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The state of research on Sardinian Silurian Crustacea

Maurizio Gnoli, Vincent Perrier, Paolo Serventi

M. Gnoli - Dipartimento di Scienze della Terra, Università di Modena e Reggio Emilia, largo S. Eufemia 19, I-41100 Modena (Italy); maurizio.gnoli@unimore.it
V. Perrier - Université de Lyon 1, UMR CNRS 5125 PEPS, 2 rue R. Dubois, F-69622 Villeurbanne cedex (France); vincent.perrier@univ-lyon1.fr
P. Serventi - Dipartimento del Museo di Paleobiologia e dell'Orto Botanico, Università di Modena e Reggio Emilia, Via Università, 4, I-41100, Modena (Italy); paolo.serventi@unimore.it,

Abstract - Among crustaceans, Ostracoda – mainly Myodocopida – and Phyllocarida are documented from the Silurian of Sardinia. A review of the knowledge on these fossil groups in the Silurian of Sardinia is presented and supplemented by some remarks on myodocope autecology and palaeobiogeography.

Key words - Silurian, Sardinia, Ostracoda, Phyllocarida.

OSTRACODA

The first evidence for bivalved ostracod crustaceans in the Silurian of Sardinia stems from the work of Mario Canavari (1899) who described 20 taxa that he assigned to the genera *Aparchites, Entomis, Kloedenia, Cypridina* and *Bolbozoe*. Thanks to the careful checking of many rock samples from over 100 localities, collected by colleagues from Modena in the last thirty years, several palaeocopid (*Aparchites*, *Beyrichia*, *Kloedenia)* and myodocope (*Bolbozoe*, '*Cypridinid*', *Entomozoe*, *Pseudoentomozoe, Richteria*) ostracod taxa have now been recorded from Sardinia (see Ferretti et al., 1999). The most recent studies dealing with this Silurian ostracod fauna are those of Perrier (2007) and Perrier et al. (2007), which concentrate on the functional morphology and autecology of the Silurian myodocopes from especially France and the Czech Republic. The Silurian myodocope fauna of Europe (e.g., Sardinia, France, Czech Republic; Fig. 1a) is now relatively well known, but the palaeocopes have not been so intensively studied. Moreover, due to recent discoveries of Silurian ostracods with soft anatomy preserved (Siveter et al., 2003; 2007 and unpublished information), it appears that many forms that were described as palaeocopes on the basis of their carapace morphology may in fact turn out to be myodocopes. This paper will concentrate on the first ostracods that appear to have colonised pelagic niches, in the late Silurian: namely the myodocopes, the group that also comprises the present day pelagic ostracod fauna.

Myodocopes of Sardinia

Since the 1980's Silurian myodocopes have been recognized as an important component of the Palaeozoic marine ecosystem, alongside palaeocope, podocope and leperditicopid ostracods. Major groups of myodocopes are differentiated on details of valve morphology,

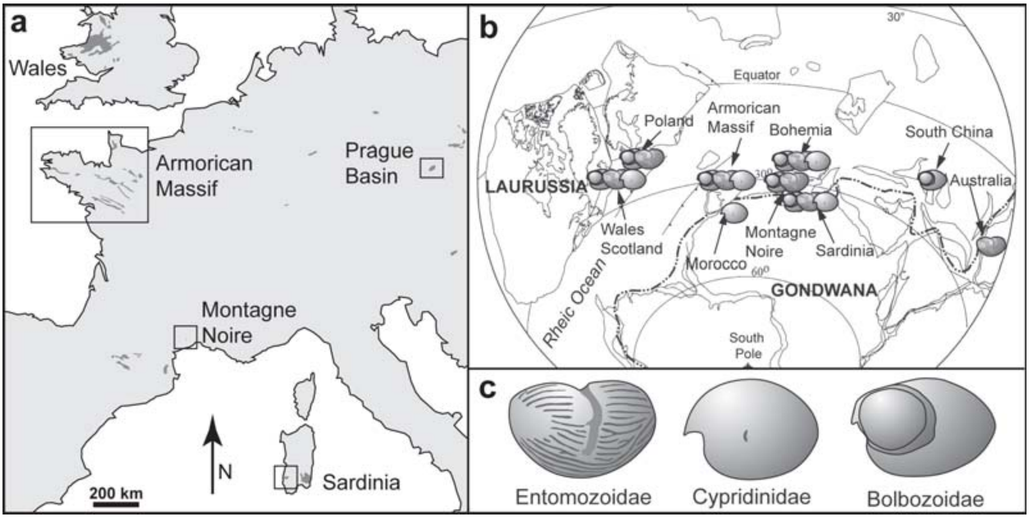

Fig. 1 - a) Occurrence of Silurian myodocopes in western Europe. Squares indicate regions with specimens figured in the present paper. b) Mid-Silurian (420 Ma) distribution of bolbozoid, cypridinid and entomozoid myodocopes (palaeogeography after Cocks & Torsvik, 2002). c) Generalized morphological reconstruction of a Silurian entomozoid, cypridinid and bolbozoid myodocope.

the soft parts being known from only two species (Siveter et al., 2003; 2007). Entomozoid, cypridinid and bolbozoid myodocopes (Fig.1c) are known from Sardinia.

ENTOMOZOIDAE

The entomozoids are recognisable by their characteristic so-called finger-print ornament (Pl. 1, Figs 1-8; see Gooday, 1983; Olempska, 1992). Their valve margins are generally convex, except for the dorsal margin, which is straight and may be slightly concave over the site of the adductorial sulcus (Pl. 1, Figs 1-4, 10-11), which has a small muscle pit (Pl. 1, Fig. 10). As with the bolbozoids, entomozoid valves are morphologically quite different from other fossil and Recent myodocopes. We regard the group as belonging to the Order Myodocopida (see Gründel, 1969) partly because of the close resemblance of their valves with *Colymbosathon ecplecticos* (see Perrier, 2007; Siveter, 2008), a Silurian cylindroleberidid myodocopid with soft parts preserved (Siveter et al., 2003).

Sardinian entomozoids. - Canavari (1899) described several entomozoids from the Ludlow Series of Sardinia. Based on examination (VP) of his original material, in the Calci Museum, University of Pisa, Italy, Perrier et al. (2007) considered that *Entomis migrans* (Pl. 1, Fig. 2), *Entomis lamarmorai* (Pl. 1, Fig. 3), *Entomis* n. f.? (Canavari, 1899, Pl. 25, Fig. 6) and possibly *Entomis meneghinii* (Canavari, 1899, Pl. 25, Figs 8-11) are conspecific with *Richteria migrans* (Barrande, 1872). Canavari (1899) distinguished his *Entomis migrans* and *Entomis lamarmorai* on the basis of ribbing patterns (compare Pl. 1, Figs 2 and 3). Chaubet (1937) interpreted similar variation in French material from Montagne Noire as polymorphism within a single species, *Entomis migrans*. There is a good though not complete degree of overlap in valve size range and also valve shape (outline) between the French and Czech material (Perrier et al., 2007). The variation in ribbing observed in Sardinian entomozoid material is similar to that of

E. migrans from France and Bohemia. Minor differences in ornament could be the result of a variety of factors including sampling across a range of "populations".

Richteria migrans gives its name to a Silurian fossil community from Sardinia ('*Entomis*' *migrans* of Ferretti et al., 1999, p. 275). *Bolbozoe bohemica* and other myodocope species referred to as "*E.*" *lamarmorai,* "*E.*" *ichnusae* and "*E.*" *meneghinii* (of Canavari, 1899) were included in the community. It occurs in the Ludlow Series and represents a shallow water pelagic assemblage (distribution: benthic assemblage (BA**)** 3 to 4). It should be noted that another *R. migrans* community is recorded in the Middle Ludlow of Czech Republic ('*Entomis*' *migrans* of Kriz 1999, p. 251).

The only other ribbed entomozoid from Sardinia, namely *Entomis* (?) *pteroides* Canavari, 1899, was assigned by Pribyl (1951) to the genus *Pseudoentomozoe*. The non-ribbed taxa that Canavari (1899, Pl. 25, Figs 12-18, Pl. 26, Figs 1-5) described as *Entomis ichnusae, Entomis zoppii, Entomis subreniformis* n. f., *Entomis* (?) *amygdaloides* n. f., *Entomis* (?) *parvula* n. f. and *Entomis* (?) f. ind. belong outside *Richteria* (see Perrier, 2007; Perrier et al., 2007); opinion on their systematic position awaits new material and further study.

CYPRIDINIDAE

The valve morphology of the Silurian so-called cypridinids is like that of Recent Cypridinidae (Siveter et al., 1987; 1991; Vannier & Abe, 1992; Perrier, 2007; Perrier et al., in prep). Their lateral outline is ovoid (Pl. 1, Figs 12-19) and they have a well-developed rostrum (Pl. 1, Figs 16-17, 20-21) and a simple crescent-shape muscle scar (Pl. 1, Figs 16, 22). Though such valves are generally regarded as cypridinids, their internal anatomy is unknown and therefore this assignment remains to be confirmed.

Silurian cypridinids have received only scant attention. Barrande (1872) did not mention such forms, even though they frequently co-occur with bolbozoids at several localities in the Prague Basin. An early description of a supposed Silurian cypridinid is that of *Cypridina tosterupi* Moberg (1895) from the '*Posidonomya* skiffer' of Sweden. This species was clearly considered by Moberg as a myodocope and was tentatively placed within *Cypridina* Milne-Edward, 1840 (see Kornicker & Sohn, 2000, p. 19-20). Several myodocope species from France and Wales awaiting detailed study were provisionally termed 'Cypridinid' or 'cypridinid-like' (Siveter et al., 1987). Kornicker and Sohn (2000) placed these forms in the Tribe Cypridinini.

Sardinian cypridinids. Canavari (1899) noted that what he described as *Cypridina tyrrhencia*, from the Silurian '*Cardiola* limestones' of southern Sardinia, resembles certain Recent and Carboniferous Cypridinidae. Based on new observations of the original material of *Cypridina tyrrhencia* Canavari, 1899 (Pl. 26, figs 10-12; herein Pl. 1, Figs 12-13) Perrier (2007) and Perrier et al. (in prep.) regard this species as similar to other Silurian cypridinids from France and Wales but within a new genus. This exclusively Silurian genus (Pl. 1, Figs 12-22) is characterized by a tiny crescent-shaped muscle scar that has no counterpart in any post-Silurian to Recent cypridinid (see Kornicker, 1975; 1981). The overall lateral outline of this new genus is simple and similar to numerous post-Silurian myodocopes (e.g., see Wilkinson et al., 2004; Weitschat, 1983).

BOLBOZOIDAE

The bolbozoids are characterized by a hemispheric protuberance (bulb) situated anterodorsally on both valves (see Siveter et al., 1987; 1991; Vannier & Abe, 1992; Perrier 2007; Perrier et al., in prep.; Pl. 2, Figs 8-11, 20-21 herein). Adjacent to the bulb is an adductorial sulcus (Pl. 2, Figs 4-7, 16-17) with a muscle scar (Pl. 2, Figs 4, 15, 25) and a more or less well-developed rostrum anteriorly (Pl. 2, Figs 6, 12-14, 16, 18-24). Apart from *Bolbozoe anomala* all other bolbozoid species have ornamented carapaces (see Perrier 2007; Pl. 2 Figs 22-23 herein). The bolbozoids have a distinctive morphology and are difficult to assign within an extant group of myodocopes.

Sardinian bolbozoids. The four bolbozoid species that Canavari (1899) described from the Silurian of Sardinia show similarity with two species originally recorded (Barrande, 1872) from the Prague Basin. *B. capellinii* Canavari, 1899 (Pl. 26, fig. 19, lost specimen), *B. italica* Canavari, 1899 (Pl. 26, figs 16-18; herein Pl. 2, Figs 1-2) and *B. lanceolata*

Plate 1

Silurian entomozoids (1-11) and cypridinids (12-22) from Europe.

Figs 1-11 - *Richteria migrans* (Barrande, 1872).

1. plastic cast made from a latex mould, incomplete right valve (NM-L 22944), Lectotype, lateral view, courtesy H. Groos-Uffenorde; Praha-Podolí, Bohemia; Scale bar = 500 µm.
2. carapace (I 71) left lateral view; Xea San Antonio, Sardinia; Scale bar = 500 µm.
3. carapace (I 73), left lateral view, previously described as *E. Lamarmorai* by Canavari (1900, pl.25, fig. 3); Xea San Antonio, Sardinia; Scale bar = 500 µm.

4-7. complete carapace (FSL 705032a), right lateral, posterior, ventral and dorsal views; La Combe d'Yzarne, France; Scale bar = 500 µm.

8. right valve (FSL 705026a), flattened specimen; Lounin, Bohemia; Scale bar = 1 mm.
9. left valve (FSL 705009a), detail of triangular smooth area, anterolateral view; Velky Vrch, Bohemia; Scale bar = 100 µm.
10. right valve (FSL 705001a), detail of adductorial sulcus and muscle scar, lateral view; Scale bar = 100 µm.
11. dorsal view of the carapace (FSL 705032a), details of central part of dorsal margin; La Combe d'Yzarne, France; Scale bar = 100 µm.

Figs 12-22 - "Cypridinid" gen. and sp. nov.

12-13. previously described as *Cypridina tyrrhenica* by Canavari (1900, pl.26, fig. 12-13), (12) right valve (I 92), (13) right valve, complete carapace (I 91); Xea San Antonio, Sardinia; Scale bar = 1 mm.

14-15. left valve (LPB 18926), (14) lateral view, (15) oblique ventral view; Les Chevrolières, Armorican Massif; Scale bar = 1 mm.

16. left valve (FSL 710652); St Jean sur Erve, Armorican Massif; Scale bar = 500 µm.
17. right valve (FSL 710520); Les Buardières, Armorican Massif; Scale bar = 500 µm.
18. right valve (FSL 710653); St Jean sur Erve, Armorican Massif; Scale bar = 500 µm.

19-20. internal view of the left valve (FSL 710592), (19) general view, Scale bar = 250 µm; (20) detail of the rostrum; Scale bar = 100 µm; Les Chevrolières, Armorican Massif.

21. right valve (FSL 710520), detail of the rostrum; Les Buardières, Armorican Massif; Scale bar = 200 µm.
22. left valve (FSL 710652), detail of the muscle scar; St Jean sur Erve, Armorican Massif; Scale bar = 100 µm.

Arrow points to anterior in each case.

Collection numbers : FSL (collections of the Université Claude Bernard Lyon 1, France); I (Museo de Storia Natural e del Territorio, Calci, Italy); LPB (University of Brest, France); MNHN (Museum d'Histoire Naturelle de Nantes, France); NM-L (Národní Museum, Prague, Czech Republic); UMC-IP-VP (University of Montpellier, France).

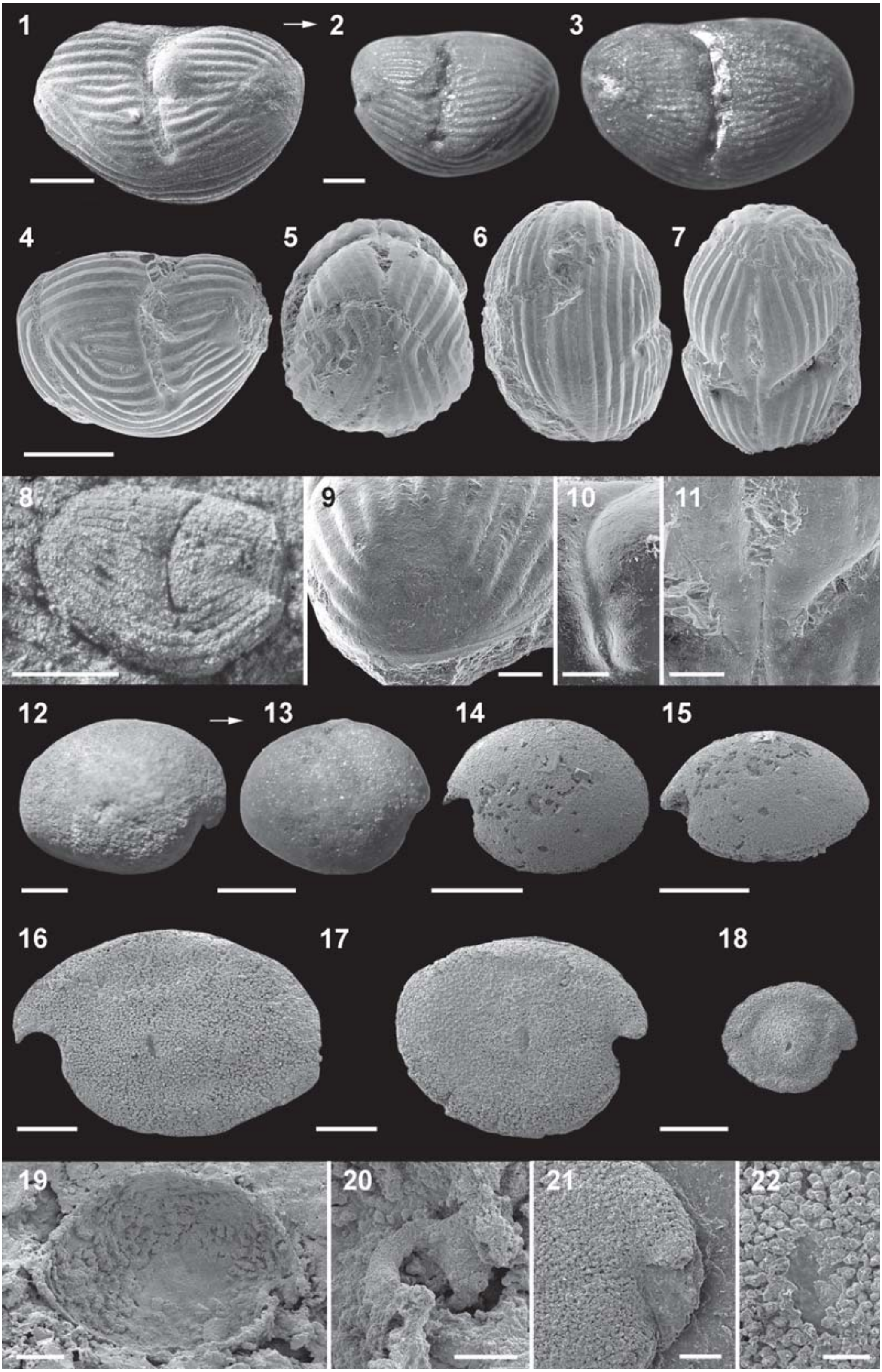
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Plate 2

Silurian bolbozoids from Europe

Figs 1-15 - *Bolbozoe anomala*.

1-2. previously described as *B. italica* by Canavari (1900, pl. 26, figs 18, 16), (1) left valve (I 98), Scale bar = 2 mm; (2) left valve (I 97a), Scale bar = 500 µm; Xea San Antonio, Sardinia.
3. previously described as *B. lanceolata* by Canavari (1899, pl.26, fig. 20), incomplete right valve (I 99); Xea San Antonio, Sardinia; Scale bar = 2 mm.
4. Lectotype, right valve (NM-L 23572); Lochkov, Bohemia; Scale bar = 2 mm.
5. Paralectotype, left valve (NM-L 13993); Lochkov, Bohemia; Scale bar = 2 mm.
6. right valve (MNHN 154); Chemiré-en-Charnie, Armorican Massif; Scale bar = 500 µm.
7. left valve (FSL 710569); Les Buardières, Armorican Massif; Scale bar = 500 µm.
8-11. complete specimen (FSL 710593), (8) lateral view of left valve, (9) frontal view, (10) oblique frontal view, (11) slightly oblique dorsal view; Les Chevrolières, Armorican Massif; Scale bar = 500 µm.
12. detail of the rostrum internal view (FSL 710592); Les Chevrolières, Armorican Massif; Scale bar = 500 µm.
13-14. detail of the rostrum (FSL 710536), (13) anteroventral view, (14) lateral view; Chemiré-en-Charnie, Armorican Massif; Scale bar = 250 µm.
15. left valve (FSL 710597); detail of the muscle scars; Les Chevrolières, Armorican Massif; Scale bar = 200 µm.

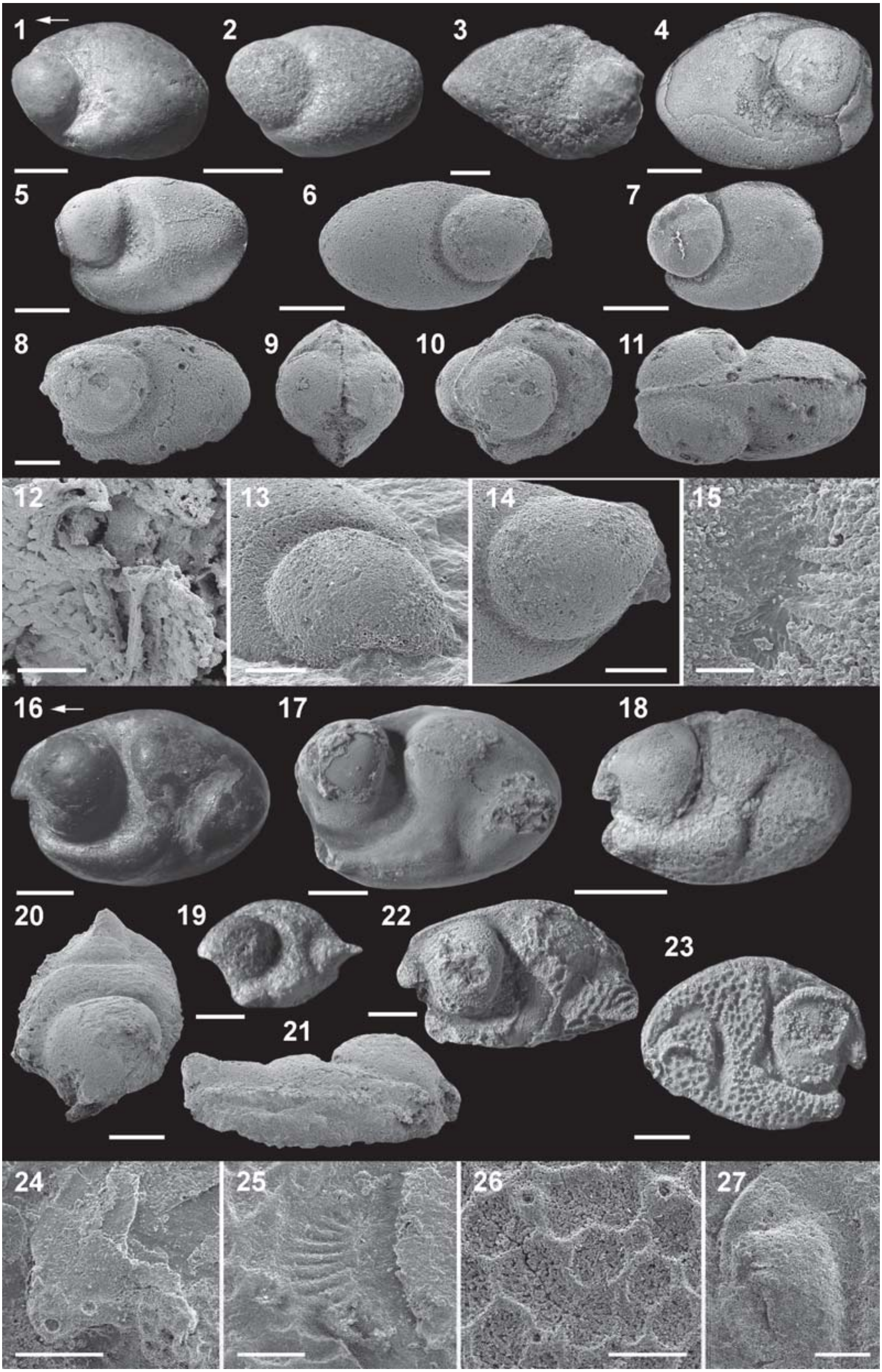
Figs 16-17, 19-21- *Parabolbozoe* sp. indet.

16. left valve, lateral view (I 96), previously described as *B. bohemica* by Canavari (1900, pl. 26, figs 15); Xea San Antonio, Sardinia; Scale bar = 2 mm.
17. left valve, lateral view (UMC-IP-VP 1), previously described as *B. bohemica* by Chaubet (1937, pl. 7, fig.18); La Combe d'Yzarne, Montagne Noire; Scale bar = 2 mm.
19. left valve, lateral view (FSL 710709); Telgruc-sur-Mer, Armorican Massif; Scale bar = 500 µm.
20-21. right valve (FSL 710710), (20) frontal view, (21) ventral view; Telgruc-sur-Mer, Armorican Massif; Scale bar = 500 µm.

Figs 18, 22-27 - *Parabolbozoe bohemica*.

18. Lectotype, left valve (NM-L 23658); Vyskocilka, Bohemia; Scale bar = 1 mm.
22. left valve, lateral view (UMC-IP-VP 6); La Combe d'Yzarne, Montagne Noire; Scale bar = 2 mm.
23. right valve, lateral view (FSL 710401); La Cultais, Armorican Massif; Scale bar = 2 mm.
24. detail of the rostrum (FSL 710759); Lounin, Bohemia; Scale bar = 500 µm
25. detail of the muscle scar (FSL 710428); La Cultais, Armorican Massif; Scale bar = 500 µm.
26. detail of the ornament and pores (FSL 710760); Lounin, Bohemia; Scale bar = 500 µm.
27. detail of the caudal process (FSL 710758); Lounin, Bohemia; Scale bar = 500 µm

Arrow points to anterior in each case. Collection numbers: FSL (collections of the Université Claude Bernard Lyon 1, France); I (Museo di Storia Naturale e del Territorio, Calci, Italy); LPB (University of Brest, France); MNHN (Museum d'Histoire Naturelle de Nantes, France); NM-L (Národní Museum, Prague, Czech Republic); UMC-IP-VP (University of Montpellier, France).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Canavari, 1899 (Pl. 16, fig. 20; herein Pl. 2, Figs 3) from the Ludlow of Sardinia may be synonyms of the unisulcate *B. anomala* (Perrier 2007; Perrier et al. in prep.; compare Pl. 2, Figs 1-8). Pribyl (1988) erected the subgenus *Bolbozoe* (*Parabolbozoe*) to embrace bisulcate *Bolbozoe* such as *B. bohemica* Barrande. The completely smooth *B. bohemica* specimen (Pl. 2, Fig. 16) of Canavari (1899) should perhaps be termed *Parabolbozoe* sp. indet. as *P. bohemica* is reticulated (Pl. 2, Figs 18 (Lectotype); Perrier et al., in prep.). Canavari's (1899) opinion that *Bolbozoe polonica* (Gürich, 1896) is a junior synonym of *B. bohemica* is probably correct.

P. bohemica gives its name to a Silurian fossil community from Sardinia (*Bolbozoe bohemica* of Ferretti et al., 1999, p. 272). *R. migrans* and another myodocope species referred to as "*E.*" *meneghinii* (of Canavari, 1899) were included in the community. It occurs in the Ludlow Series and corresponds to a deeper environment (distribution: BA 4 to 5) than the closely related *R. migrans* Community. Another *P. bohemica* pelagic community was described in the middle Ludlow of the Czech Republic (*B. bohemica* of Kriz 1999, p. 250).

Discussion

Functional morphology

Locomotion - The rostral incisure in Recent myodocopes is an important functional feature, allowing protrusion of the frontal (especially the second) pairs of appendages for swimming. A comparable rostral complex occurs in Silurian myodocopes (Pl. 1, Figs 14-21; Pl. 2, Figs 12-14, 20-21, 24), suggesting that if similarly powerful anterior appendages were present, then the bolbozoids and most likely the cypridinids were probably able to swim actively in the water column (Siveter et al., 1991; Vannier & Abe, 1992; Perrier, 2007).

Vision - All Silurian myodocopes have either a prominent mostly unornamented bulb (bolbozoids; Pl. 2) or an unornamented area in the anterodorsal part of their valves (cypridinids and entomozoids; Pl. 2). These features seem to have been directly or indirectly related to vision (Vannier & Abe, 1992; Perrier et al., in prep). This hypothesis is strengthened by the presence and position of a lateral eye in two Silurian fossil myodocope species (Siveter et al., 2003; 2007), where it lies in the same anterodorsal position as the bulb and the unornamented area of other Silurian myodocopes. Recent myodocope species also have their visual apparatus sited anterodorsally (see Land & Nilsson, 1990). It is likely that Silurian myodocopes had lateral compound eyes, comparable to those of Recent and Mesozoic (e.g., *Triadocypris* Weitschat, 1983) myodocopids.

Associated faunas

Associates of the myodocopes of the Silurian of Sardinia (Ferretti, 1990) and other coeval outcrops comprise what is essentially a relatively low diversity invertebrate fauna (Siveter et al., 1989; 1991; Vannier & Abe, 1992; Perrier, 2007). Most of the associated groups are pelagic (e.g., cephalopods, graptolites); benthic or nektobenthic forms (e.g., phyllocarids, bivalves) are few. Combined with sedimentary evidence, the faunal association seems to indicate that the bottom water was in general inimical for benthic life.

Depositional environment

The Silurian myodocopes of Sardinia occur in a complex sedimentary and tectonic setting, within displaced blocks of different ages, and especially in an '*Orthoceras*' limestone (*siluricus* conodont Biozone; Ludlow Series) and a micrite (Pridoli Series) microfacies (Siveter et al., 1991, p. 164-165). Myodocopes were originally obtained from near Flumminimaggiore (Canavari, 1899), by calcining *ex situ* '*Orthoceras*' limestone blocks found in dry-stone walls. Ferretti (1990, Fig. 4) reported that ostracodes can form up to 60 % of the skeletal clasts in some of the limestone blocks. Sardinian myodocopes are generally associated with a recurring orthoconic nautiloid-graptolite-dominated pelagic fauna, with bivalves typically the only sign of a benthic epifauna. The implication - the occurrence of anoxic bottom conditions - is, clearly, important with respect to notions of the habitat of Silurian myodocopes. The facies of the orthoceratid-dominated assemblage in Sardinia has been considered to represent shallow shelf conditions, albeit with anoxic bottom waters (Gnoli et al., 1979), or a deep-water environment (Jaeger, 1976).

PALAEOGEOGRAPHICAL DISTRIBUTION

Some Silurian myodocope species had a wide, possibly cosmopolitan distribution, whereas others seem to have been restricted to particular regions (Siveter et al. 1991; Vannier & Abe 1992; Perrier et al., 2007). Each group of myodocopes (bolbozoids, cypridinids and entomozoids) has at least some species with a relatively widespread palaeogeographic distribution (Fig. 1b). For example *B. anomala*, *P. bohemica* and *R. migrans* have transoceanic distribution, being present on both sides of the large scale Rheic Ocean which was present between the palaeocontinents of Gondwana and Laurussia (Cocks & Torsvik, 2002; see Fig. 1b). This mode of distribution resembles that of Recent pelagic species and endorses the notion that such Silurian forms had a pelagic lifestyle. Species with a more limited geographical distribution perhaps occupied other ecological niches within the water column, or had a different mode of dispersal, or were controlled by different environmental factors.

LIFESTYLE

Several lines of evidence indicate that perhaps the majority of Silurian myodocopes had a pelagic lifestyle (Siveter, 1984; Siveter et al., 1987; 1991; Vannier & Abe 1992; Perrier et al., 2007). Fossil evidence comes from the functional morphology of the carapace, the faunal associates and the depositional environment. Morphological evidence indicates active swimming (rostral complex) and probably well developed visual organs (visual window) in most groups. Some species seem to have had a wide geographical distribution comparable with that of Recent pelagic species. Sedimentological and fossil data (e.g., the nature of faunal associates) indicate that in the case of many Silurian myodocopes bearing localities there was an ocean bottom impoverished in oxygen and unsuitable for benthic life (e.g., black muds). Uncertainties remain concerning their precise habitat and migration pattern within the water column (Perrier, 2007).

PHYLLOCARID MALACOSTRACA

Phyllocarid remains from Sardinia consist of a few three-dimensionally preserved specimens, partly incomplete, from the Fluminimaggiore and Mason Porcus formations of southwestern Sardinia and several phosphatized gnathal lobes that commonly occur in the acid-resistent residues of conodont samples from several localities of southern Sardinia.

The first mention of phyllocarids from Sardinia is due to Taricco (1922, p. 4), who referred on the occurrence of a "phyllocarid bed" within the Ordovician Puddinga sequence at "Roia Srappas" locality, near Fluminimaggiore. However, that fauna was later described as *Tariccoia arrusensis* Hammann, Pillola & Laske, an unusual trilobite-like arthropod (Hammann et al., 1990).

For long time nobody refer on the occurrence of these fossils, until Helmcke (1973) and Jaeger (1976), who reported on their occurrence in the uppermost Silurian-Lower Devonian from southeastern Sardinia. Gnoli & Serpagli (1984) illustrated for the first time phyllocarids from southwestern Sardinia, describing both macro- and microremains. Finally, Gnoli & Serventi (2005) revised that collection and described new material from the same area.

Six taxa have been recognized from the Silurian of Sardinia (Gnoli & Serventi, 2005):
Ceratiocaris (*Bohemicaris*) *bohemica* (Barrande, 1872);
Ceratiocaris? (*Bohemicaris*) sp. ind. cf. *bohemica* (Barrande, 1872);
Ceratiocaris (*Ceriatiocaris*) cf. *cornwallisensis damesi* Chlupac, 1963;
Dithyrocaris cf. *neptuni* Hall, 1863;
Warneticaris cenomanensis (Tromelin, 1874);
Warneticaris sp. ind. cf. *cenomanensis* (Tromelin, 1874).

Ceratiocaris (*Bohemicaris*) *bohemica* is largely the most documented species from the Silurian of Sardinia. Some abdominal somite, caudal parts and telson fragments are

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Plate 3

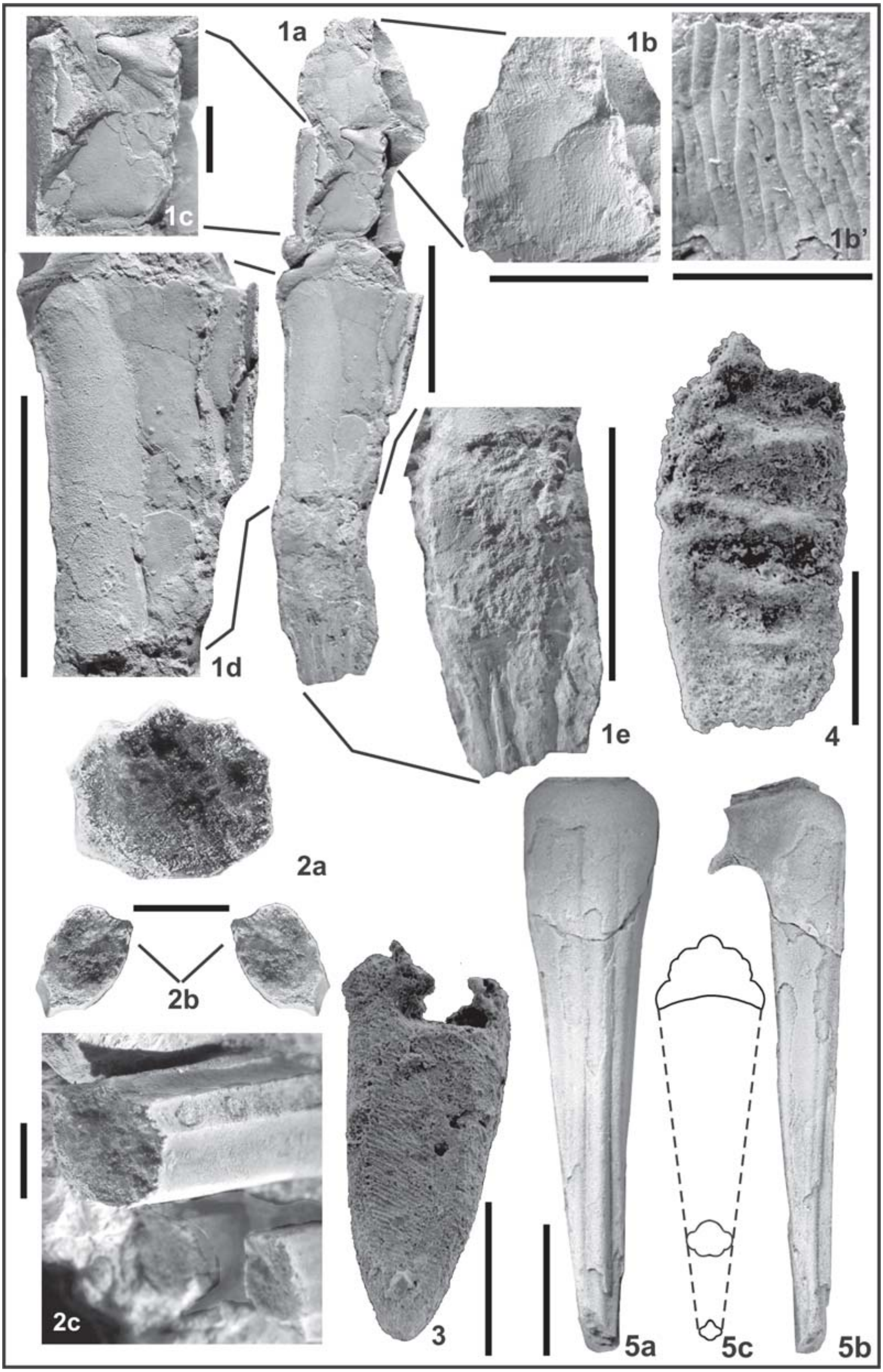
Figs 1-2 - *Ceratiocaris* (*Bohemicaris*) *bohemica* (Barrande, 1872).

1. specimen IPUM 24236; Fluminimaggiore area, Pridoli. a) upper view of the whole specimen, scale bar = 20 mm; b) 5th segment showing sub-parallel wrinkled pattern of ornamentation of the same specimen scale bar = 10 mm; b') particular enlarged to show the very small slit-like structures between the ribs forming ornamentation of the same specimen, scale bar = 5 mm; c) upper view of the 6th abdominal somite of the same specimen, scale bar = 5 mm; d) upper view of the 7th abdominal somite of the same specimen, scale bar = 20 mm; e) poorly preserved caudal part of the same specimen, scale bar = 20 mm..
2. specimen IPUM 24243; scattered block ARG-BK 15, Pridoli. a, b) telson and furcal rami of another specimen (IPUM 24243) showing their polygonal cross-sections (pentagonal the telson, more complex and rounded the furcal rami), scale bar = 15 mm; c) the same specimen in perspective view with the alveoli for bristle insertion, scale bar = 5 mm; note: the left furcal ramus cross-section of fig. 2b is figured reflecting the right one horizontally because this specimen is poorly preserved.

Figs. 3-4 - *Ceratiocaris* gr. *bohemica* (Barrande, 1872).

3. molar part of gnathal lobe of the left mandible (IPUM 19803) occlusal view; sample MP 3, Pridoli, x 50.
4. middle part of gnathal lobe of the right mandible (IPUM 19804) occlusal view; sample MP 4, Pridoli, x 50.

Fig. 5 - *Ceratiocaris* (*Ceratiocaris*?) cf. *cornwallisensis damesi* (IPUM 24237), a) dorsal view of the telson; b) lateral view of the telson showing the ventral recumbent protection to the articulation for the furcal rami movement; c) schematic proximal, distal, and terminal telson cross-sections; level MP 5 Pridoli.


1a
1b
1b'
1c
1d
1e
2a
2b
2c
3
4
5a
5c
5b

documented from Ludlow and Pridoli of southwestern Sardinia, whereas gnathal lobes occur from Wenlock to Pridoli from several localities of the southern part of the island. The other taxa are definitely rarer, since their documentation is limited to a few fragments from the Pridoli of Fluminimaggiore area (Gnoli & Serventi, 2005).

REFERENCES

BARRANDE, J. (1872). Système Silurien du centre de la Bohème. 1, 647 pp. Prague-Paris.

CANAVARI M. (1899). Fauna dei calcari nerastri con Cardiola ed *Orthoceras* di Xea San Antonio in Sardegna. *Palaeontographica Italica*, 5: 187-210.

CHAUBET M.C. (1937). Contribution à l'étude du Gothlandien du versant méridional de la Montagne Noire. 223 pp. Faculté des sciences de Montpellier, Montpellier.

COCKS L.R.M. & TORSVIK T.H. (2002). Earth geography from 500 to 400 million years ago: a faunal and palaeomagnetic review. *Journal of the Geological Society, London*, 159: 631-644.

FERRETTI A. (1990). Microbiofacies and constituent analysis of Upper Silurian-Lowermost Devonian limestones from south western Sardinia. *Bollettino della Società Paleontologica Italiana*, 28: 87-100.

FERRETTI A., GNOLI M. & VAI G.B. (1999). Silurian to Lower Devonian communities of Sardinia. *In* Boucot A.J. & Lawson J.D. (Eds), Paleocommunities a case study from the Silurian and Lower Devonian. Cambridge University Press, Cambridge: 271-281.

GNOLI M., PAREA G.C., RUSSO F., & SERPAGLI E. (1979). Palaeoecological remarks on the '*Orthoceras* limestones' of south-western Sardinia (middle-upper Silurian). *Memorie della Società Geologica Italiana*, 20: 405-423.

GNOLI M. & SERPAGLI E. (1984). Evidence of phyllocarid remains from Silurian-Devonian boundary beds in southwestern Sardinia. *Neues Jahrbuch für Geologie und Paläontologie Monatshefte*, 5: 257-268.

GNOLI M. & SERVENTI P. (2005). New Evidence of Silurian Phyllocarid remains from SW Sardinia. *Bollettino della Società Paleontologica Italiana*, 44 (3): 255-262.

GOODAY A.J. (1983). Entomozoacean Ostracods from the Lower Carboniferous of south western England. *Palaeontology*, 26: 755-788.

GRÜNDEL J. (1969). Neue taxonomische Einheiten der Unterklasse Ostracoda (Crustacea). *Neues Jahrbuch für Geologie und Paläontologie*, 6: 353-361.

HAMMANN W., LASKE R. & PILLOLA G.L. (1990). *Tariccoia arrusensis* n.g. n.s., an unusual trilobite-like arthropod. Rediscovery of the "phyllocarid" beds of Taricco (1922) in the Ordovician "Puddinga" sequence of Sardinia. *Bollettino della Società Paleontologica Italiana*, 29 (2): 153-178.

JAEGER H. (1976). Silur und Unterdevon vom Thüringischen Typ in Sardinien und seine regional geologische Bedeutung. *Nova Acta Leopoldina*, 224: 263-399.

KORNICKER L.S. (1975). Antarctic Ostracoda (Myodocopina). *Smithsonian Contributions to Zoology*, 163: 1-720.

KORNICKER L.S. (1981). Revision, Distribution, Ecology, and Ontogeny of the Ostracode Subfamily Cyclasteropinae (Myodocopina: Cylindroleberididae). *Smithsonian Contributions to Zoology*, 319: 1-548.

KORNICKER L.S. & SOHN I.G. (2000). Myodocopid Ostracoda from the Late Permian of Greece and a basic classification for Paleozoic and Mesozoic Myodocopida. *Smithsonian Contribution to Paleobiology*, 91: 1-33.

KRIZ, J. (1999). Bivalvia dominated communities of Bohemian type from the Silurian and Lower Devonian carbonate facies. *In* Boucot A.J. & Lawson J.D. (eds), Paleocommunities a case study from the Silurian and Lower Devonian. Cambridge University Press, Cambridge: 229-252

LAND M.F. & NILSSON D.E. (1990). Observations on the compound eyes of the deep-sea ostracod *Macrocypridina castanea*. *Journal of Experimental Biology*, 148: 221-233.

MILNE–EDWARD H. (1840). Ordre des Cyproides ou des Ostracodes. *Histoire Naturelle des Crustacés*, 3: 393–410.

MOBERG J.C. (1895). Silurisk posidonomyaskiffer, enegendomlig utbildning af skanes oefversilur. *Sveriges geologiska undersoekning, serie C*, 156: 1–23.

OLEMPSKA E. (1992). Shell Structure of the entomozoaceans: allegedly planktonic ostracodes of the Palaeozoic. *Acta Palaeontologica Polonica*, 36: 373-398.

PERRIER V. (2007). Biodiversité et écologie des ostracodes myodocopes (Crustacea) du Silurien supérieur d'Europe. 2 Volumes, 534 pp. Unpublished PhD thesis, Faculty of Science Lyon 1, UMR 5125 PEPS.

PERRIER V., VANNIER J. & SIVETER D.J. (2007). The Silurian pelagic myodocope ostracod *Richteria migrans*. *Transactions of the Royal Society of Edinburgh, Earth Sciences*, 98: 1–13.

PRIBYL A. (1951). On the Bohemian Ostracoda of the families Entomozoidae and Entomoconchiadae. *Bulletin International, Academie Tchèque des Sciences*, 9: 1-28.

PRIBYL A. (1988). Ostracodes from the Silurian of central Bohemia. *Sbornik geologickych Ved Paleontologie*, 29: 49-143.

SIVETER D.J. (1984). Habitats and modes of life of Silurian ostracods. *In* Bassett M.G. & Lawson J.D. (eds), The Autecology of Silurian Organisms, Special Papers in Palaeontology, London: 71-85.

SIVETER, D.J. 2008. Ostracods in the Palaeozoic? *Senckenbergiana lethaea*, 88: 1-9.

SIVETER D.J., VANNIER J. & PALMER D. (1987). Silurian Myodocopid Ostracodes: Their depositional Environment and the Origin of their Shell Microstructures. *Palaeontology*, 30: 783-813.

SIVETER D.J., VANNIER J. & PALMER D. (1991). Silurian Myodocopes: Pioneer pelagic ostracods and the chronology of an ecological shift. *Journal of Micropalaeontology*, 10:157-173.

SIVETER D.J., SUTTON M.D., BRIGGS D.E.G. & SIVETER D.J. (2003). An Ostracode Crustacean with Soft Parts from the Lower Silurian. *Science*, 302: 1749-1751.

SIVETER D.J., SIVETER D.J., SUTTON M.D. & BRIGGS D.E.G. (2007). Brood care in a Silurian ostracode. *Proceedings of the Royal Society of London. Series B*, 274: 465-469.

TARICCO M. (1922). Sul Paleozoico del Fluminese. *Bollettino del Regio Comitato Geologico d'Italia*, 48 (1920-21): 1-22.

VANNIER J. & ABE K. (1992). Recent and early Paleozoic Myodocope Ostracodes: Functional Morphology, Phylogeny, Distribution and Lifestyles. *Palaeontology*, 35: 485-517.

WEITSCHAT W. (1983). On *Triadocypris spitzbergensis*. *In* Stereo-Atlas of Ostracod Shells, Bate R.H., Neale J.W., Sheppard L.M. & Siveter D.J. (eds), The Broadwater Press, Hertfordshire: 127-138.

WILKINSON I.P., WILLIAMS M., SIVETER D.J., & WILBY P.R. (2004). A Carboniferous necrophagous Myodocopid ostracod from Derbyshire, England. *Revista Espanola de Micropaleontologia*, 36 (1): 187-198.