Bollettino della Società Paleontologica Italiana	23 (2)	1984	205-209	—	Modena, Settembre 1985

A preliminary report on new micropaleontological discoveries in the Silurian of Southwest Sardinia

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KEY WORDS — Ostracodes (Myodocopida), Faunal assemblage, Biostratigraphy, Fluminimaggiore area, Paleozoic.

ABSTRACT — Myodocopid ostracodes from Late Silurian beds of southwestern Sardinia, studied for the first time by Canavari in 1899, were recovered from the type-locality and adjacent areas to try a taxonomical and biostratigraphical revision of this group of fossils (Palmer & Siveter, in preparation). Associated faunas (conodonts, graptolites, cephalopods, trilobites and phyllocarids) furnished the stratigraphic control of the various sampled beds. Among various fossils the rhaphiophorid trilobite Ampyx *sp. aff.* roualti *Barrande and the monograptid* Saetograptus *cf.* fritschi *Perner, both stratigraphically important, are reported for the first time from the Upper Silurian of southwestern Sardinia.*

RIASSUNTO — [Alcune scoperte micropaleontologiche nel Siluriano della Sardegna sud-occidentale]. *— Viene descritto il ritrovamento di ostracodi siluriani (Myodocopida), studiati per la prima volta dal Canavari (1899), nella località tipo e in zone limitrofe della Sardegna sud-occidentale per una revisione tassonomica e biostratigrafica (Palmer & Siveter, in preparazione) di questo gruppo di fossili. Le faune associate (conodonti, graptoliti, cefalopodi, trilobiti e fillocaridi) hanno fornito il controllo stratigrafico dei vari livelli campionati. Viene inoltre segnalata, per la prima volta nel Siluriano superiore della Sardegna sud-occidentale, la presenza del trilobite* Ampyx *sp. aff.* roualti *Barrande e del monograptide* Saetograptus *cf.* fritschi *Perner, entrambi di notevole importanza stratigrafica.*

INTRODUCTION

In the spring of 1984 a paleontological collecting trip to Southwest Sardinia was organized by Dr. M. Gnoli, assisted by Mr. Rompianesi. Part of its objective was to facilitate a search for Silurian myodocopid ostracodes by Dr. D. Palmer of Trinty College, Dublin, who is working on this group of fossils with Dr. D. Siveter of Leicester University, England.

The following is a brief preliminary report with an emphasis on the ostracode search.

Myodocopid ostracodes are an extant group of dominantly pelagic ostracodes with an ancestry in the Lower Paleozoic (? Ordovician, Silurian). The group includes several unusually large (up to 10 mm in length) forms and it is particularly the Silurian representatives of these and the genera *Bolbozoe* Barrande 1872 and *Entomis* Jones 1861 that we are concerned with. Barrande (1872) described a number of species from the Silurian of Bohemia and Jones (1861, 1884, 1898) described others from Scotland and Wales and noted (1884) the occurrence of this type of ostracode in rocks of the same age (Silurian) from Australia and Poland. At the end of the nineteenth century Canavari (1899) described a predominantly myodocopid ostracode fauna from the Silurian of southwestern Sardinia and later the occurrence of this type of ostracode was reported from Brittany by Kerforne (1901).

Since then only the Bohemian species have been revised (Bouček, 1936; Přibyl, 1950) and no comparison or synthesis from a taxonomic, biostratigraphic or paleoecological point of view has been attempted. It is just this that Siveter and Palmer are now trying to do.

A common problem for the « paleotaxonomist » is that of judging the validity of older described species, which may have been based on very few specimens, in the light of modern taxonomic practice. The original description and illustrations may be of only limited use, simply because the criteria for separating the taxa of a particular group have changed. This problem arises with the Silurian myodocopid ostracodes and particularly with reference to Canavari's species from Sardinia. He described (1899) some eight new

species of *Entomis* and three of *Bolbozoe,* thus contributing an important addition to the taxa of this group of fossils. However, it is likely that some of this species are not well founded, being based on very few specimens with inadequate preservation. Also, he did not indicate typical specimens and consequently lectotypes have yet to be selected for those of his species which are valid. This can only be done by examining the original specimens. The modern criteria for assessing these ostracode species utilizes the form and position of adductorial muscle scars and the presence of a rostral notch and incisure (Siveter, 1985). These are features which were not recognized generally in the past, neither by Canavari, nor by most other early investigators. Exception to this were Jones and Gürich. The latter illustration of *Bolbozoe polonica* (Gürich, 1896) from the Ludlow *Cardiola* shales of southern Poland clearly shows the adductorial muscle scar and rostral notch.

Unfortunately Canavari's original specimens are not apparently available for study at the moment being *in transit* between the Department of Earth Sciences of the University of Pisa and a museum at Calci. Consequently the collection of topotype material is particular important if we are to have any well based understanding of Canavari's important Sardinian species.

THE SARDINIAN LOCALITIES

All Canavari's material came from a locality he called Xea Sant'Antonio near the village of Fluminimaggiore in southwestern Sardinia. He used this locality name following La Marmora (1857) and Meneghini (1880) but it is no one that is in contemporary local use or on recent maps. However, it is clear from the introduction to his (1899) paper that it was a somewhat vague area rather than a specific locality since he quotes from La Marmora (1857, p. 49) description. The fossils had been found in « le pierres dont sont faits les murs des maisons et des enclos de ce village ». In other words they were within *ex situ* blocks of unknown but presumable local provenance. It is significant and important for understanding the biostratigraphical problem to realize that Canavari did not himself visit Sardinia at all but relied on recovering his fossils from blocks which were sent to him in Pisa and which he broke up in his laboratory. The details of these procedures are contained in his introduction and it is interesting to note that he had to work through 1200 kg of rock in order to find the specimens on which his paper is based. Even so, of the three new species of *Bolbozoe* only one (*B. italica*) was based on more than a few specimens and of the ten new species of *Entomis* only three were common (*E. lamarmorai, E. icnusae, E. meneghini*) as a fourth Barrande species *E. migrans.*

Over the last two decades or so the biostratigraphy and paleontology of the Lower Paleozoic of Southwestern Sardinia has been investigated by a number of Italian paleontologists. A review of the paleontological aspects of this work has recently been compiled in Serpagli & Gnoli (1984) whilst biostratigraphical information is contained in Gnoli *et al.* (1981), Serpagli (1967, 1971, 1983), Serpagli & Mastandrea (1980) and Serpagli *et al.* (1978).

Now thanks to this recent work it is possible to critically examine the geological context of Canavari's material.

A section has been found in the Perd e Fogu track up the hillside above (to northeast of) the cemetery of Fluminimaggiore (see Serpagli, 1971). Here there are highly deformed black shales, in part of Llandovery age (Taricco, 1920-22), and fossiliferous limestone lenses and beds, the lateral persistence of which is hard to check. However, it has also been shown (Serpagli, 1971) that there is not a comformable succession here but that post depositional « mixing » has occurred, certainly tectonic in origin but possibly also a mass movement of sedimentary origin. The shales are plastically deformed with flattening, stretching and cleavage whilst the limestone blocks are virtually undeformed with the fossils for the most part being preserved in full three dimensions (Gnoli *et al.,* 1979, pp. 407, 408).

At the present stage of investigation of the fauna, given this complicated geological setting, each limestone block has to be regarded as a separate entity from both the biostratigraphical and paleoecological point of view. Formal investigations using this approach have been initiated over the past few years, especially by Serpagli on conodonts (1967, 1971, 1983) and Gnoli & Serpagli on nautiloids and phyllocarids (1977, 1984). Drs. J. Kříž and P. Štorch (Geological Survey of Czechoslovakia, Prague) are currently working on bivalves and graptolites respectively from this and other adjacent localities in southwestern Sardinia.

This particular section has not yet yielded many myodocopids, only one block has so far been found to contain any and these are accompanying a predominantly orthocone rich fauna. The locality did however yield identifiable Lower Ludlow graptolites. A 20 cm thick limestone block (433/12) with a few orthocones contained a monotypic profusion of saetograptids (*Saetograptus* cf. *fritschi* Perner) which according to Přibyl (1942) have a range restricted to the upper part of the *L. scanicus sensu lato* zone in Bohemia, from where they were originally described. From the

same locality Štorch has collected *Colonograptus roemeri, C.* cf. *colonus* and *Monograptus* aff. *uncinatus* (personal communication to M. Gnoli). Thus the graptolites support the conodont evidence (Serpagli ,1971) for the age of the limestones in this section.

Wenlock graptolites (*M. priodon* (Bronn)) were recorded from the original Xea S'Antonio locality by Meneghini (1857, 1880). Generally speaking it is an easily recognized species but is a rather long ranging form being found from Late Llandovery to Late Wenlock times. However, recently it has been shown by Lenz (1974) that careful observation of certain morphological changes with time allow a recognition and separation of at least Late Llandovery, low to mid Wenlock and Late Wenlock forms. Such diagnosis remains to be made for Sardinian specimens and in the absence of other graptolites characteristic of the different Wenlock zones, we are not yet in a position to differentiate the Wenlock succession here compared with that Gortani (1922) was able to achieve in the southwestern part of the island. Anyway Upper Wenlock sediments have been documented by Serpagli (1971) on the basis of conodonts of the *sagitta* Zone.

A second locality called Galemmu, five hundred metres to the northwest (see Serpagli, 1983, p. 156, fig. 1 for locality map) was also examined. Here none of the blocks examined were *in situ* but had been removed from a field and piled up at its edge.

The most obviously fossiliferous limestone blocks were those with an abundant macrofauna of orthoconic nautiloids. Presumably it was just such blocks that were shipped to Canavari in Pisa to break down in his search for ostracodes. Sometimes there is an accompanying subordinate fauna of bivalves, mainly cardiolids (often juveniles) and less frequently graptolites. This is the often recorded and well known association of these « *Orthoceras* limestones ».

Of six such blocks which were broken and carefully examined in the field, two also contained numerous specimens of the distictive « fingerprint » ostracode *Entomis* cf. *migrans*. Also, five superficially unfossiliferous micritic limestone blocks were searched and yielded a sparse ostracode fauna. Again *E.* cf. *migrans* was found but here accompained by *Entomis* sp. plus the peculiar and distinctive large thin shelled myodocopid *Bolbozoe* sp. with its characteristic rostral notch. The presence of this feature has been homologised with a similar one on living myodocopids (Siveter, 1985, p. 78), where there are strongly developed frontal appendages used for swimming and hence a pelagic mode of life.

Few graptolites were recovered from these blocks so that a detailed biostratigraphical control will depend on the extraction of conodonts until the biostratigraphy of the ostracodes themselves can be finally proven. The latter will have to be based on the sections in the Welsh Borderlands where both ostracodes and graptolites occur together. However it may be noted that the lithologies and macrofauna of these Galemmu blocks are very similar to those found at the first locality.

A third locality was visited, a hillside section at Mason Porcus 2.5 km east-northeast of Fluminimaggiore (see Serpagli, 1983, p. 156, fig. 1 for the locality map), where no previous attempt had been made to collect ostracodes. The section is currently the subject of detailed investigation by Gnoli, Kříž, Olivieri and Serpagli and will certainly be of considerable importance to the understanding of the geology of the Silurian and Lower Devonian in southwestern Sardinia. This is because, although exposure is by no means perfect, a relatively undisturbed sequence from Uppermost Silurian into the Devonian can be seen in limestones with a long angle of dip. As yet no details have been published but the presence of the Silurian-Devonian boundary has shown by the occurrence of the conodont *Icriodus woschmidti woschmidti* (see Serpagli, 1983). Provisionally the different identifiable beds in the succession have been numbered and collected for both micro and macro-paleontological study; a study of the phyllocarid remains has already been published by Gnoli & Serpagli (1984).

Immediately above level 2 there is an 8 cm orthocone rich limestone, which passes up into 10 cm of flaggy micritic limestone. The latter is generally unfossiliferous but yielded a few laminae with poorly preserved monograptid graptolites. Representatives of this important group of fossils have not previously been found at this stratigraphic level in Southwest Sardinia. The species present have yet to be identified.

At level 3 a further flaggy micritic limestone with calcareous nodules was examined and is of particular interest. Again a few graptolites were found with some orthocone represented by the Pridoli index species *Orthocycloceras fluminese* (Meneghini) (=*O. bohemicum* Barrande), a few *Bolbozoe* specimens and a single cephalon of the small blind trilobite *Ampyx* sp. aff. *roualti* Barrande. There are several significant aspects of this fauna.

As mentioned previously for level 2, graptolites have not been found as high as this in southwestern Sardinia before. Jeager (1976, 1977) found *Monograptus dubius* cf. *thuringicus* in the Baccu Scottis and Goni sections (southeastern Sardinia) within Ockerkalk type limestones which also yielded *Scyphocrinus* in their upper part and *M. uniformis* zone graptolites above, thus clearly indicating the presence of the Silurian-Devonian boundary in that part of the island and

providing a good correlation with Thuringian sections.

The graptolites from level 3 have yet to be identified but the presence of the small but distinctive rhaphiophorid trilobite may well be indicative of the Ockerkalk horizon. Jaeger records it (1976, p. 268; 1977, p. 121) as occurring rarely at this level in Thuringia and this is its first record in Sardinia.

The occurrence of *Bolbozoe* sp. at this level is of great interest since it considerably increases the range of the genus in Europe. It was not previously known to extend as high as this in Sardinia and the only European records of it in post *leintwardinensis* strata are from Whitcliffe Formation (Ludfordian Stage, Ludlow Series) i.e. pre-*ultimus* zone in the Long Mountain, Welsh Borderlands (Great Britain). Recently, a brief description has been published (Wang Shang-qi & Zhang Xiao-bin, 1983) of a Lower Devonian (Zlichov) ostracode assemblage from Guanxi province, South China. It is claimed to contain a new *Bolbozoe* species (*largiglobosa*) but critical diagnostic features of the genus, such as the rostral incisure are not described. This may a result of poor preservation. However, acceptance of such a significant extension of the strata record of the genus should await confirmation of the presence of such structures.

At level 5 a limestone block yielded numerous orthocones (*Arionoceras affine* (Meneghini), *Parakionoceras originale* (Barrande), *Orthocycloceras fluminese* (Meneghini), *Anaspyroceras* cf. *pseudocalamiteum* (Barrande)), and relatively fewer specimens of various bivalves (not cardiolids), ceriatocarid fragments, large *Bolbozoe* sp. and poorly preserved graptolites. A small loose block also probably from this level yielded further small orthocones, *Bolbozoe* sp. and a ceriatocarid fragment. It is from this level that some of the ceriatocarid specimens described by Gnoli & Serpagli (1984) were found.

Correlation at this stratigraphic level has been achieved largely through the use of various pelagic fossil organism. These tend to fall into two groups despite their presumed pelagic mode of life, on the one hand the more diverse faunas of the «*Orthoceras*» type limestones (conodonts, orthoconic nautiloids, bivalves, scyphocrinitids, phyllocarids and small blind trilobites) and on the other hand the less diverse predominantly graptolitic faunas of the more shaly or fine grained clastic strata. Fortunately due to the frequent vertical repetition of these two facies at some localities, correlation can be achieved using both « facies faunal » elements over a widespread area.

CONCLUDING REMARKS

The « *Orthoceras* » limestone type facies is distributed throughout the region of Paleotethys from Northwest Spain, Montagne Noire, Thuringia, Bohemia, Carnic Alps, Sardinia, Turkey and along the North African Platform. Beyond this the cosmopolitan graptolites and conodonts help achieve correlation on a worldwide basis. The problem areas for correlation are those with relatively shallow water shelf and platform deposits containing predominantly endemic benthic faunas. The British, Balto-Scandian and Podolian outcrops fall into this category and whilst a reasonable level of intercorrelation within this area has recently been achieved, using paleocope ostracodes (Shaw, 1969; Martinsson, 1967, 1977), it was the difficulty of correlation out from the area that historically caused so much of the confusion over the Siluro-Devonian boundary. The occurrence and recognition of conodont faunas (in absence of graptolites at this level in the British-Scandian region) has now resolved many of these problems (see Aldridge, 1975 and Aldridge *et al.*, 1979). However, it is interesting that the possibility now arises of adding a new cosmopolitan pelagic faunal element, namely the myodocopid ostracodes, to those which are useful for intercorrelations between the « *Orthoceras* » limestone facies of Mediterranean area and the shelf-platform areas of the British and Balto-Scandian region let alone Australia and China.

In conclusion, topotype material for Canavari's (1899) Silurian myodocopid ostracode species has been collected from near Fluminimaggiore, Southwest Sardinia, as part of a revision of this group of ostracodes currently being undertaken by Dr. D. Siveter (Leicester University) and Dr. D. Palmer (Trinity College, Dublin). Furthermore new finds were made from adjacent localities both at the same stratigraphic horizon (Ludlow) and higher (top Ludlow-Pridoli) in the succession. These finds were accompanied by discoveries of graptolite faunas new to these localities and Southwest Sardinia in general. It is hoped that their identification will lead to a reinforcement of the biostratigraphy already established by conodonts for this area.

ACKNOWLEDGMENTS

We want express our sincere thanks to Prof. E. Serpagli for encouragement and critical reading the manuscript and to Mr. P. Rompianesi (Institute of Paleontology, University of Modena) for his help during field work. D. Palmer is grateful to Dr. W. Watts (Provost of Trinity College, Dublin) who provided found for the visit to Sardinia. This work was carried out with the financial support of the Ministero della Pubblica Istruzione (M.P.I.) and of the Italian Consiglio Nazionale delle Ricerche (C.N.R.).

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(manuscript received April 3, 1985
accepted May 2, 1985)

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