parvus* Zone. The Lower Tesero Mb. (05BU7B-05BU13) is interpreted as a short-term transgressive-regressive cycle.

- The Lower Mazzin Mb., a 2.90 m interval from top of 05BU13A to base of 05BU15, is composed of grey mudstone and pelletoid-lumped wackestone with planar microbialitic structures. Bioturbation is present and may be frequent; a few layers display mottled structure. Fossils are rare (ostracods, gastropods); only the lower part of this interval 05BU13A-05BU13B, still referred to the *parvus* Zone, produced a few small *H. parvus*. The environment is interpreted as calm, oxygenated, marine inner offshore, well below fair-weather waves. Absence or scarcity of grain-supported storm-layers (e.g. Tesero section) is in accord with relative deepening of a transgressing sea.

- The 1.35 m Upper Tesero Mb. consists of five oolitic-intraclastic beds (samples 05BU15-05BU16) alternating with mudstone-wackestone, thinning and fining upwards. Fossils are extremely scarce; no conodonts were found. This sequence can be explained in terms of lateral shifting of coastal facies and storm layers following rapid marine shallowing.

- The 60 m Upper Mazzin Mb. (samples 05BU16N-05BU33) corresponds to a major influx of fine terrigenous siliciclastic sediment. In the lower part, thin wavy-bedded, bioturbated grey siltstone alternates with thin beds of mudstone with occasionally prominent planar microbialitic lamination. Some calcarenitic storm layers are intercalated up-section (05BU16N-05BU25). Fossils are sparse. Rare foraminifers, small gastropods and ostracods accumulated in thin layers. *Lingula* occurs at 12 m from the base of the Werfen Fm. This brachiopod is considered in the context of the End-Permian mass extinction as a disaster taxon (Rodland & Bottjer 2001). At 16 m, sample BU18, the biotic diversity increases slightly with appearance of *Unionites* and microgastropods. At 18 m above the base of the Werfen Fm. (50 cm below 05BU19), the *Claraia wangi-griesbachi* group occurs in association with *Unionites canalensis*, aviculopectinids, *B. vaceki*, *Holopella gracilior*, *Lingula*, and ostracods. Recurring conodont faunas allow discrimination of three conodont biozones with entry of the biozonal markers *I. lobata* (BU23), *I. staeschei* (at 42.80 m, 05BU25A) and *I. isarcica* (at 45 m, 05BU27) (Perri & Farabegoli 2003). Conodont abundance and diversity is again re-established and can be compared with those of the 05BU9-05BU12B interval.

Late Induan-Early Olenekian conodont faunas of the Southern Alps are represented by very shallow-water taxa such as the multi-element species *Hadrodontina aequabilis*, *H. anceps* and *H. obliqua* (Perri & Andraghetti 1987; Perri 1991). The inferred depositional environment of the lower part is prograding thin deltaic lobes in a well ventilated, low-energy, shallow sea, probably with a substantial influx of brackish water. The unbioturbated upper interval marks return to schizohaline conditions with modest reduction in terrigenous input.

Ostracod palaeontology (SC)

Forty-seven samples bracketing the Permian-Triassic boundary were processed by hot acetolysis (Lethiers & Crasquin-Soleau 1988; Crasquin-Soleau et al. 2005), 27 of them producing ostracods. Sixty-two species belonging to 31 genera are identified and figured (Pl. 1-6). One genus and 13 species are new and are described here. One species is newly named. There are 27 species in open nomenclature because of insufficiency of material or inadequate preservation to justify extended treatment. All the ostracod species are illustrated and biostratigraphic data reported on Tab. 1.

All specimens are deposited in the Pierre et Marie Curie University (Paris, France) with collection numbers P6M.

Systematic Palaeontology

Abbreviations: L: length, H: height, W: width; AB: anterior border; VB: ventral border; PB: posterior border; DB: dorsal border; LV: left valve; RV: right valve.

Subphylum **Crustacea** Brünnich, 1772

Class **Ostracoda** Latreille, 1806

Subclass **Podocopa** Müller, 1954

Order **Palaeocopida** Henningsmoen, 1953

Suborder **Kloedenellocopina** Scott, 1961

Superfamily **Kloedenelloidea** Ulrich & Bassler, 1908

Family **Knoxitidae** Egorov, 1950

Genus *Langdaia* Wang, 1978

Type species: *Langdaia suboblunga* Wang, 1978

Langdaia laolongdongensis Crasquin-Soleau & Kershaw, 2005

Pl. 1, figs 1-2

2005 *Langdaia laolongdongensis* n. sp. Crasquin-Soleau & Kershaw, p. 135-137, pl. 2, figs 7-12.

Stratigraphic and geographic distribution. Earliest Griesbachian of Sichuan (Crasquin-Soleau & Kershaw 2005); samples 05BU14, 05BU19, 05BU19A, 05BU21, 05BU23, Mazzin Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Langdaia suboblunga Wang, 1978

Pl. 1, fig. 3

1978 *Langdaia suboblunga* gen. et sp. nov. Wang, p. 289, pl. 2, figs 8-11.

2005 *Langdaia suboblunga* Wang, 1978 – Crasquin-Soleau & Kershaw, pl. 2, figs 1-6.

Stratigraphic and geographic distribution. Early Triassic of Guizhou and Yunnan (Wang 1978), earliest Griesbachian of Sichuan (Crasquin-Soleau & Kershaw 2005), South China; sample 05BU19, Mazzin Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Genus *Glyptopleurina* Coryell, 1928

Type species: *Glyptopleurina montifera* Coryell, 1928

Glyptopleurina pasinii Crasquin n. sp.

Pl. 1, figs 4-5

?1981: *Glyptopleurina* (?) sp. A – Pasini, p. 10-12, pl. 3, figs 1-11.

Derivation of name. Dedicated to Prof. Mario Pasini who described the first Late Permian ostracods from the Southern Alps.

Holotype. One complete carapace figured Pl. 1, fig. 4; collection number P6M2233.

Paratype. One complete carapace figured Pl. 1, fig. 5, collection number P6M2234.

Type-level. Sample 05BU05, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., Changhsingian; Late Permian.

Material. 2 carapaces, 1 isolated valve and several fragments.

Diagnosis. A species of *Glyptopleurina* with two parallel ridges on L2, important flattening of posterior part of the carapace and large reticulation.

Description. Carapace of heavy aspect; DB straight; AB with small radius of curvature, with maximum of convexity located in the lower 1/3 of height; VB long and nearly straight; PB with small radius of curvature and maximum of curvature located high; L2 and S2 well developed; S1 observable on some specimens (Pasini 1981; Pl. 3, fig. 1); L2 elongated backward and subdivided in two parts by the presence of two parallel ridges, one in dorsal position and the other one in median position; dorsal ridge originates at S2 level close to the hinge and finishes at the upper extremity of L2, which is above the hingeline; the median ridge begins below S2, which is located at mid-height and mid-length, follows L2 and ends at its extremity; BP strongly compressed laterally back of L2, producing

a flattening along the BP which continues on the ventral part of the carapace; left valve overlaps right on free margins; surface with coarse reticulation; possible sexual dimorphism (with higher BP).

Remarks. It was not possible to find Pasini's original material. The figured specimens of *Glyptopleurina?* sp. A (Pasini 1981; Pl. 3, figs 1-11) may belong to our new species.

Size. L= 520-615 µm, H= 280-340 µm.

Stratigraphic and geographic distribution. Digenera and Rio Barbide (Pasini 1981); samples 05BU4A, 05BU5 and 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Genus *Knoxiella* Egorov, 1950

Type species: *Knoxiella semilukiana* Egorov, 1950

Knoxiella ventrospinosa Crasquin n. sp.

Pl. 1, figs 7-11

Derivation of name. From the presence of a spine located in the ventral part of the carapace.

Holotype. One complete carapace figured Pl. 1, figs 7 and 11; collection number P6M2236.

Paratype. One complete carapace figured Pl. 1, fig. 8, collection number P6M2237.

Type-level. Sample BU1A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., Changhsingian; Late Permian.

Material. More than 30 carapaces and several fragments.

Diagnosis. A species of *Knoxiella* with a small spine in the median part of the ventral border of the left valve.

Description. DB straight for both valves, AB rounded with maximum convexity located below mid-height; VB nearly straight on LV, slightly arched on RV; PB with small radius of convexity and maximum convexity located near the upper 1/3 of height; RV overlaps LV all around free margins with maximum on VB; S2 well developed; carapace laterally flattened on anterior and posterior parts; surface smooth.

Remarks. This species could be distinguished from other species of the genus, like *Knoxiella suboblunga* Wang, 1978 (Late Permian of Guizhou and Yunnan, South China; Wang 1978) or *Knoxiella infirma* Shi, 1982 (Wordian of Turkey; Crasquin-Soleau et al. 2004), Changhsingian of Hubei Province (Chen & Shi 1982) and Saudi Arabia (Crasquin-Soleau et al. 2005) by its ventral spine and its shallower S2.

Size. L= 440-635 µm, H= 240-355 µm.

Stratigraphic and geographic distribution. samples 05BUSC1, 05BU1A, 05BU1B, 05BU1C, 05BU03, 05BU09, 05BU10, 'Ostracod unit' and Bulla Mb., Bellerophon Fm., Lower Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Family Serenidae Rozhdvenskaya, 1972

Genus *Sargentina* Coryell & Johnson, 1939

Type species: *Sargentina allani* Coryell & Johnson, 1939

Sargentina postacuta (Zalányi, 1974)

Pl. 1, fig. 12-14

1974 *Hollinella permiana* sp. nov. Zalányi, p.108-109, pl.1, fig. 4; pl.14, figs 3a-d.

1974 *Hollinella postacuta* sp. nov. Zalányi, p.113-114, pl.1, figs 2a-d.

1974 *Hollinella visnyoensis* sp. nov. Zalányi, p.113-114, pl.1, figs 3a-c.

PLATE 1

All specimens are from the Bulla section, Southern Alps, Italy. Scale bar is 100 µm. All specimens are stored at the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

Figs. 1-2 - *Langdaia laolongdongensis* Crasquin-Soleau & Ker-shaw, 2005.

Fig. 1 - Collection number: P6M2230, left lateral view of complete carapace, sample number 05BU05; fig. 2 - Collection number P6M2231, left lateral view of complete carapace; sample number 05BU05.

Fig. 3 - *Langdaia suboblunga* Wang, 1978. Collection number: P6M2232, left lateral view of complete carapace, sample 05BU19.

Figs 4-5 - *Glyptopleurina pasinii* Crasquin n. sp.

Fig. 4 - Holotype, collection number: P6M2233, left lateral view of complete carapace, sample 05BU05; fig. 5 - Paratype, collection number P6M2234, right lateral view of complete carapace, sample 05BU7A.

Fig. 6 - *Geffenina?* sp. 1. Collection number: P6M2235, left lateral view of complete carapace, sample 05BU7A.

Figs 7-11 - *Knoxiella ventrospinosa* Crasquin n. sp.

Fig. 7 - Holotype, collection number: P6M2236, left lateral view of complete carapace. sample 05BU1A; fig. 8 - Paratype, collection number P6M2237, left lateral view of complete carapace, sample 05BU1A; fig. 9 - collection number: P6M2238, left lateral view of complete carapace, sample number 05BU1A; fig. 10 - collection number: P6M2239, right lateral view of complete carapace, sample number 05BU1A; fig. 11 - enlargement of fig. 7. Detail of the ventral spine.

Figs 12-14 - *Sargentina postacuta* (Zalányi, 1974).

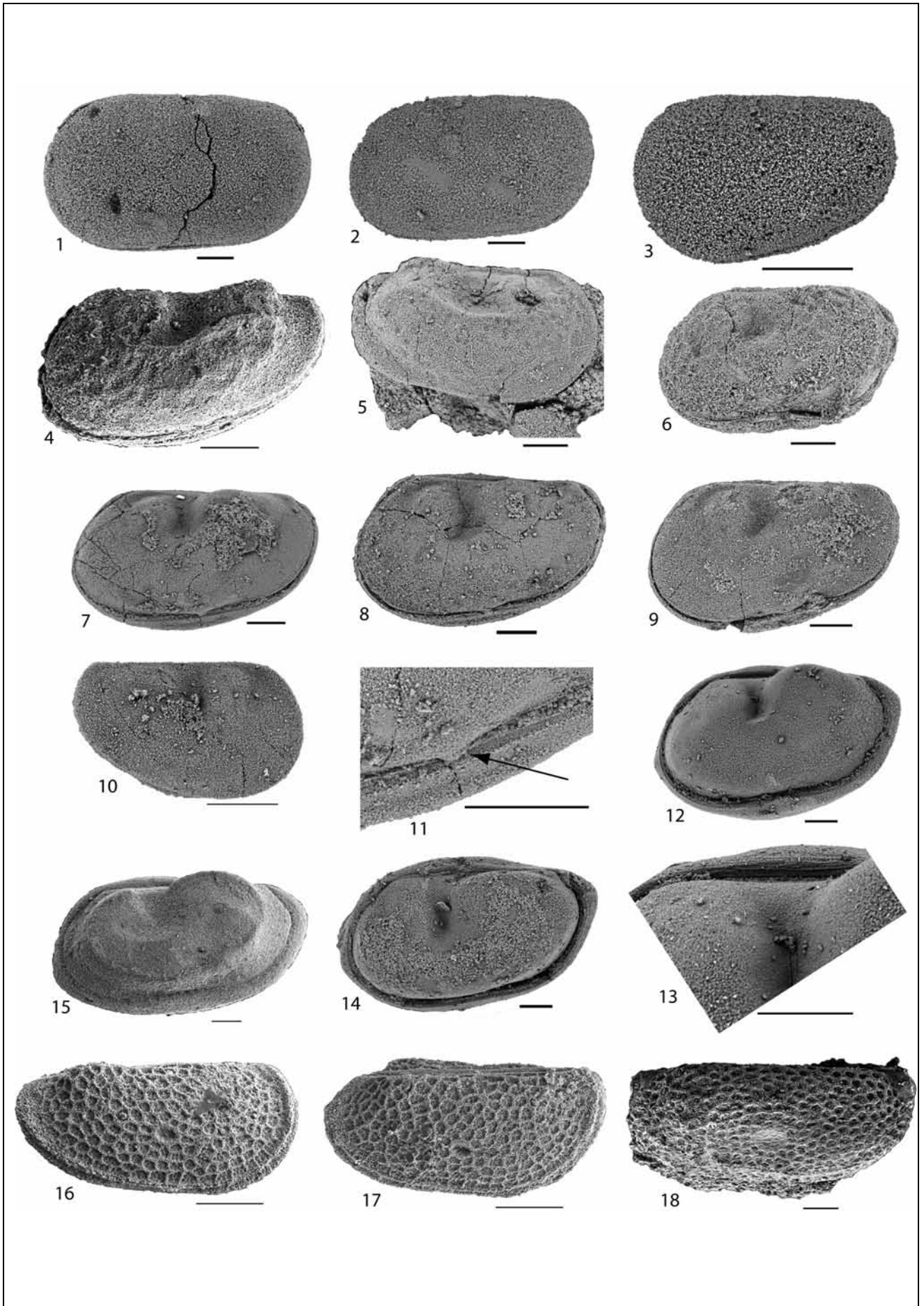
Fig. 12 - Collection number P6M2240, left lateral view of complete carapace, sample number 05BU1A; fig. 13 - Detail of complete carapace of figure 12; fig. 14 - Collection number P6M2241, left lateral view of complete carapace, sample number 05BU1A

Fig. 15 - *Sargentina* n. sp. A. Collection number P6M2242, left lateral view of a complete carapace, sample 05BU03.

Figs 16-17 - *Knighina bullaensis* Crasquin n. sp.

Fig. 16 - Holotype, Collection number P6M2243, right lateral view of complete carapace, sample 05BU05; fig. 17. Paratype, Collection number P6M2244, right lateral view of complete carapace, sample 05BU05.

Fig. 18 - *Kirkbya* cf. *buekkensis* Kozur 1985. Collection number P6M2245, right lateral view of complete carapace, sample number 05BU4A.



1981 *Sargentina dolomitica* sp. n. Pasini, p.7-9, pl.1, figs 5-7; pl.2, figs 1-13; fig.2.

Revised diagnosis. A species of *Sargentina* with AB and PB angular at RV; striation parallel to the margins and present all around the overlap of RV on LV.

Discussion. Zalányi (1974) described 3 new species from the Late Permian of the Bükk Mountains, Hungary. These three species are here considered to be synonyms; similar salient intraspecific variation is apparent also in Pasini's (1981) Italian material as well as in our material. Of the three species names used by Zalányi (1974), the second (*postacuta*) is selected because of overuse of "*permiana*" as a species name.

Stratigraphic and geographic distribution. Late Permian, Bükk Mountains, Hungary (Zalányi 1974); Trento (northern Italy), late Changhsingian; Digonera and Vigo di Fassa, Trento (northern Italy), Late Bellerophon Fm., late Changhsingian (Pasini 1981); samples 05BU1A, 05BU1B, 05BU2A, 05BU9 and 05BU12, 'Ostracod unit', Bellerophon Fm., Lower Tesero Mb., Werfen Fm., Bulla section, northern Italy (see Tab. 1).

Sargentina n. sp. A

Pl. 1, fig. 15

Remarks. This species is characterized by an important ridge which begins on the upper part of S2, winds round S2, runs parallel to VB and follows the external part of L3. There is also a small horizontal ridge below S2. This species is very characteristic and different from other representative of the genus, but unfortunately we found only one specimen.

Stratigraphic and geographic distribution. Sample 05BU03, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Suborder **Kirkbyocopina** Gründel, 1969

Superfamily Kirkbyoidea Ulrich & Bassler, 1906

Family Kirkbyidae Ulrich & Bassler, 1906

Genus *Knightina* Kellett, 1933

Type species: *Amphissites allorismoides* Knight, 1928

Knightina bullaensis Crasquin n. sp.

Pl. 1, figs 16-17

Derivation of name. From Bulla, the name of the type section.

Holotype. One complete carapace figured Pl. 1, fig. 16, collection number P6M2243.

Paratype. One complete carapace figured Pl. 1, fig. 17, collection number P6M2244.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., Changhsingian; Late Permian.

Material. 2 carapaces and several fragments.

Diagnosis. A species of *Knightina* with elongated carapace and with reticulation on marginal surface.

Description. Subrectangular carapace with long straight DB; AB with small radius of curvature, and maximum curvature located close to DB; VB long and straight; PB with small radius of curvature; all surface covered by large anastomosing reticulation and particularly on the marginal surface where reticulation is perpendicular to the free borders; kirkbyan pit clear, located in central part of the carapace just below mid-height; posterior shoulder clear but not overhanging the hinge line.

Remarks. *Knightina bullaensis* n. sp. can be compared to *K. hungarica* Kozur, 1985a from the early Wuchiapingian of Bükk Mountains (Hungary) (Kozur 1985) but the reticulation is larger and finer and is present on the marginal surface of the present material.

Size. L= 400-415 µm, H= 190-200 µm.

Stratigraphic and geographic distribution. Sample 05BU05, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Suborder **Beyrichicopina** Scott, 1961

Superfamily Kirkbyoidea (Ulrich & Bassler, 1906)

Family Kirkbyidae Ulrich & Bassler, 1906

Genus *Parahollinella* Zalányi, 1974 emend. Kozur, 1985

Type species: *Parahollinella hungarica* Zalányi, 1974

Parahollinella visnyoensis Kozur, 1985

Pl. 2, fig. 4

1985a *Parahollinella visnyoensis* n. sp. Kozur, p. 32-33, pl. 7, figs 8-9.

1985a *Kegelites visnyoensis* n. sp. Kozur, p. 117.

1985b *Parahollinella visnyoensis* - Kozur, pl. 4, fig. 3.

Stratigraphic and geographic distribution. Wuchiapingian (Abadehian) of Bükk Mountains, Hungary (Kozur 1985a); samples 05BU6 and 05BU7A, Bulla Mb., Bellerophon Fm., Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Family Beyrichiidae Matthew, 1886

Genus *Neoulrichia* Kozur, 1981

Type species: *Neoulrichia pulchra* Kozur, 1981

Neoulrichia pulchra Kozur, 1981

Pl. 2, figs 8-9

?1981 Drepanellacea (?) - Pasini, pl. 1, figs 2-3.

1981 *Neoulrichia pulchra* n. gen. n. sp. Kozur, p. 201, pl. 1, fig. 1.

1985b *Neoulrichia pulchra* Kozur 1981 - Kozur, pl. 10, fig. 3.

Stratigraphic and geographic distribution. Basal Dzulfian (early Wuchiapingian) of the Bükk Mountains, Hungary (Kozur 1981, 1985b); Rio Barbide and Digonera sections, northern Italy (Pasini 1981); samples 05BU1A, 05BU1B, 'Ostracod unit', Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Order **Podocopida** Müller, 1894

Suborder **Podocopina** Sars, 1866

Superfamily **Bairdioidea** Sars, 1888

Family **Bairdiidae** Sars, 1888

Genus *Bairdia* McCoy, 1844

Type species: *Bairdia curta* McCoy, 1844

Bairdia ortiseiensis Crasquin n. sp.

Pl. 2, figs 13-18

Derivation of name. From Ortisei town, northern Italy, close to the Bulla section.

Holotype. One complete carapace figured Pl. 2, fig. 13, collection number P6M2259.

Paratype. One complete carapace figured Pl. 2, fig. 14, collection number P6M2261.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian.

Material. 48 carapaces and numerous fragments

Diagnosis. A species of the *Bairdia* with AVB and PVB flattened and reticulated carapace, the reticulation is elongate, paralleling the margins.

Description. Carapace with huge frame; BD recitilinear on LV and arched on RV; AB with small radius of convexity and at right angles to DB in adults (more rounded in small forms); VB nearly linear or gently concave on RV, concave on LV; PB with small radius of convexity; AB and PB strongly flattened laterally; PDB nearly straight on both valves; carapace thick with maximum thickness around mid-length; RV overlaps LV all around the borders with maximum overlap on dorsal borders; surface reticulated; reticulation elongate and arranged parallel to margins; central part of the carapace smoother.

Remarks. *Bairdia ortiseiensis* n. sp. does not closely resemble other species of the genus.

Size. L= 370-990 µm, H= 235-620 µm.

Stratigraphic and geographic distribution. Samples 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., Lower Tesero Mb., Werfen Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Bairdia cheni Crasquin n.sp.

Pl. 3, figs 1-3

Derivation of name. Dedicated to Dr. Chen T.C., Nanjing, who described many species from Permian strata of South China.

Holotype. One complete carapace figured Pl. 3, fig. 1, collection number P6M2265.

Paratype. One complete carapace figured Pl. 3, fig. 2, collection number P6M2267.

Type-level. Sample 05BU4A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. 6 carapaces.

Diagnosis. A species of *Bairdia* with elongated carapace, DB, ADB and PDB straight, with sharp angles between ADB-DB and PDB on RV; BD regularly arched on LV.

Description. Carapace elongate; PDB, DB and ADB straight on LV; angles between PDB and DB and between DB and ADB sharp on LV; angle between PDB and DB 130-140°; angle between DB and ADB 15-45-150°; ADB and PDB nearly straight on RV; DB regularly arched on RV; AB with small radius of convexity and maximum curvature located high; VB straight to convex on LV, concave on RV; PB with very small radius of curvature and maximum convexity located low; LV overlaps RV, maximum on DB and VB; carapace smooth; small shouldering of DB on RV.

Remarks. *Bairdia cheni* n. sp. is very close from *B. cf. trianguliformis* Chen, 1958 *sensu* Shi & Chen, 1987 from the Late Permian of the Meishan section, South China. The overlap in our material is more important and the carapace is more asymmetric from the AB to PB, with maximum height located in the first 1/3 of length; the BP has a smaller radius of curvature. *B. cheni* n. sp. can be compared with three species described by (Chen 1958) from the Early Permian of Lungtan (South China): *B. beedei* Ulrich & Bassler, 1906, *B. piscariformis* Chen, 1958 and *B. lungtanensis* Chen, 1958. These three species may be synonyms. With our material, the AB has smaller radius of curvature and the carapace is more elongate.

Size. L= 600-1150 µm, H= 285-590 µm.

Stratigraphic and geographic distribution. Samples 05BU3, 05BU4A, 05BU5, Bulla Mb., Bellerophon Fm., Bulla section, late Changhsingian, Late Permian; Southern Alps, northern Italy (see Tab. 1).

Bairdia galei Croneis & Thurman 1939 *sensu*

Shi & Chen, 1987

Pl. 2, figs 11-12

2002 *Bairdia galei* Geis - Shi & Chen, p. 64, pl. 2, figs 13-16

Remarks. Our material appears to be conspecific with the species figured by Shi & Chen (2002) under the name *B. galei*, but it differs from *B. galei* described originally from the Early Carboniferous of the North American Platform (Geis 1932).

Stratigraphic and geographic distribution. Late Permian of Heshan and Yishan, Guangxi Province, South China (Shi and Chen 2002); Samples 05BU5,

05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian; Bulla section, northern Italy (see Tab. 1).

Bairdia (Rectobairdia) kershawi Crasquin n. sp.

Pl. 4, figs 18-19

1987 *Rectobairdia tantilla* (Kummerow) - Shi & Chen, p. 41-42, pl. 5, figs 3-10.

2002 *Rectobairdia tantilla* (Kummerow) - Shi & Chen, p. 71-72, pl. 8, figs 5-7, pl. 9, figs 6-9.

Derivation of name. Dedicated to Dr. Steve Kershaw, Brunel University, Uxbridge, UK.

Holotype. One complete carapace figured Pl. 4, fig. 18, collection number P6M2304.

Paratype. One complete carapace figured Pl. 4, fig. 19, collection number P6M2305.

Type-level. Sample 05BU5, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. 10 carapaces and numerous fragments.

Diagnosis. A species of *Bairdia* (*Rectobairdia*) with elongated carapace, height almost constant along its length, AB with a large radius of curvature.

Description. Carapace elongated, H/L= 0.45, DB long (+/- half of length), straight on both valves, could be slightly concave on LV in its medium part; AB with large radius of curvature and maximum of convexity located at mid-height or above; VB concave on both valves, PB with small radius of curvature, maximum of convexity located in lower 1/3 of height: overlap moderate with maximum dorsally; surface smooth.

Remarks. Shi & Chen (1987, 2002) ascribed specimens from Late Permian of Meishan section (Zhejiang Province) and of Heshan and Yishan areas (Guangxi Province, South China) to *Rectobairdia tantilla* (Kummerow 1953) from the Middle Devonian of Poland and Germany. The two species are close but the AB of *R. tantilla* has a greater radius of curvature and the ADB is more horizontal.

Size. L= 850-1020 µm, H= 400-450 µm.

Stratigraphic and geographic distribution. Heshan and Yishan areas, Guangxi province, Meishan, Zhejiang Province, South China, late Changhsingian, Late Permian. Samples, 05BU5, 05BU6, Bulla Mb., Bellerophon Fm., Bulla section, late Changhsingian, Late Permian; Southern Alps, northern Italy (see Tab. 1).

Genus *Bairdiacratia* Crasquin gen. n.

Derivation of name. From being intermediate between the genera *Bairdia* and *Acratia*

Type species. *Bairdiacratia qinglaili* Crasquin n. sp. (Pl. 3, figs 13-16).

Type horizon. Sample 05BU7A, Bulla Mb., Bellerophon Fm.; late Changhsingian; Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy.

Diagnosis. A new genus with AB characteristic of the genus *Acratia* (acratian beak) and PB characteristic of *Bairdia*, AB and PB flattened.

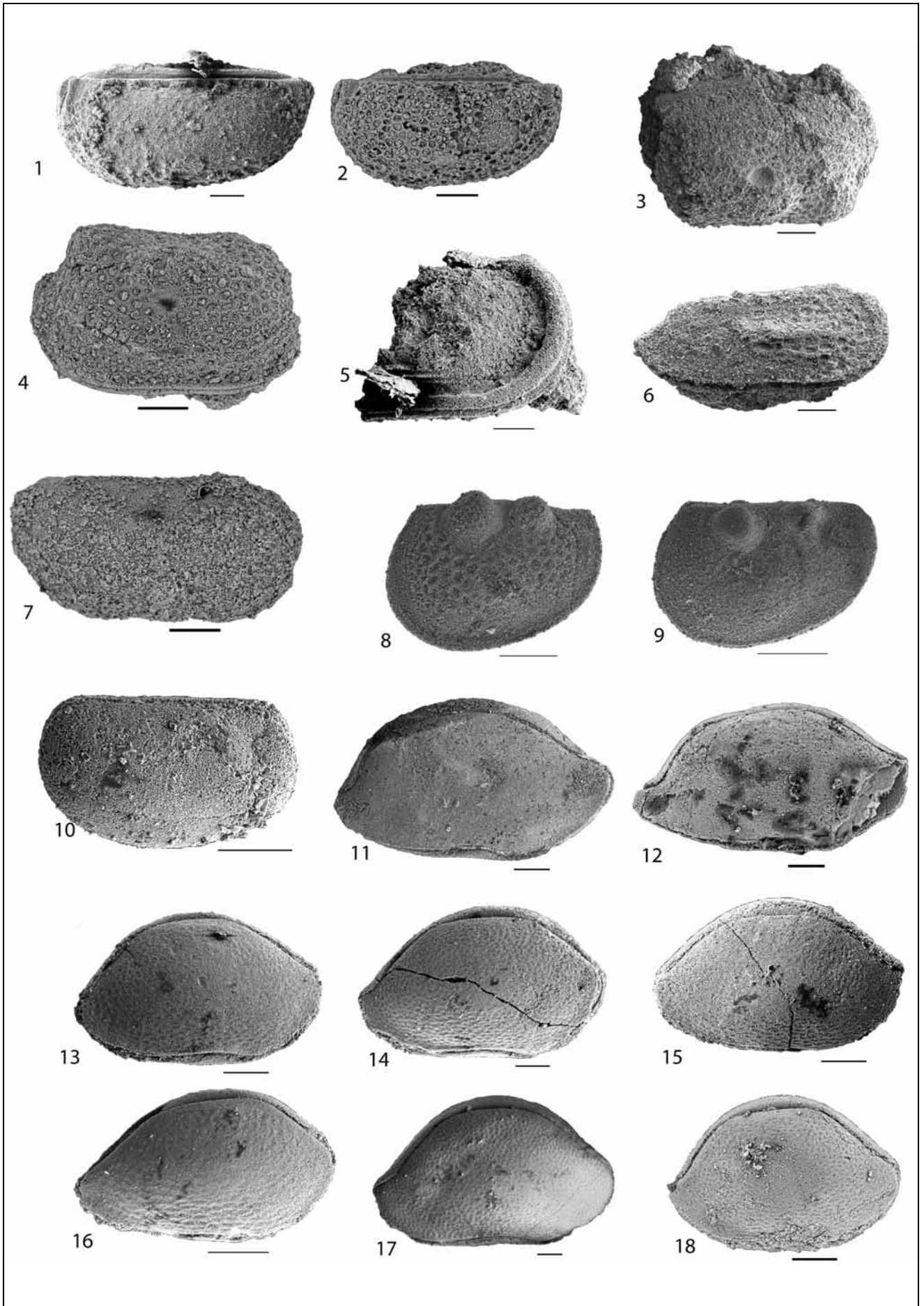
Remarks. *Bairdiacratia* n. gen. resembles *Lobobairdia* Kollman, 1963 from the Late Triassic (Kollmann 1963) in general outline, but our material lacks a groove on AB and PB.

Distribution. Late Changhsingian, Late Permian, Southern Alps, northern Italy; Dajiang section, Guizhou Province, Meishan section, Zhejiang Province, Jiangsu section, Hubei Province, South China.

PLATE 2

All specimens are from Bulla section, Southern Alps. Scale bar is 100 µm. All specimens are stored in the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

- Figs 1-2 - *Kirkbyia* sp. 1.
Fig. 1 - Collection number P6M2246, left lateral view of complete carapace, sample number 05BU05; fig. 2 - Collection number P6M2247, left lateral view of complete carapace, sample number 05BU7A.
- Fig. 3 - cf. *Shleesha pinguis* (Ulrich & Bassler, 1906). Collection number P6M2248, right lateral view of complete carapace, sample number 05BU05.
- Fig. 4 - *Parabollinella visnyoensis* Kozur, 1985. Collection number P6M2249, right lateral view of right valve, sample number 05BU06.
- Fig. 5 - Kirkbyidae sp. 1. Collection number P6M2250, right lateral view of right valve, sample 05BU05.
- Fig. 6 - Kirkbyidae sp. 2. Collection number P6M2251, right lateral view of right valve, sample 05BU05.
- Fig. 7 - Kirkbyidae sp. 3. Collection number P6M2253, right lateral view of right valve, sample 05BU17.
- Figs 8-9 - *Neoulrichia pulchra* Kozur, 1981.
Fig. 8 - Collection number P6M2254, left lateral view of complete carapace, sample number 05BU1A; fig. 9 - Collection number P6M2255, left lateral view of complete carapace, sample number 05BU1A.
- Fig. 10 - *Paraparchites* sp. 1. Collection number P6M2256, left lateral view of complete carapace, sample number 05BU05.
- Figs 11-12 - *Bairdia galei* Croneis & Thurman 1939 *sensu* Shi & Chen, 1987.
Fig. 11 - Collection number P6M2257, right lateral view of complete carapace, sample number 05BU05; fig. 12 - Collection number P6M2258, right lateral view of complete carapace, sample number 05BU4A.
- Figs 13-18 - *Bairdia ortiseiensis* Crasquin n. sp.
Fig. 13 - Holotype, collection number: P6M2259, right lateral view of complete carapace, sample 05BU05; fig. 14 - Collection number: P6M2260, right lateral view of complete carapace, sample 05BU05; fig. 15 - Paratype, collection number P6M2261, right lateral view of complete carapace, sample number 05BU05; fig. 16 - Collection number: P6M2262, right lateral view of complete carapace, sample number 05BU05; fig. 17 - Collection number: P6M2263, right lateral view of complete carapace, sample number 05BU05; fig. 18 - Collection number: P6M2264, right lateral view of complete carapace, sample number 05BU7A.



Species included in *Bairdiacratia* Crasquin

gen. n.

Bairdiacratia qinglaii Crasquin n. sp.

Bairdiacratia tergilata Crasquin n. sp.

Bairdiacratia n. sp. 1

Bairdiacratia n. sp. 2

Bairdiacratia n. sp. 3

Lobobairdia rostriformis Chen, 1982 (in Chen & Shi 1982)

Bairdiacratia qinglaii Crasquin n. gen. n. sp.

Pl. 3, figs 13-16

Derivation of name. Dedicated to Prof. Feng Qinglai, Chinese University of Geosciences, Wuhan, China

Holotype. One complete carapace figured Pl. 3, fig. 13; collection number P6M2277.

Paratype. One complete carapace figured Pl. 3, fig. 14, collection number P6M22279.

Type-level. Sample 05BU7A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. Fifteen carapaces and numerous fragments.

Diagnosis. A species of *Bairdiacratia* Crasquin gen. n. with short carapace, AB relatively large, and AB and PB strongly compressed laterally.

Description. Short ($0.60 < H/L < 0.70$) and thick carapace; PDB and ADB straight on both valves; DB straight on RV and gently convex on LV; AB characterized by typical "acratian beak", VB straight on LV and gently concave on RV; typical "bairdian" PB; AB and PB strongly compressed laterally; maximum of height located in front of mid-length; LV overlaps RV all around the carapace, with maximum on dorsal part; carapace could be ornamented by reticulation parallel to margins (Pl. 3, fig. 16).

Size. L= 490-920 μ m, H= 340-565 μ m.

Stratigraphic and geographic distribution. Samples 05BU3, 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Bairdiacratia tergilata Crasquin n. gen. n. sp.

Pl. 3, figs 17-18

Derivation of name. From Latin *tergum-i*: back and *latus-um*: large.

Holotype. One complete carapace figured Pl. 3, fig. 18, collection number P6M2281.

Paratype. One complete carapace figured Pl. 3, fig. 17, collection number P6M2282.

Type-level. Sample 05BU3, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

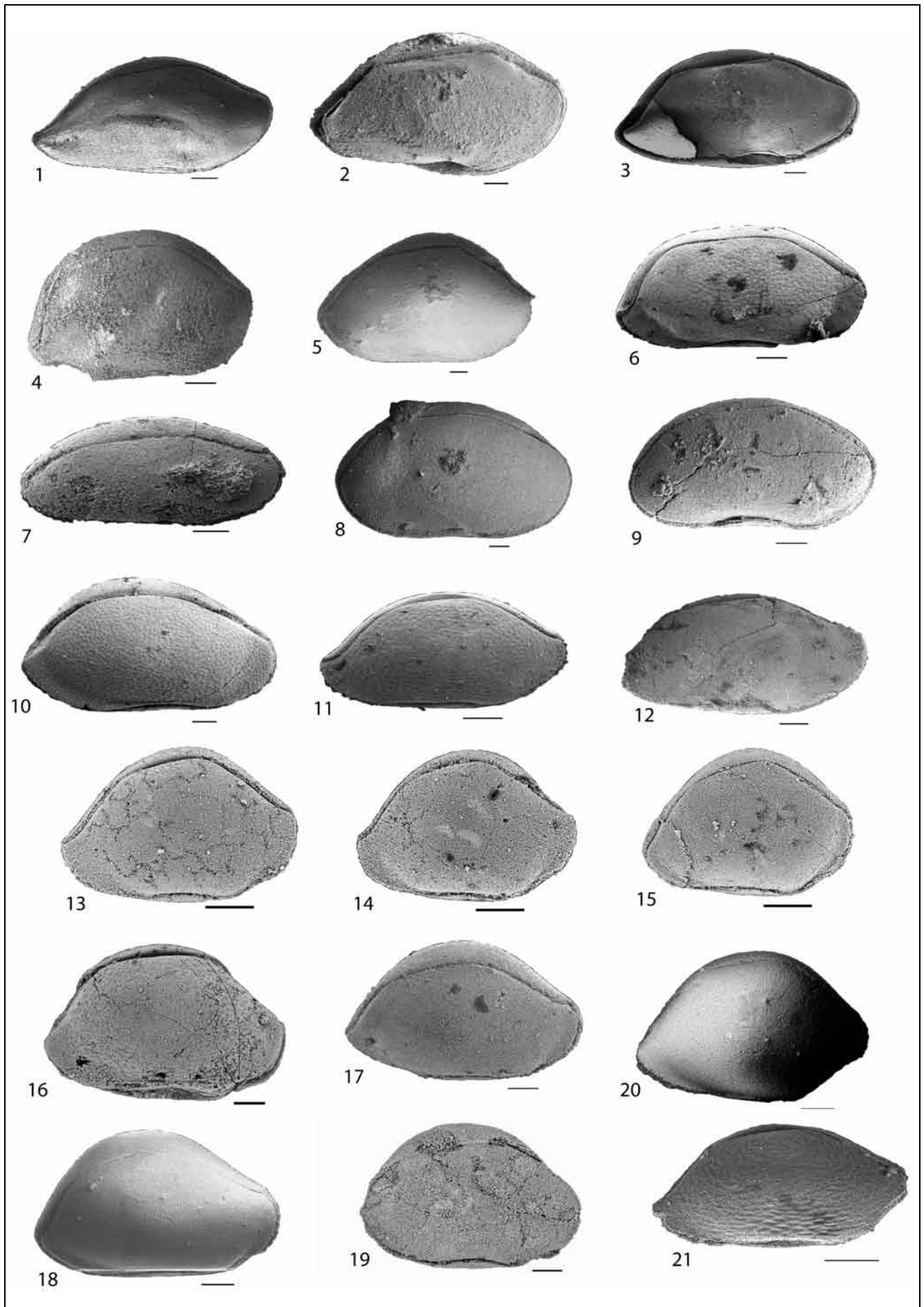
Material. Six carapaces and numerous fragments.

Diagnosis. A species of *Bairdiacratia* Crasquin gen. n. with very important overlap of LV on RV on all dorsal margins.

PLATE 3

Except figs 19 and 20 which come from South China, all specimens are from Bulla section, Southern Alps. Scale bar is 100 μ m. All specimens are housed in the Pierre et Marie Curie University Collections (Paris, France) under numbers P6M.

- Figs 1-3 - *Bairdia cheni* Crasquin n. sp.
 Fig. 1 - Holotype, Collection number: P6M2265, right lateral view of complete carapace, sample 05BU4A; fig. 2 - Collection number: P6M2266, right lateral view of complete carapace, sample 05BU05; fig. 3 - Paratype, Collection number: P6M2267, right lateral view of complete carapace, sample number 05BU4A.
- Fig. 4 - *Bairdia* sp. 4. Collection number: P6M2268, right lateral view of complete carapace, sample 05BU05.
- Fig. 5 - *Bairdia* sp. 5. Collection number: P6M2269, right lateral view of complete carapace, sample 05BU05.
- Fig. 6 - *Bairdia* sp. 1. Collection number: P6M2270, right lateral view of complete carapace, sample 05BU03.
- Fig. 7 - *Bairdia* sp. 2. Collection number: P6M2271, right lateral view of complete carapace, sample 05BU03.
- Figs 8-9 - *Bairdia* sp. 3.
 Fig. 8 - Collection number: P6M2272, right lateral view of complete carapace, sample 05BU05; fig. 9 - Collection number: P6M2273, right lateral view of complete carapace, sample 05BU05.
- Fig. 10 - *Bairdia* sp. 6. Collection number: P6M2274, right lateral view of complete carapace, sample 05BU4A.
- Fig. 11 - *Bairdia* sp. 7. Collection number: P6M2275, right lateral view of complete carapace, sample 05BU03.
- Fig. 12 - *Bairdia* cf. *subcontracta* Chen, 1987. Collection number: P6M2276, right lateral view of complete carapace, sample number 05BU03.
- Figs 13-16 - *Bairdiacratia qinglaii* Crasquin n. gen. n. sp.
 Fig. 13 - Holotype, Collection number: P6M2274, right lateral view of complete carapace, sample 05BU7A; fig. 14 - Collection number: P6M2278, right lateral view of complete carapace, sample 05BU7A; fig. 15 - Paratype, Collection number: P6M2279, right lateral view of complete carapace, sample number 05BU7A; fig. 16 - Collection number: P6M2280, right lateral view of complete carapace, sample number 05BU7A.
- Figs 17-18 - *Bairdiacratia tergilata* Crasquin n. gen. n. sp.
 Fig. 17 - Paratype, Collection number: P6M2282, right lateral view of complete carapace, sample 05BU03; fig. 18 - Holotype, Collection number: P6M2281, right lateral view of complete carapace, sample 05BU03.
- Fig. 19 - *Bairdiacratia* n. gen. n. sp. 3. Collection number: P6M2284, right lateral view of complete carapace from Dajiang section, Guizhou Province, South China, sample 05PAJ22, Dajiang section, Guizhou Province, China (location in Forel et al. 2009).
- Fig. 20 - *Bairdiacratia* n. gen. n. sp. 1. Collection number: P6M2285, right lateral view of complete carapace from Meishan section, Feijiang Province, South China, sample 04C16.3, Meishan section, Zhejiang Province, China.
- Fig. 21 - *Bairdiacratia* n. gen. n. sp. 2. Collection number: P6M2286, right lateral view of complete carapace, sample 05BU05.



Description. Carapace thick with DB slightly convex on RV and arched on LV; ADB and PDB nearly straight; AB with typical “acratian beak” in its ventral part; VB nearly straight on LV, slightly concave on RV; PB with typical *Bairdia* shape; AB compressed laterally; PB compressed laterally but only in its ventral part; LV overlaps RV all around the carapace; very important overlap on dorsal parts of the carapace; surface smooth.

Remarks. *Bairdiacratia tergilata* Crasquin n. gen. n. sp. differs from *B. qinglaili* Crasquin n. gen. n. sp. by its important overlap in the dorsal part of the carapace, its longer carapace and more tapering PB.

Size. L= 680-800 µm, H= 450-470 µm.

Stratigraphic and geographic distribution. Samples 05BU3 and 05BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Bairdiacratia n. gen. n. sp. 1

Pl. 3, fig. 20

Remarks. This specimen is reported from the Permian-Triassic boundary stratotype at Meishan, South China. It presents an AB with small radius of convexity and maximum of curvature located high, BP tapering, PDB, DB and ADB straight on RV, overlap of LV on RV moderate. Revision of the Meishan ostracods is in progress.

Stratigraphic and geographic distribution. Sample 04C16.3, Baoqing Mb., Changxing Fm., late Changhsingian, Late Permian; Meishan section, Zhejiang Province, South China (Crasquin et al. in progress).

Bairdiacratia n. gen. n. sp. 2

Pl. 3, fig. 21

Remarks. This specimen of *Bairdiacratia* gen. n. is very elongate, AB with very small radius of convexity and maximum of convexity located high. The carapace is reticulate; the reticulation is elongate, parallel to the margins. This species is new but we found only one specimen.

Stratigraphic and geographic distribution. Sample 05BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Bairdiacratia n. gen. n. sp. 3

Pl. 3, fig. 19

Remarks. This specimen comes from the Permian-Triassic boundary at the Dajiang section in Guizhou Province, South China (Forel et al. 2009). This specimen is poorly preserved but has characteristics of

Bairdiacratia. It is close to *B. tergilata* n. gen. n. sp. with a larger PB but the preservation doesn't allow specific attribution. The publication of the Dajiang ostracods is in progress.

Stratigraphic and geographic distribution. Samples 05PAJ22, Wujiaping Fm., late Changhsingian, Late Permian; Dajiang section, Guizhou Province, South China (Forel et al. 2009).

Genus *Bairdiacypris* Bradfield, 1935

Type species: *Bairdiacypris deloi* Bradfield, 1935

Bairdiacypris longirobusta Chen, 1958

Pl. 4, fig. 1-2

1958 *Bairdiacypris longirobusta* Chen (sp. nov.), p. 232, 255, pl. 7, figs 1-3.

1978 *Bairdiacypris longirobusta* Chen - Guan, p.157, pl. 40, figs 7-8.

1982 *Bairdiacypris longirobusta* Chen - Chen & Shi, p. 136, pl. 10, figs 12-18.

1987 *Bairdiacypris longirobusta* Chen - Shi & Chen, p. 50, pl. 12, figs 21-22, pl. 16, figs 14-15.

2002 *Bairdiacypris longirobusta* Chen - Shi & Chen, p. 83, pl. 21, figs 4-7.

Stratigraphic and geographic distribution. Early Permian of Lungtan (Chen 1958); Late Permian of Nantong, Jiangsu Province and Mianyang, Hubei Province (Chen & Shi 1982); Meishan section, Zhejiang Province, South China (Shi & Chen 1987) and Heishan and Yishan in Guangxi Province, Changhsingian (Shi & Chen 2002). Sample 05BU6, Bulla Mb., Bellerophon Fm., sample 05BU7B, lower Tesero Mb., Werfen Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Bairdiacypris? caeca Shi, 1987

Pl. 4, figs 4-5

1987 *Bairdiacypris? caeca* Shi sp. nov. (in Shi & Chen 1987), 52, pl. 13, figs 1-6.

2002 *Bairdiacypris? caeca* Shi - Shi & Chen, p.86, pl. 22, figs 12-19.

Stratigraphic and geographic distribution. Changhsingian of Meishan section, Zhejiang Province, South China (Shi & Chen 1987) and Heishan and Yishan in Guangxi Province (Shi & Chen 2002). Sample 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Bairdiacypris wangi Kozur, 1985

Pl. 4, fig. 6

1985a *Bairdiacypris wangi* n. sp. Kozur, p. 80-81, pl. 17, figs 5-6.

Stratigraphic and geographic distribution. Wu-chiapingian (Abadehian), Bükk Mountains, Hungary. Sample 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Liuzhinia* Zheng, 1976

Type species: *Liuzhinia subovata* Zheng, 1976

Liuzhinia antalyaensis Crasquin-Soleau, 2004

Pl. 4, figs 9-10

2004 *Liuzhinia antalyaensis* Crasquin-Soleau n. sp. (in Crasquin-Soleau et al.), p. 286, pl. 3, figs 6-13.

2006 *Liuzhinia antalyaensis* Crasquin-Soleau, 2004 - Crasquin-Soleau et al., p. 62, pl. 3, figs 12-13.

Stratigraphic and geographic distribution. Çürük dag section, western Taurus, Turkey, Early Triassic (Crasquin-Soleau et al. 2004); Fengshan area, Guangxi Province, South China, Griesbachian, Early Triassic (Crasquin-Soleau et al. 2006). Sample 05BU14, 05BU17, 05BU18, 05BU21, Lower and Upper Mazzin Mbs, Werfen Fm., Induan, Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Paracypris* Sars, 1866

Type species: *Paracypris polita* Sars, 1866

Paracypris gaetanii Crasquin-Soleau, 2006

Pl. 4, fig. 12

2006 *Paracypris gaetanii* Crasquin-Soleau n. sp. (in Crasquin-Soleau et al.), p. 64, pl.4, figs 1-4.

Stratigraphic and geographic distribution. Fengshan area, Guangxi Province, South China, Griesbachian, Early Triassic (Crasquin-Soleau et al. 2006). Sample 05BU24, Upper Mazzin Mb., Werfen Fm., Induan, Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Paramacrocypris*

Type species: *Paramacrocypris schallreuteri* Kozur, 1985

Paramacrocypris schallreuteri Kozur, 1985

Pl. 4, figs 13-14

1985a *Paramacrocypris schallreuteri* n. gen. n. sp. Kozur, p. 109-110, pl. 21, fig. 9.

Stratigraphic and geographic distribution. Wu-chiapingian (Dzulfian), early Late Permian, Bükk Mountains, Hungary (Kozur 1985a). Samples 05BU3,

05BU4A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Petasobairdia* Chen, 1982

Type species: *Petasobairdia bicornuta* Chen, 1982

Petasobairdia nantongensis Chen, 1982

Pl. 4, figs 16-17

1982 *Petasobairdia nantongensis* Chen gen. et sp. nov. (in Chen & Shi), p. 130-131, pl. 4, figs 1-9.

1987 *Petasobairdia nantongensis* Chen - Shi & Chen, p. 47, pl. 7, figs 12-16, pl.19, figs 1-4.

2002 *Petasobairdia nantongensis* Chen - Shi & Chen, p. 75, pl. 17, figs 7-9.

Stratigraphic and geographic distribution. Late Permian of Jiangsu and Hubei Provinces (Chen & Shi 1982), of Meishan section, Zhejiang Province (Shi & Chen 1987) and of Guangxi Province (Shi & Chen, 2002), South China. Samples 05BU05, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Family Microcheilinellidae Gramm, 1975

Genus *Microcheilinella* Geis, 1933

Type species: *Microcheilus distortus* Geis, 1932

Microcheilinella lata Crasquin n. sp.

Pl. 5, figs 1-4

Derivation of name. From latin *latus*, *a*, *um*: large, plump.

Holotype. One complete carapace figured Pl. 5, fig. 1, collection number P6M2306.

Paratype. One complete carapace figured Pl. 5, fig. 2, collection number P6M2307.

Type-level. Sample 05BU6, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. Ten carapaces and several fragments.

Diagnosis. A species of *Microcheilinella* with DB slightly concave on RV, VB nearly straight on RV, hinge short and invaginated, maximum of overlap on PB and PDB and minimum overlapping in PVB.

Description. Carapace with rounded form; H/L = 0.55.

RV: DB straight, with short and invaginated hinge; AB rounded with large radius of convexity, maximum of convexity located in the lower 1/3 of height; VB nearly straight; PB with maximum of convexity located close to VB; LV outline regularly rounded, PVB slightly truncated; LV strongly overlaps RV around all margins; minimum of overlap on PVB; in dorsal view,

carapace thin for the genus, with maximum thickness located behind mid-length; thickness equivalent to height.

Remarks. *Microcheilinella lata* n. sp. is very close from *M. sp. sensu* Crasquin-Soleau et al. 2004 from the late Middle Permian of Turkey. This last species is shorter but presents the same type of outline and overlap.

Size. L= 332-545 µm, H= 180-300 µm.

Stratigraphic and geographic distribution. Samples 05BU6 and 06BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Microcheilinella peraxilis Shi, 1987

Pl. 5, fig. 6

1987 *Microcheilinella peraxilis* Shi sp. nov. (in Shi & Chen), p. 62, pl. 14, figs 23-27.

Stratigraphic and geographic distribution. Sample 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1); Late Permian, Meishan section, Zhejiang Province, South China.

Family Acratiidae Gründel, 1962

Genus *Acratia* Delo, 1930

Type species: *Acratia typica* Delo, 1930

Acratia zhongyingensis Wang, 1978

Pl. 5, figs 10-12

1978 *Acratia zhongyingensis* sp. nov. Wang, p. 295, pl. 4, figs 5-6.

2002 *Acratia zhongyingensis* Wang - Shi & Chen, p. 82-83, pl. 20, figs 25-26.

Stratigraphic and geographic distribution. Late Permian of Western Guizhou province (Wang 1978) and Meishan section, Zhejiang Province, South China (Shi & Chen 2002); Samples 05BU1A, 05BU1B, 05BU9, 'Ostracod unit', Bellerophon Fm. and Lower Tesero Mb., Werfen Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy.

Family Geroidae Gründel, 1962

Genus *Pseudacanthoscapha* Kozur, 1985

Type species *Acratia? striatula* Shi, 1982

Pseudacanthoscapha striatula (Shi, 1982)

Pl. 5, fig. 22

1982 *Acratia? striatula* Shi sp. nov. (in Chen & Shi), p. 139, pl. 11, figs 9-11.

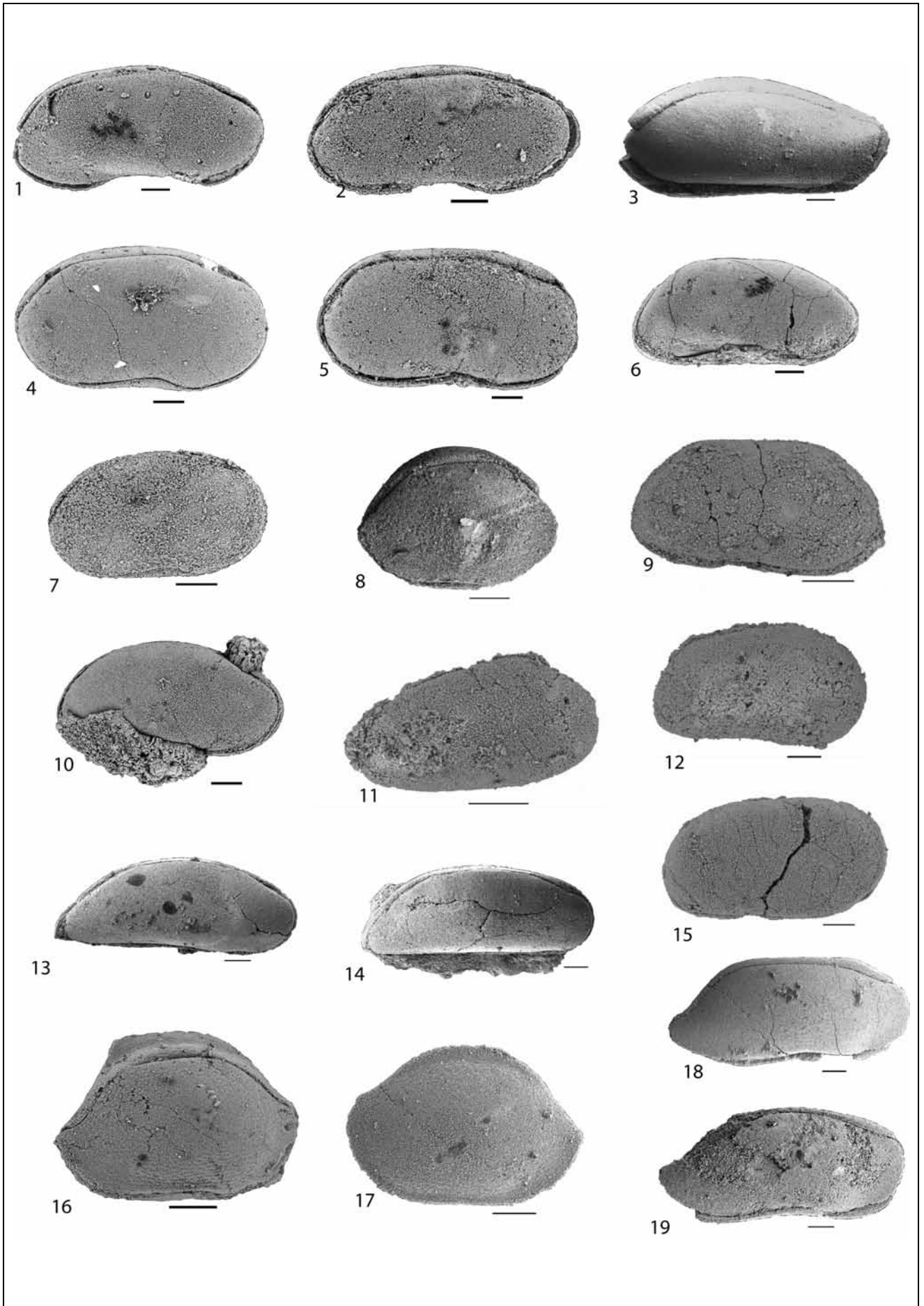
1985a *Pseudacanthoscapha beckeri* n. gen. n. sp. - Kozur, p. 110, pl. 18, fig. 9.

1987 *Acratia striatula* Shi - Shi & Chen, p.49, pl. 11, figs 13-18, pl. 17, figs 1-4.

PLATE 4

All specimens are from Bulla section, Southern Alps. Scale bar is 100 µm. All the specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), undernumbers P6M.

- Figs 1-2 - *Bairdiacypris longirobusta* Chen, 1958.
Fig. 1 - Collection number: P6M2287, right lateral view of complete carapace, sample 05BU06; fig. 2 - Collection number: P6M2266, right lateral view of complete carapace, sample 05BU06.
- Fig. 3 - *Bairdiacypris* sp.1. Collection number: P6M2289, right lateral view of complete carapace, sample 05BU03.
- Figs 4-5 - *Bairdiacypris? caeca* Shi, 1987.
Fig. 4 - Collection number: P6M2290, right lateral view of complete carapace, sample number 05BU7A; fig. 5 - Collection number: P6M2291, right lateral view of complete carapace, sample number 05BU7A.
- Fig. 6 - *Bairdiacypris wangi* Kozur, 1985. Collection number: P6M2292, right lateral view of complete carapace, sample 05BU06.
- Fig. 7 - *Fabalitycypris* cf. *vinsyoensis* Kozur, 1985. Collection number: P6M2293, right lateral view of complete carapace, sample 05BU7A.
- Fig. 8 - *Cryptobairdia* cf. *postilonga* Chen, 2002. Collection number: P6M2294, right lateral view of complete carapace, sample 05BU05.
- Figs 9, 12 - *Liuzhinia antalyaensis* Crasquin-Soleau, 2004.
Fig. 9 - Collection number: P6M2295, right lateral view of complete carapace, sample number 05BU18; fig. 12 - Collection number: P6M2296, right lateral view of complete carapace, sample number 05BU17.
- Fig. 10 - *Macrocypris* sp.1. Collection number: P6M2297, right lateral view of complete carapace, sample 05BU11.
- Fig. 11 - *Paracypris gaetani* Crasquin-Soleau, 2006. Collection number: P6M2298, right lateral view of complete carapace, sample 05BU24.
- Figs 13-14 - *Paramacrocypris schallreuteri* Kozur, 1985.
Fig. 13 - Collection number: P6M2299, right lateral view of complete carapace, sample number 05BU03; fig. 14 - Collection number: P6M2300, right lateral view of complete carapace, sample number 05BU03.
- Fig. 15 - *Paracypris* sp. 1. Collection number: P6M2301, right lateral view of complete carapace, sample 05BU23.
- Figs 16-17 - *Petasobairdia nantongensis* Chen, 1982.
Fig. 16 - Collection number: P6M2302, right lateral view of complete carapace, sample number 05BU7A; fig. 17 - Collection number: P6M2303, left lateral view of complete carapace, sample number 05BU05.
- Figs 18-19 - *Bairdia (Rectobairdia) kershawii* Crasquin n. sp.
Fig. 18 - Holotype, Collection number: P6M2304, right lateral view of complete carapace, sample 05BU5; fig. 19. Paratype, Collection number: P6M2305, right lateral view of complete carapace, sample 05BU5.



Stratigraphic and geographic distribution. Basal Dzulfian (early Wuchiapingian) of Bükk Mountains (Hungary; Kozur 1985a), Changhsingian of Meishan section, Zhejiang (Shi & Chen 1987) and Mianyuangi, Hubei (Chen & Shi 1982); sample 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Superfamily Cytheroidea Baird, 1850

Family Bythocytheridae Sars, 1928

Genus *Parabythocythere* Kozur, 1981

Type species: *Parabythocythere permica* Kozur, 1981

***Parabythocythere? chongpani* Crasquin n. sp.**

Pl. 5, figs 13-16

Derivation of name. Dedicated to Prof. Chongpan Chonglakmani from Suranaree University of Technology, Nakhon Ratcharisma, Thailand.

Holotype. One complete carapace figured Pl. 5, fig. 14, collection number P6M2319.

Paratype. One complete carapace figured Pl. 5, fig. 13, collection number P6M2318.

Type-level. Sample 05BU3, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Bulla Mb., Bellerophon Fm., late Changhsingian; Late Permian.

Material. Five carapaces and several fragments.

Diagnosis. A species doubtfully attributed to the genus *Parabythocythere* with very delicate reticulation parallel to its free margins.

Description. Carapace with straight DB; AB with small radius of curvature and maximum of convexity located at mid-height; VB convex with maximum of height located in front of mid-length; PB with small radius of curvature and maximum of convexity located around upper 1/3 of height; BP compressed laterally; RV overlaps LV; primary ornament difficult to observe (only a shallow S2 on some carapaces); reticulation very delicate like fingerprints, parallel to free margins; dorsal view biconvex with maximum thickness posteriorly, BP strongly compressed.

Remarks. *Parabythocythere? chongpani* Crasquin n. sp. differs from *P. permica permica* Kozur, 1981 from the Late Permian of the Bükk Mountains, Hungary, and the Meishan section in South China and from *P. permiana reticulata* Kozur, 1985 from the Middle Permian of the Bükk Mountains, by its more tumid and fine ornament. The doubt as to generic attribution comes from the fact that the primary lobation is totally absent.

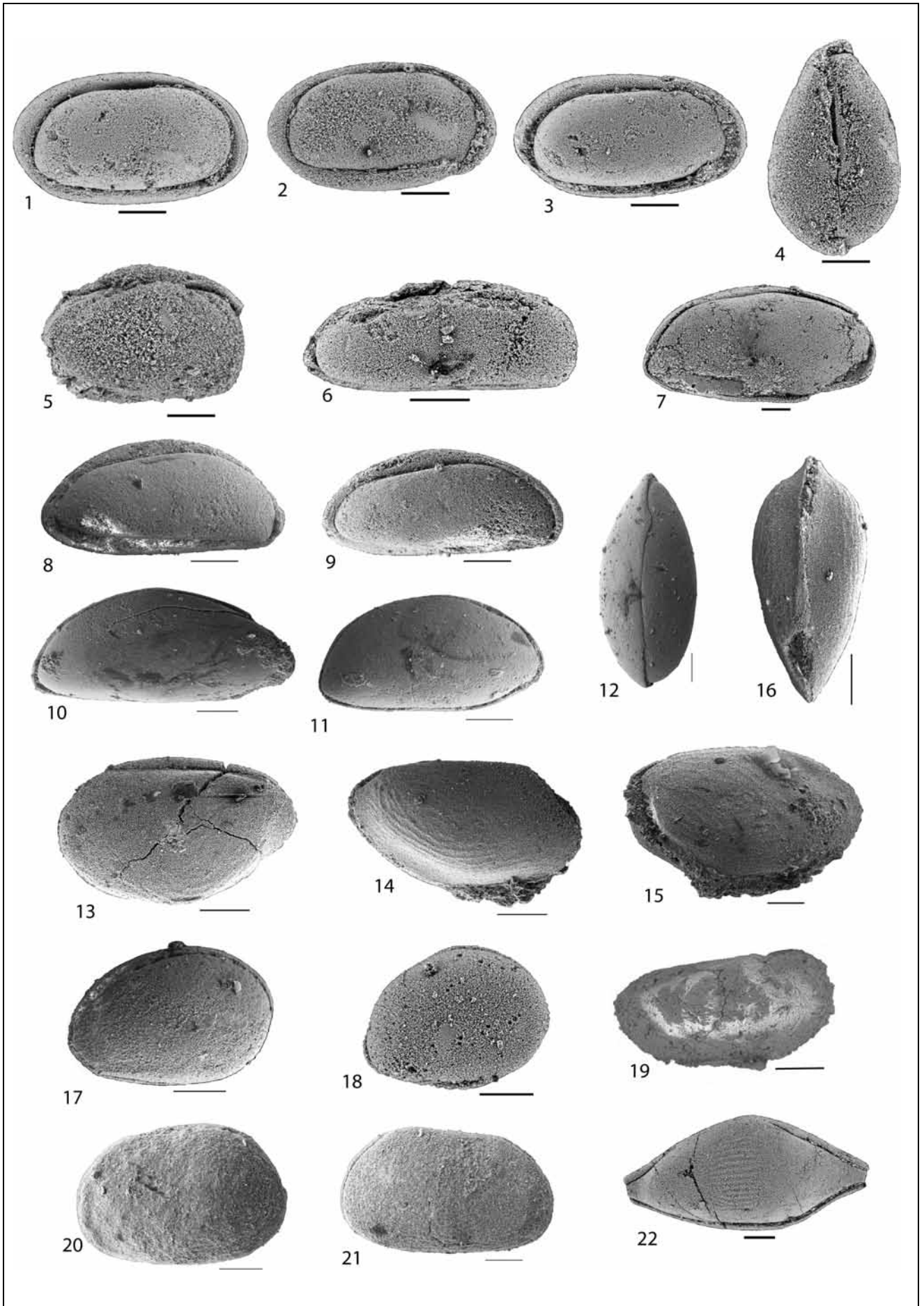
Size. L= 450-634 µm, H= 225-400 µm.

Stratigraphic and geographic distribution. Samples 05BU3 and 06BU5, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

PLATE 5

All specimens are from the Bulla section, Southern Alps. Scale bar is 100 µm. All the specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), under numbers P6M.

- Figs 1-4 - *Microcheilinella lata* Crasquin n. sp.
 Fig. 1 - Holotype, Collection number: P6M2306, right lateral view of complete carapace, sample 05BU06; fig. 2. Paratype, Collection number: P6M2307, right lateral view of complete carapace, sample 05BU06; fig. 3. Collection number: P6M2308, right lateral view of complete carapace, sample number 05BU06; fig. 4 - Collection number: P6M2309, dorsal view of complete carapace, sample number 05BU09.
- Fig. 5 - *Microcheilinella* sp. 2. Collection number: P6M2310, right lateral view of broken carapace, sample 05BU7A.
- Fig. 6 - *Microcheilinella peraxilis* Shi, 1987. Collection number: P6M2311, right lateral view of complete carapace, sample 05BU06.
- Fig. 7 - *Acratia* sp. 1. Collection number: P6M2312, right lateral view of complete carapace, sample 05BU06.
- Figs 8-9 - *Acratia* sp. 2.
 Fig. 8 - Collection number: P6M2313, right lateral view of complete carapace, sample number 05BU05; fig. 9 - Collection number: P6M2314, right lateral view of complete carapace, sample number 05BU05.
- Figs 10-12 - *Acratia zhongyingensis* Wang, 1978.
 Fig. 10 - Collection number: P6M2315, right lateral view of complete carapace, sample number 05BU1A; fig. 11 - Collection number: P6M2316, right lateral view of complete carapace, sample number 05BU1A; fig. 12 - Collection number: P6M2317, dorsal view of complete carapace, sample number 05BU1A.
- Figs 13-16 - *Parabythocythere? chongpani* Crasquin n. sp.
 Fig. 13 - Paratype, Collection number: P6M2318, right lateral view of complete carapace, sample 05BU03; fig. 14 - Holotype, Collection number: P6M2319, right lateral view of complete carapace, sample 05BU03; fig. 15 - Collection number: P6M2320, right lateral view of complete carapace, sample number 05BU05; fig. 16 - Collection number: P6M2321, dorsal view of complete carapace, sample number 05BU05.
- Figs 17-18 - *Basslerella obesa* Kellett, 1935 *sensu* Chen & Shi, 1982.
 Fig. 17 - Collection number: P6M2322, right lateral view of complete carapace, sample number 05BU05; fig. 18 - Collection number: P6M2323, right lateral view of complete carapace, sample number 05BU06.
- Fig. 19 - *Kerocythere?* sp. 1. Collection number: P6M2324, right lateral view of right valve, sample 05BU23.
- Figs 20-21 - *Callicythere mazurensis* (Styk, 1972).
 Fig. 20 - Collection number: P6M2325, right lateral view of complete carapace, sample 05BU1C; fig. 21 - Collection number: P6M2326, left lateral view of complete carapace, sample 05BU1C.
- Fig. 22 - *Pseudacanthoscapha striatula* (Shi, 1982). Collection number: P6M2327, right lateral view of complete carapace, sample 05BU7A.



Family Cytherideidae Sars, 1925

Genus *Basslerella* Kellett, 1935

Type species: *Basslerella crassa* Kellett, 1935

***Basslerella obesa* Kellett, 1935 sensu Chen & Shi, 1982**

Pl. 5, figs 17-18

non 1935 *Basslerella obesa* Kellett, p. 156, pl. 17, fig. 6

1982 *Basslerella obesa* Kellett, 1935 in Chen & Shi, p.140, fig. 11, figs 12-25

1987 *Basslerella obesa* Kellett - Shi & Chen, p. 54, pl. 13, figs 24-27

1992 *Basslerella obesa* Kellett - Yi, pl. 2, fig.3

2002 *Basslerella obesa* Kellett - Shi & Chen, p. 88, pl. 23, figs 26-35

Remarks. The form here reported conforms with the species described by Chinese authors from the Late Permian of Hubei Province (Chen & Shi 1982), the Late Permian of Meishan, Zhejiang Province (Shi & Chen 1987, 2002), and Datian, Fujian Province (Yi 1992) in South China but it is not the species *B. obesa* originally described by (Kellett 1935) from the Late Pennsylvanian? - Early Permian of Kansas. The specimens discovered here are more elongate and probably belongs to another genus which is not possible to precise for the time being. A new species should be described in the future when more material will be available.

Stratigraphic and geographic distribution.

Early to Late Permian of Guangxi Province, Zhejiang Province, Fujian Province, South China; Samples 05BU5 and 05BU6, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (cf. Tab. 1).

Family Cytherissinellidae Kashevarova, 1958

Genus *Callicythere* Wei, 1981

Type species: *Callicythere emeiensis* Wei, 1981

***Callicythere mazurensis* (Styk, 1972)**

Pl. 5, figs 20-21

1972 *Lutkevichinella mazurensis* Styk n. sp. p.877, pl. 2, figs 9-12.

1985b *Callicythere mazurensis* (Styk, 1972) - Kozur, pl. 3, fig. 7

Stratigraphic and geographic distribution. Late Middle Permian (Kozur 1985b) - Early Triassic (Styk 1972) of the Bükk Mountains, Hungary; Sample 05BU1C, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Order **Platycopida** Sars, 1866

Suborder **Platycopina** Sars, 1866

Superfamily Cavellinoidea Egorov, 1950

Family Cavellinidae Egorov, 1950

Genus *Cavellina* Coryell, 1928

Type species: *Cavellina puchella* Coryell, 1928

***Cavellina bellerophonella* Crasquin n. sp.**

Pl. 6, figs 3-7

Derivation of name. From the Bellerophon Formation, the type level.

Holotype. One complete carapace figured Pl. 6, fig. 3, collection number P6M2330.

Paratype. One complete carapace figured Pl. 6, fig. 4, collection number P6M2331.

Type-level. Sample 05BU1A, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., late Changhsingian; Late Permian.

Material. 150 carapaces and numerous fragments.

Diagnosis. A species of *Cavellina* with elongate carapace, PB and AB with small radius of curvature.

Description. Carapace elongated ($0.55 < H/L < 0.60$); anterior and posterior parts of DB rectilinear on RV, regularly arched on LV; AB with small radius of curvature; maximum of curvature located above mid-height, maximum of curvature on LV located higher than on RV; ABV rounded on LV and truncated on RV; VB straight on RV, nearly straight to slightly convex on LV; PB with small radius of curvature, maximum of convexity located at or below mid-height; LV overlaps carapace flattened on all the free margins, flattening underlined by a small sulcus; RV all around the carapace, maximum of overlap at ADB and AB; dorsal view biconvex; surface smooth.

Remarks. The genus *Cavellina* is abundant in the Middle Permian, for example in the Bükk Mountains (Kozur 1985a) and in Oman (Crasquin-Soleau et al. 1999), but occurrences in the Late Permian are rare. Shi & Chen (1987) show two species of *Cavellina* in the late Changhsingian of Meishan section (South China) but the figured specimens belong to the genus *Sulcella* (presence of posteroventral sulcus).

Cavellina bellerophonella n. sp. may be compared to *C. boomeri* Crasquin-Soleau, 1999 from the Wordian of Oman (Crasquin-Soleau et al. 1999) and to *C. visnyoensis* Kozur, 1985 from late Middle Permian of the Bükk Mountains (Kozur 1985a). *C. boomeri* has a more rounded and larger AB. *C. visnyoensis* has a greater H/L ratio, a larger PB and a flattening of the carapace in the postero-dorsal area. *C. alpina* n. sp. is shorter; *C. triasica* Crasquin n. sp. is more square.

Size. L= 515-765 μ m, H= 335-485 μ m.

Stratigraphic and geographic distribution. Samples 05BUSC1, 05BUSC2, 05BU1A, 05BU1B, 'Ostra-

cod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina alpina Crasquin n. sp.

Pl. 6, figs 8-10

Derivation of name. From the Alps, area of discovery.

Holotype. One complete carapace figured Pl. 6, fig. 8, collection number P6M2336.

Paratype. One complete carapace figured Pl. 6, fig. 9, collection number P6M2335.

Type-level. Sample 05BUSE1, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; 'Ostracod unit', Bellerophon Fm., late Changhsingian; Late Permian.

Material. Fifteen carapaces and numerous fragments.

Diagnosis. A species of *Cavellina* with square carapace and BP with a large radius of curvature.

Description. Carapace stocky ($0.62 < H/L < 0.69$), high, BD regularly arched on both valves, AB and PB with large radius of curvature, maximum of curvature of AB located above mid-height and of PB below; VB nearly straight or slightly convex; LV overlaps RV all around the carapace; the overlap is fine; presence of the thin sulcus all around free margins; carapace smooth; carapace biconvex in dorsal view, compressed at extremities.

Remarks. *Cavellina alpina* Crasquin n. sp. is shorter than other species of the genus (see above)

Size. L= 480-720 µm, H= 235-450 µm.

Stratigraphic and geographic distribution. Sample 05BUSE1, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina triassica Crasquin n. sp.

Pl. 6, figs 13-14

Derivation of name. From the Triassic period.

Holotype. One complete carapace figured Pl. 6, fig. 14, collection number P6M2340.

Paratype. One complete carapace figured Pl. 6, fig. 13, collection number P6M2341.

Type-level. Sample 05BUSE24, Bulla section (GPS coordinates: N 46°34.221' - E 11°37.762'), Southern Alps, northern Italy; Upper Mazzin Mb., Werfen Fm., Induan, Early Triassic.

Material. Fifteen carapaces and fragments.

Diagnosis. A species of *Cavellina* with rectangular carapace; AB and PB with large radius of curvature and very small overlap of LV on RV.

Description. Carapace rectangular; DB regularly arched on both valves; AB with large radius of curvature, maximum of convexity located above mid-height; VB sub-rectilinear; BP largely arched with maximum of convexity located at mid-height, radius of curvature equivalent to AB; LV overlaps RV slightly and the over-

lap is the same all around the carapace; carapace smooth.

Remarks. *Cavellina triassica* n. sp. differs from other species of the genus by its rectangular outline. This is the first species of the genus described in the Triassic.

Size. L= 495-570 µm, H= 320-350 µm.

Stratigraphic and geographic distribution. Samples 05BU19A, 05BU24, Upper Mazzin Mb., Werfen Fm., Early Triassic; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Cavellina visnyoensis Kozur, 1985

Pl. 6, figs 11-12

1985a *Cavellina visnyoensis* n. sp., Kozur, p. 21, pl. 4, fig. 10, pl. 5, figs 1-2

Stratigraphic and geographic distribution.

Early Late Permian, Bükk Mountains, Hungary (Kozur 1985a); sample 05BU1A, 'Ostracod unit', Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Genus *Sulcella* Coryell & Sample, 1932

Type species: *Sulcella sulcata* Coryell & Sample, 1932

Sulcella suprapermiana Kozur, 1985

Pl. 6, figs 1-2

1985a *Sulcella suprapermiana* Kozur, p. 22, pl. 5, figs 6, 8.

1998 *Sulcella suprapermiana* Kozur, 1985 - Crasquin-Soleau & Baud, p. 134, pl. 4, figs 1-3.

1999 *Sulcella suprapermiana* Kozur, 1985 - Crasquin-Soleau et al., p. 169, 190, pl. 4, fig. 15.

Stratigraphic and geographic distribution. Late Permian, Bükk Mountains, Hungary (Kozur 1985a); late Middle Permian-early Late Permian, Hydra Island, Greece (Crasquin-Soleau & Baud 1998); Middle Permian of the Sultanate of Oman (Crasquin-Soleau, Brouin et al. 1999); samples 05BU3, 05BU5, 05BU6, 05BU7A, Bulla Mb., Bellerophon Fm., late Changhsingian, Late Permian; Bulla section, Southern Alps, northern Italy (see Tab. 1).

Palaeocological inferences

Ostracods are predominantly benthic inhabitants and, therefore, reflect sea-floor conditions. Different families and /or superfamilies had specific palaeoecological preferences. Such preferences of Late Palaeozoic-Early Triassic ostracod families/superfamilies may be summarized as follow (Lethiers 1982; Melnyk & Maddocks 1988). The Bairdioidea are present in shallow to

deep, open carbonate environments with normal salinity. The Kloedenellidae characterize very shallow, euryhaline environments, whereas the Cavellinidea, Beyrichiidae and Paraparchitidae are adapted to euryhaline environments in shallow to very shallow waters. The Sansabellidae occur in shallow normal marine environments, and the Kirkbyidae in sublittoral, normal marine environments. The Cytherelloidea recorded here are inhabitants of open marine environments. All ostracods reported here are typical of tropical warm waters. Almost all specimens are represented by closed carapaces. This indicates limited transport and/or burying in a soft substratum (Oertli 1971). The number of specimens per sample varied greatly, from 0 to more than 950 (Fig. 4).

1. 'Ostracod unit' (samples BUSC1 to BU1C – figs 3 to 5)

This lower unit of the Bulla section is characterised by relative low diversity (2 to 5 species) and high numbers of specimens: 63 for sample 05BU1C, 160 for samples 05BUSC1 and 05BUSC2, and more than 950 for sample 05BU1A. In the lower samples (05BUSC1 and 05BUSC2), the ostracod assemblages represent normal marine conditions in a shallow environment. In the upper part, sample 05BUSC1 is unusual in composition, having a very high number of specimens (more than 950) for 5 species. *Cavellina bellerophonella* n. sp. and *Sargentina postacuta* represent about 92% of the specimens obtained, *S. postacuta* aggregating 730 specimens. Such proliferation of one or two species indicates a stressed environment where a limited number of species are capable of adaptation and thus flourishing. The stress could be due to modification of the salinity and/or oxygenation associated with reduction in bathymetry. Sample 05BUSC2 has the same 5 species but with fewer specimens and more even representation of them. This could indicate a return to more normal marine conditions. Sample 05BU1C, with 63 specimens belonging mainly to *Knoxiella ventrospinosa* n. sp. accords with this trend.

The unconformity-paraconformity U1 (Farabegoli et al. 2007 and references therein) marks the limit between the 'Ostracod unit' and the Bulla Mb. and is attributed to a rapid sea-level fall. It is reflected in the ostracod assemblage more by a change in composition than by significant extinctions despite their being decreased taxonomic diversity and a decrease in number of specimens.

2. The Bulla Member (samples 05BU2 to 05BU7A – Figs 3 to 5)

This member displays the most diverse ostracod assemblages in the Bulla section with 48 species occurring in this interval.

The basal sample (05BU2), containing only 8 specimens of a single species, is insufficient for palaeoecologic interpretation. We observed an important increase in specimen numbers from sample 05BU2A to 05BU6 (Tab. 1 and Fig.3). There is a drop in specimen numbers in sample 05BU7A but the diversity is still high. The

PLATE 6

All specimens are from the Bulla section, Southern Alps. Scale bar is 100 µm. All specimens are housed in the Pierre et Marie Curie University Collections (Paris, France), under numbers P6M.

- Figs 1-2 - *Sulcella suprapermiana* Kozur, 1985.
Fig. 1 - Collection number: P6M2328, left lateral view of complete carapace, sample number 05BU06; fig. 2 - Collection number: P6M2329, right lateral view of complete carapace, sample number 05BU7A.
- Figs 3-7 - *Cavellina bellerophonella* Crasquin n. sp.
Fig. 3 - Holotype, Collection number: P6M2330, left lateral view of complete carapace, sample 05BU1A; fig. 4. Paratype, Collection number: P6M2331, left lateral view of complete ♀ carapace, sample 05BU1A; fig. 5 - Collection number: P6M2332, dorsal view of complete ♂ carapace, sample number 05BU1A; fig. 6 - Collection number: P6M2333, left lateral view of complete ♂ carapace, sample number 05BU1A; fig. 7 - Collection number: P6M2334, dorsal view of complete ♀ carapace, sample number 05BU1A.
- Figs 8-10 - *Cavellina alpina* Crasquin n. sp.
Fig. 8 - Paratype, Collection number: P6M2335, left lateral view of complete carapace, sample 05BUSC1; fig. 9 - Holotype, Collection number: P6M2336, left lateral view of complete carapace, sample 05BUSC1; fig. 10 - Collection number: P6M2337, dorsal view of complete carapace, sample number 05BUSC1.
- Figs 11-12 - *Cavellina visnyoensis* Kozur, 1985.
Fig. 11 - Collection number: P6M2338, left lateral view of complete carapace, sample 05BU1A; fig. 12 - Collection number: P6M2339, dorsal view of complete carapace, sample 05BU1A.
- Figs 13-14 - *Cavellina triassica* Crasquin n. sp.
Fig. 13 - Paratype, Collection number: P6M2340, left lateral view of complete carapace, sample 05BU19A; fig. 14. Holotype, Collection number: P6M2341, left lateral view of complete carapace, sample 05BU24.
- Figs 15-16 - *Fabalicypriis?* sp. A.
Fig. 15 - Collection number: P6M2342, left lateral view of complete carapace, sample number 05BU02; fig. 14 - Collection number: P6M2343, left lateral view of complete carapace, sample number 05BU04.
- Figs 17-19 - *Arqoviella* sp.1
Fig. 17 - Collection number: P6M2344, right lateral view of complete carapace, sample number 05BUSC2; fig. 18 - Collection number: P6M2345, left lateral view of complete carapace, sample number 05BUSC2; fig. 19 - Collection number: P6M2346, dorsal view of complete carapace, sample number 05BUSC2.

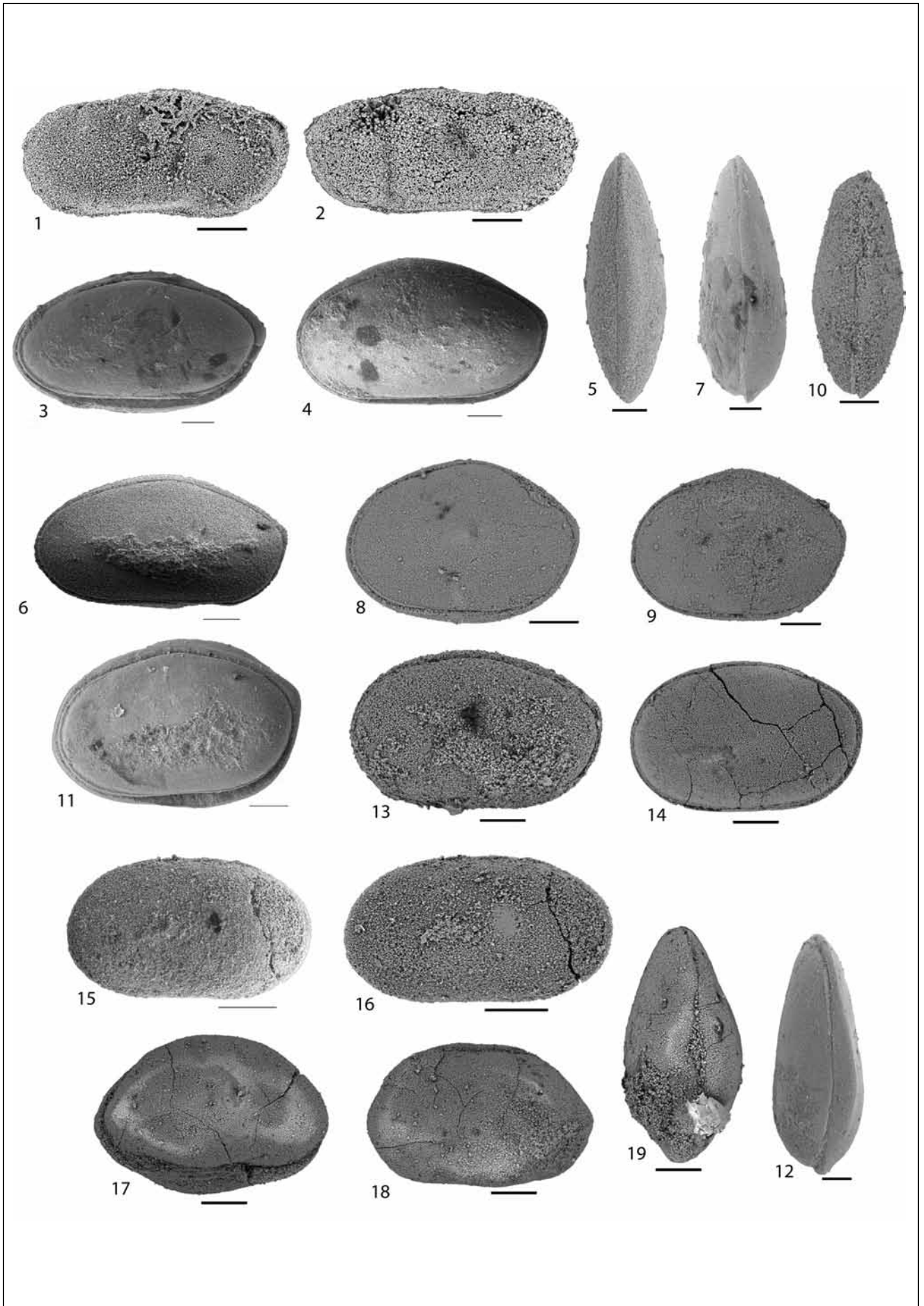
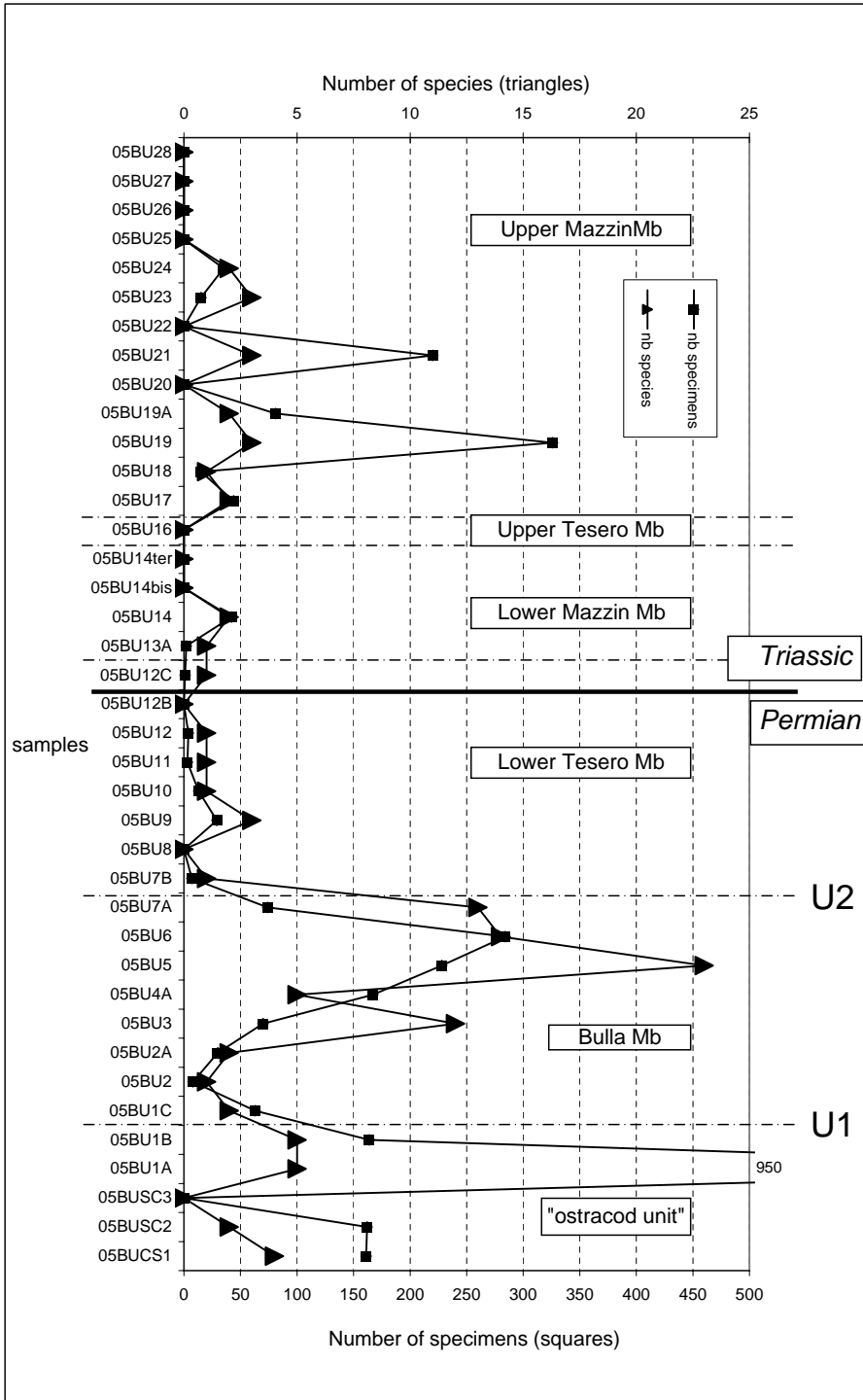


Fig. 4 - Number of species and specimens per sample.



first Bairdioidea appear in sample 05BU7A indicating a more open marine environment. They dominate the ostracod assemblages in all of the Bulla Mb. Except *K. ventrospinosa* n. sp., *Sargentina postacuta* and *Argoviella* sp.1, all ostracod species present in Bulla Mb. are absent from the 'Ostracod unit'. Therefore, the possibility of reworking of fossils from the 'Ostracod unit' is not supported here. The abundant and diverse ostracod faunas, particularly in samples 05BU3, 5, 6 and 7A, are accord with the return of normal marine open condi-

tions connected with a transgressive phase. The peak of diversity and abundance occurred in sample 05BU6.

A drastic drop in the ostracod community occurred between samples 05BU7A and 05BU7B with a loss of 12 species. This break corresponds with unconformity U2 of Farabegoli et al. (2007), interpreted as a rapid sea-level fall.

3. The Lower Tesero Member (samples 05BU7B to 05BU12D – Figs 3 to 5)

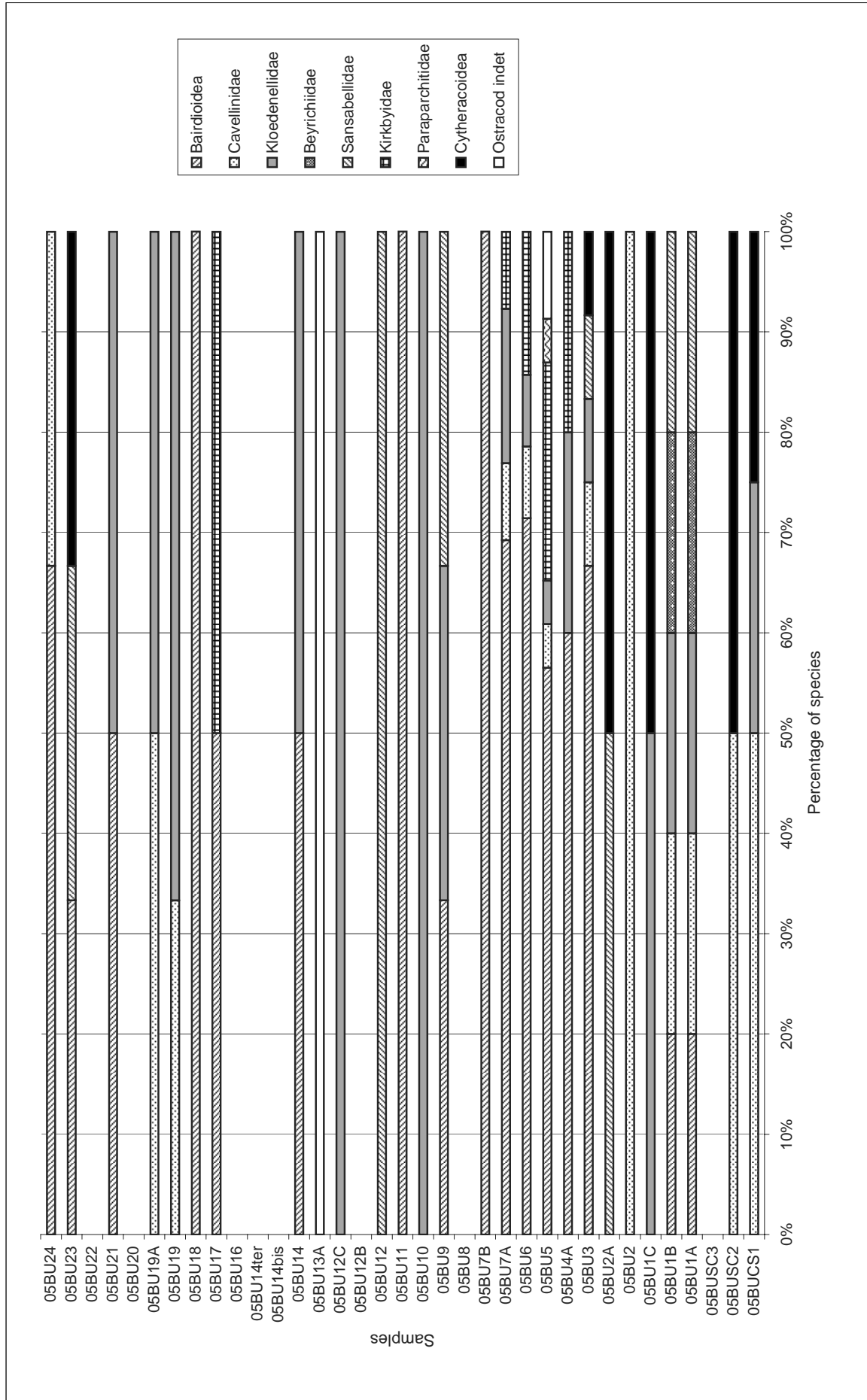


Fig. 5 - Distribution of ostracod families or superfamilies in the Bulla section (as percentages of species).

Diversities and abundances are very low for the entire member; they follow the main extinction event. The basal sample 05BU7B, having only one species represented by only seven specimens, is clearly not significant. The succeeding sample 05BU8 proved barren. Samples 05BU9 and 10 are characterized by species which appeared in the 'Ostracod unit' and are absent in the Bulla Mb. Sample 05BU9 is more diverse (3 species) and could represent a shallow marine environment. *Knoxiella ventrospinosa* n. sp. in sample 05BU10 belongs to Kloedenellidae, a family adapted to restricted environments such as low oxygen concentrations associated with microbialite deposition. For the rest of the Lower Tesero Mb., ostracod assemblages are absent or poorly represented and not of value for palaeoecologic interpretation. This paucity phase includes the Permian-Triassic boundary at 05BU12B level.

4. Lower Mazzin Member and Upper Tesero Member (samples 05BU13A to 05BU16 – Figs 3 to 5)

The paucity phase continues in these two members; samples proved barren or produced very rare ostracod assemblages.

5. Upper Mazzin Member (samples 05BU17 to 05BU33 – Figs 3 to 5)

An sharp increase of diversity with some peaks separated by barren samples occurs in this upper part of the section. Samples 05BU17, 18, 19, 19A, 21, 23 and 24 have associations with different percentages of Bairdioidea, Cavellinidae and Kloedenellidae which could be interpreted as shallow marine environments, with a more open marine location for samples 05BU18, 23 and 24. All samples after 05BU24 proved barren.

Conclusion

– This study presents for the first time the ostracod fauna of the Bulla section, parastratotype of the

Permian-Triassic boundary. Sixty-two species, belonging to 31 genera are discriminated and figured. One genus and 13 species are new.

– The 'Ostracod unit' has high diversity and great abundance of specimens characteristic of normal shallow marine conditions with a peak of stressed conditions.

– Unconformity-paraconformity U1, which marks the end of the 'Ostracod unit', is not clearly identified in itself in the ostracod assemblages. The top of 'Ostracod unit' and U1 are marked by a drop in diversity and abundance of specimens (Fig. 4) and is followed by a change in the ostracod faunal composition and a drop of species number (Fig. 3A).

– The Bulla Member displays maximum ostracod diversity and abundance linked with the transgressive trend reported for this period.

– Unconformity-paraconformity U2, at the boundary between the Bellerophon and Werfen formations (Bulla and Lower Tesero members) is the main extinction level for ostracods, as it is for all other groups.

– The Lower Tesero, Lower Mazzin and Upper Tesero members have very rare faunas.

– The lower part of the Upper Mazzin Mb. is characterized by an uneven burst of diversity before the great period of taxonomic paucity observed during the late Griesbachian all over the world (Crasquin et al. 2007).

Acknowledgements. We acknowledge with pleasure the sedimentary framework, generated largely by our colleague and friend Prof. Enzo Farabegoli, that has provided the context within which we have been able to place the ostracod faunas considered here.

Dr. Stephen Kershaw (Brunel University, Uxbridge, GB) and Dr. Avi Honigstein (Jerusalem, Israel Geological Survey) provided detailed and constructive reviews of our paper. We are most grateful to them. We also thank Maurizio Gaetani for his precise work on the manuscript.

The field work in Italy was supported by ECLIPSE2 and PICS CNRS 3361 research programs.

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