

A report on Silurian and lowermost Devonian chitinozoans from South-western Sardinia

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ABSTRACT – Nineteen chitinozoan species were identified in several isolated blocks of micritic limestones from South-western Sardinia. Ludlow, Přídolí and lowermost Devonian (Lochkovian) chitinozoan assemblages were distinguished. The tentative chitinozoan stratigraphy of individual blocks is proposed. It supports the previous stratigraphic data based on bivalves from the same blocks.

RIASSUNTO – [Segnalazione di chitinozoi nel Siluriano superiore e nel Devoniano basale della Sardegna sud-occidentale] – Diciannove specie di chitinozoi sono state identificate entro blocchi di calcare micritico provenienti dalla Sardegna sud-occidentale. Sono state riconosciute diverse associazioni a chitinozoi, attribuite al Ludlow, Přídolí ed al Devoniano basale (Lochkoviano). Viene proposta una collocazione stratigrafica dei singoli blocchi grazie ai chitinozoi. I dati emersi confermano quanto già suggerito dai bivalvi ritrovati negli stessi livelli.

INTRODUCTION

This paper presents the first information about Silurian and the lowermost Devonian chitinozoans from South-Western Sardinia.

All the samples for the chitinozoan investigation (41 samples) were supplied by J. Kříž from rock material remaining from a previous study of Silurian-Devonian bivalves from Sardinia (Kříž & Serpagli, 1993). Numbers of localities and samples (= blocks) used in the mentioned study were adopted herein. A key to understand the different labelling used by Czech (Prague) and Italian-(Modena) teams to identify the sampling localities is explained in the «Appendix». For the geological setting of the studied area see Kříž & Serpagli (1993, p. 291-292).

List of localities and blocks studied for chitinozoans (Text-fig. 1)

1 - Fluminimaggiore, Xea S'Antonio (Sentiero Fluminimaggiore), blocks: 1-3, 6, 11, 17-18.

2 - Fluminimaggiore, Galemme, blocks: 1-9, 12, 15-17, 22-23, 30-31, 36-37, 43, 45-48.

3 - Fluminimaggiore, Mason Porcus, blocks: 2, 5, 6; layers MP5 and MP6.

5 - Domusnovas, Su Nuargi, block: 1.

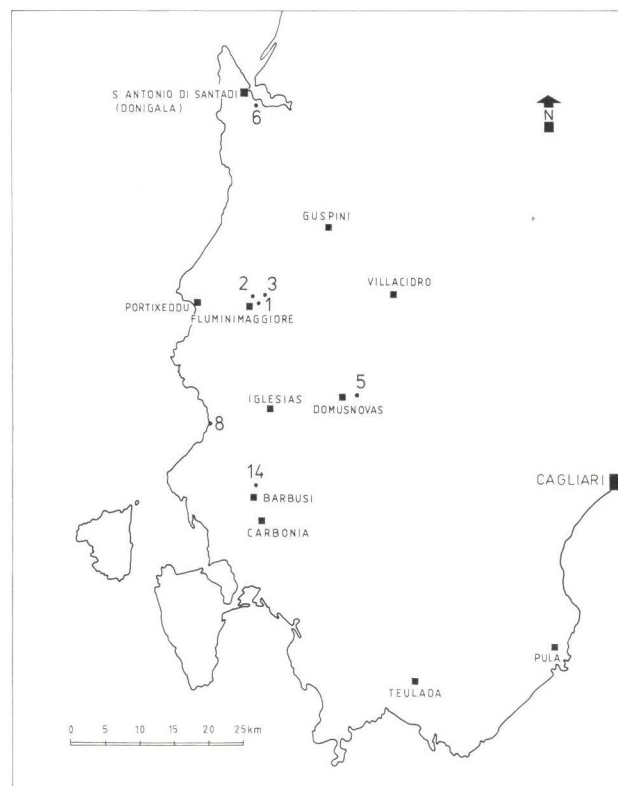
6 - S'Antonio Donigala, blocks: 0, 7.

8 - Fontanamare, block: 1.

14 - Barbusi, block: 1.

CHITINOZOANS

Ten samples have yielded determinable, biostratigraphically useful chitinozoans. Other sam-



Text-fig. 1 - Location map of the studied localities. Adopted from Kříž & Serpagli (1993).

ples were either barren or contained very rare chitinozoans, which were more or less destroyed.

Productive samples contain only a small number of chitinozoans as well as other organoclasts. The

number of chitinozoans ranges from one to seven specimens per gram of rock. In general, the chitinozoans are moderately preserved. Short spines of thick-walled forms are usually conserved, while the long processes or spines of thin-walled taxa (e.g. *Ancyrochitina*) are mostly broken. Typical is the low diversity of chitinozoans. A maximum of five species has been recorded from one assemblage.

LIST OF CHITINOZOANS

Ancyrochitina ancyrea (Eisenack, 1931)
Ancyrochitina sp.
Angochitina cf. *elongata* Eisenack, 1931
Angochitina cf. *echinata* Eisenack, 1931
Angochitina sp.
Belonechitina? cf. *latifrons* (Eisenack, 1964)
Bulbochitina? sp. (?? aff. *B. bulbosa* or aff. *B. suchomastensis*)
Cingulochitina cf. *wronai* Paris & Kríz, 1984
Conochitina pachycephala Eisenack, 1964
Conochitina cf. *tuba* Eisenack, 1932
Conochitina sp. aff. *C. elegans* Eisenack, 1931
Conochitina sp.
Eisenackitina bohémica (Eisenack, 1934)
Eisenackitina cf. *bohémica* (Eisenack, 1934)
Eisenackitina cf. *lagenomorpha* (Eisenack, 1931)
Eisenackitina? sp. A (?? aff. *E. lagena*)
Eisenackitina? sp. B (?? aff. *E. intermedia* or *E. barrandei*)
Eisenackitina sp. C (?? aff. *E. bohémica*)
Gotlandochitina? sp.
Urnochitina urna (Eisenack, 1934)

STRATIGRAPHY AND CORRELATION

Tentative stratigraphy and superposition of individual blocks with chitinozoans are shown on Text-fig. 2. On the basis of chitinozoan biostratigraphy, the blocks could be subdivided into four groups.

(1) Blocks 2/46 and 6/7: The important species

Conochitina pachycephala occurs in the assemblage. This world-wide index species ranges from upper Sheinwoodian (Wenlock) to upper Gorstian (Ludlow). Other conochitinids referred to *Conochitina* cf. *tuba* do not provide a more precise biostratigraphic evaluation.

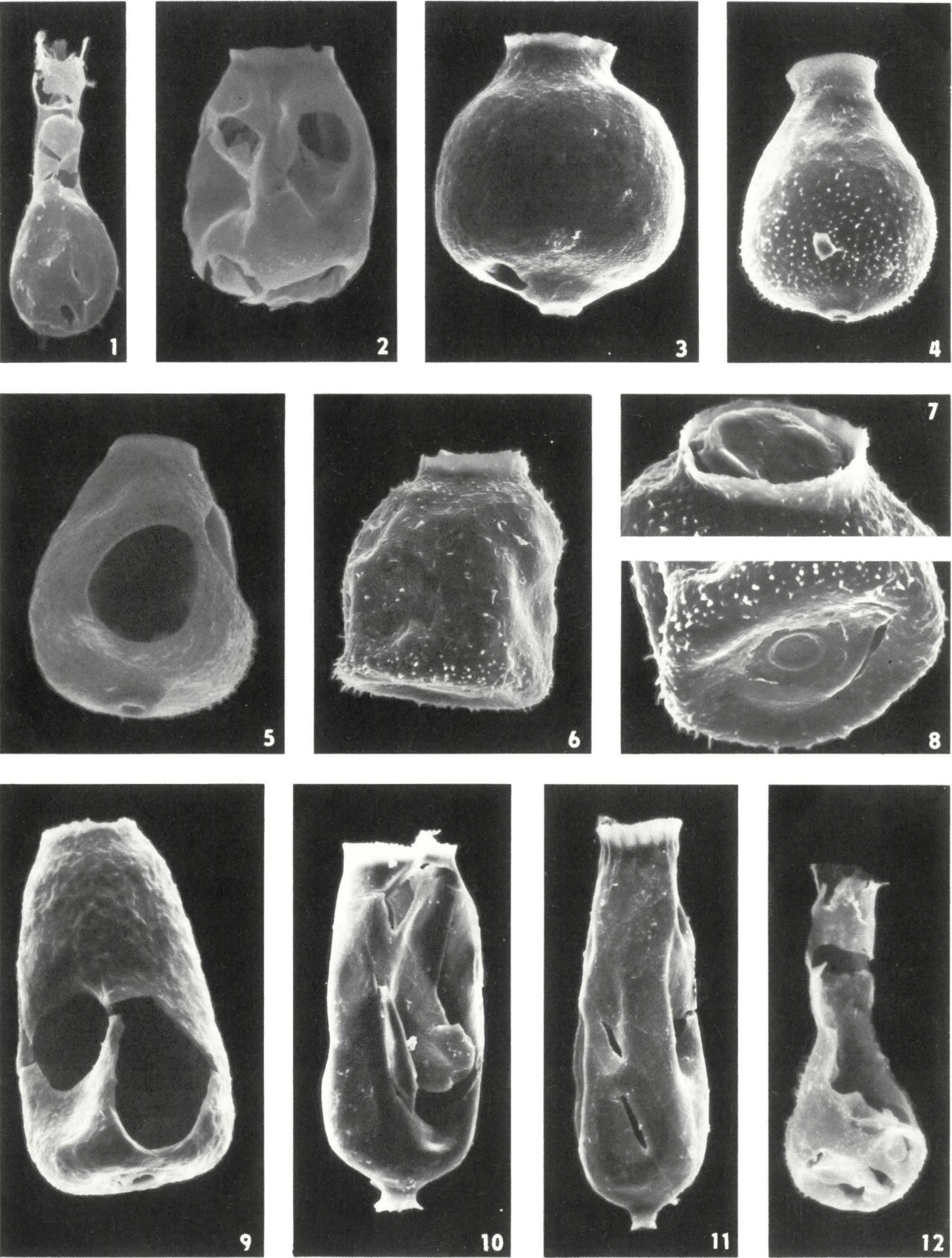
(2) Blocks 2/17, 1/X and 2/15: Chitinozoan assemblages indicate Ludlow ages, especially upper Gorstian to lower Ludfordian. This interval corresponds to the *Angochitina elongata* chitinozoan Biozone (Verniers *et al.*, 1995). The specimens of *Angochitina* cf. *elongata*, *Angochitina* cf. *echinata*, *Belonechitina*? cf. *latifrons*, *Eisenackitina* cf. *lagenomorpha* and *Eisenackitina*? sp. B are similar to forms occurring in the mid-Ludlow sequences of the Prague Basin (Dufka, unpub. data). The uncertainty in species determination is caused by poor preservation of chitinozoans and possible destruction of the fine sculpture. Moreover, the specimens of *Angochitina* genera from Sardinia display a different shape of the chamber when compared with typical forms from Baltoscandia (see e.g. Laufeld, 1974).

(3) Beds (samples) 3/MP5 and 3/MP6: *Urnochitina urna* is a predominant form in these samples. This chitinozoan species is one of the most significant biostratigraphic markers for the Přídolí. The sample 3/MP5 yielded a monospecific assemblage of the typical *U. urna* that corresponds to the Přídolí age. An ill-preserved *Angochitina* sp. was found in the sample 3/MP6. This form resembles the lowermost Devonian index species *Angochitina chlupaci* Paris *et al.* in the vesicle shape. *U. urna* and *A. chlupaci* occur simultaneously in the basalmost Devonian strata of the Karlštejn section in the Prague Basin (Paris *et al.*, 1981, p. 8). Thus a lowermost Lochkovian age for sample 3/MP6 is not excluded.

(4) Blocks 2/9, 2/7, 2/30: The important Lochkovian species *Eisenackitina bohémica* was determined from these samples. This species displays a large morphological variability (cf. Paris, 1981). Morphological transitions between *E. bohémica*, *E. cf. bohémica* and *Eisenackitina* sp. C were observed.

EXPLANATION OF PLATE 1

- Fig. 1 - *Angochitina* sp., block 3/MP6, GSP-519, x 350.
 Fig. 2 - *Eisenackitina*? sp. A, block 2/15, GSP-509, x 350.
 Figs. 3-5 - *Eisenackitina bohémica* (Eisenack). 3-4) block 2/30, GSP-513, x 300. 5) block 2/7, GSP-504, x 350
 Figs. 6-8 - *Eisenackitina* cf. *bohémica* (Eisenack), block 2/7, GSP-505. 6) x 350. 7) Detail of the oral pole showing slightly displaced operculum, x 600. 8) Detail of the aboral pole showing the basal scar, x 500.
 Fig. 9 - *Eisenackitina*? sp. B, block 2/15, GSP-509, x 300.
 Figs. 10-11 - *Urnochitina urna* (Eisenack), block 3/MP6, GSP-519, x 350.
 Fig. 12 - *Angochitina* cf. *echinata* Eisenack, block 2/46, GSP-515, x350.



The variability of sculpture and chamber shape should indicate the existence of different species. Nevertheless, it is very difficult to choose precise morphological features discriminant at specific level. Specimens resembling the typical forms of *E. bohémica*, described and illustrated from the Lochkovian of Bohemia (Eisenack, 1934; Paris, 1981, Pl. 27, figs. 15-19; Chlupáč *et al.*, 1985), were recorded from samples 2/7 and 2/30. They have concave flanks (an ovoid chamber), a short narrow neck and a protruded mucron.

Eisenackitina sp. C exhibits a simple basal scar and a chamber outline more similar to *E. intermedia* or *E. barrandei* than to *E. bohémica*. The aboral margin of its chamber often has longer spines (5-7 µm). The size of ornamentation decreases oralwards and the neck is mostly smooth. These sculptural variances do not appear to be a result of selective destruction of spines as supposed by Paris (1981, Pl. 29, fig. 14) for some forms of early Devonian *E. bohémica* from the Armorica massif. Some specimens (Pl. 2, figs. 7-8) bearing the distinct basal ring of spines resemble the unnamed Desmochitinidae forms reported by Achab & Asselin (1993, Pl. 1, fig. 10) from the Přídolí Chaleurs Group of Eastern Canada. Thus the sample 2/9, where *Eisenackitina* sp. C predominates and «true» *E. bohémica* is absent, should be dated either as Přídolí or basal Devonian.

Bulbochitina? sp. is smooth (? destroyed sculpture) or has a tiny ornamentation composed of grana or short spines. When morphological measurements are compared, this form is closer to early Devonian *B. bulbosa* Paris (Paris, 1981) than to Přídolí *B. suchomastensis* Paris (Paris *et al.*, 1981).

The chitinozoan assemblages can be very well correlated (see text-fig. 2) with bivalvia dominated communities described by Kříž & Serpagli (1993).

Blocks (samples) with mid-Ludlow Communities *Cardiola donigala* and *Cardiola docens* (lower part of the community range) contain several chitinozoan species that occur in the coeval global chitinozoan Biozone *Angochitina elongata* (Verniers

et al., 1995): *Conochitina pachycephala* (last occurrence is in the lower part of the biozone), *Belonechitina* cf. *latifrons*, *Angochitina* cf. *elongata*, *A.* cf. *echinata* and *E.* cf. *lagenomorpha* (first occurrence is in the upper part of the biozone).

In the layer (sample) 3/MP5, with typical bivalves of the upper Přídolí *Cheiopteria-Patrocardia-Cardiolinka* Community, an *Urnochitina urna* dominated chitinozoan assemblage was recorded.

Minor discrepancies between the stratigraphic information given by chitinozoans and bivalves appear in the topmost Přídolí or Lochkovian assemblages.

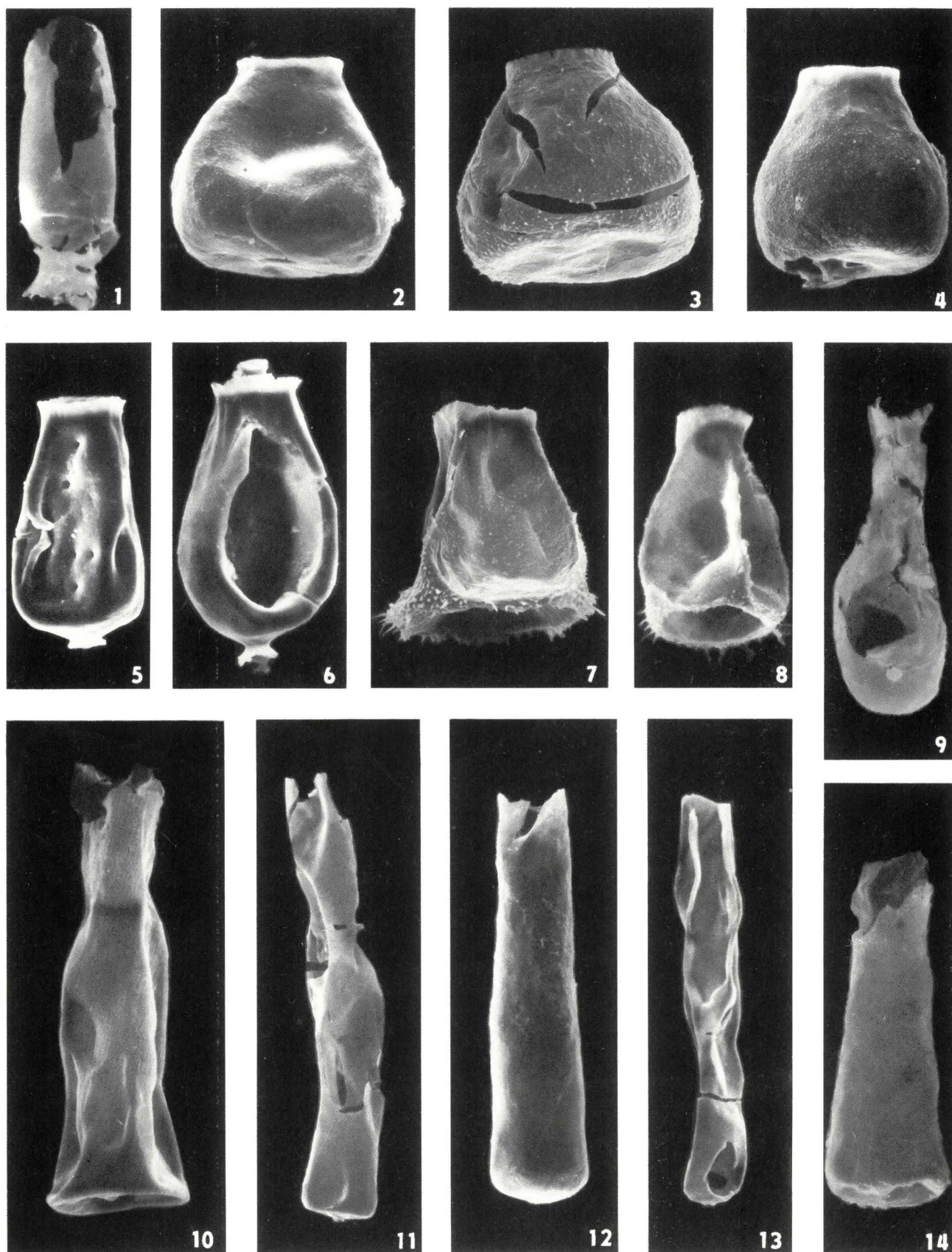
The block (sample) (2/7) with the monospecific *Pteridopecten cybele nesiotis* Community, regarded most probably as upper Přídolí (Kříž & Serpagli, 1993), yielded *Eisenackitina bohémica*, an important chitinozoan species that appears in the basal Lochkovian.

Two blocks (3/MP6 and 2/30) bearing the *Patrocardia evolvens evolvens*-Panenka Community (Lochkovian) present two different chitinozoan assemblages. An *Urnochitina urna* dominated assemblage was found in layer (sample) 3/MP6 (type horizon for this bivalvia community). The common occurrence of *U. urna* and the index conodont species *Icriodus w. woschmidti* (cf. Kříž & Serpagli, 1993, p. 294) are significant in the layer, indicating Silurian-Devonian boundary strata. The assemblage with *E. bohémica*, *Eisenackitina* sp. C and *Bulbochitina*? sp. from the block 2/30 has an obvious early Devonian (Lochkovian) character and therefore is considered younger than the previous one containing *Urnochitina urna*.

Silurian and lowermost Devonian chitinozoans from Sardinia manifest a close affinity with the coeval assemblages from the Prague Basin in Bohemia and from the Montagne Noire. In the Prague Basin, the assemblages containing *Conochitina pachycephala*, *Belonechitina* cf. *latifrons*, *Angochitina echinata* and *Angochitina* cf. *elongata* were discovered in the lower Ludfordian sequence (*E. beaumonti* horizon, section 777) of the Kosov

EXPLANATION OF PLATE 2

- Fig. 1 - *Cingulochitina* cf. *wronai* Paris, block 3/MP6, GSP-518, x 350.
 Figs. 2-4 - *Bulbochitina*? sp. 2) block 2/30, GSP-513, x 300. 3) block 2/7, GSP-505, x 450. 4) block 2/7, GSP-504, x 300.
 Figs. 5-6 - *Urnochitina urna* (Eisenack) 5) block 3/MP6, GSP-519, x 350. 6) block 3/MP5, GSP-517, x 350.
 Figs. 7-8 - *Eisenackitina* sp. C, block 2/7. 7) GSP-505, x 450. 8) GSP-504, x 350.
 Fig. 9 - *Angochitina* sp., block 3/MP6, GSP-518, x 350.
 Fig. 10 - *Conochitina* sp. aff. *C. elegans* Eisenack, block 2/17, GSP-511, x 350.
 Figs. 11-12 - *Conochitina pachycephala* Eisenack. 11) block 2/46, GSP-514, x 200. 12) block 6/7, GSP-523, x 200.
 Fig. 13 - *Conochitina* cf. *pachycephala* Eisenack, block 2/46, GSP-514, x 200.
 Fig. 14 - *Belonechitina*? cf. *latifrons* (Eisenack), block 1/X (Xea S'Antonio), GSP-521, x 350.



BLOCK/ SAMPLE NO.	Ancyrochitina sp.	Conochitina sp.	Ancyrochitina ancyrea	Conochitina cf. tuba	Eisenackitina ? sp. A	Conochitina pachycephala	Conochitina sp. aff. C. elegans	Belonechitina ? cf. latifrons	Angochitina cf. elongata	Angochitina cf. echinata	Angochitina sp.	Eisenackitina cf. lagenomorpha	Eisenackitina ? sp. B	Cingulochitina cf. wronai	Urnochitina urna	Eisenackitina bohemia	Eisenackitina cf. bohemia	Eisenackitina sp. C	Gotlandochitina ? sp.	Bulbochitina ? sp.	TENTATIVE STRATIGRAPHY	BIVALVIA COMMUNITIES*
2/30																•	•	•	•		Lower Devonian (Lochkovian)	Patrocardia e. evolvens - Panenka
2/7	•										•					•	•	•	•		Lower Devonian (Lochkovian)	Pterinopecten cybele nesiotis
2/9																	•	•			?upper Přídolí- lower Lochkovian	Pterinopecten cybele nesiotis
3/MP6											•			•	•						Přídolí- lower Lochkovian	Patrocardia e. evolvens - Panenka
3/MP5															•						Přídolí	Cheiopteria Patrocardia-Cardiolinka
2/15		•			•							•	•								Ludlow	Cardiola docens
1/X			•	•			•	•	•	•											lower-middle Ludlow	Cardiola docens
2/17	•	•					•	•		•											lower-middle Ludlow	Cardiola docens
6/7	•		•	•	•	•					•										upper Wenlock- middle Ludlow	Cardiola donigala
2/46		•	•	•		•															upper Wenlock- middle Ludlow	Cardiola docens

Text-fig. 2 - Stratigraphic considerations based on chitinozoan assemblages and correlation with bivalvia dominated communities (* Kříž & Serpagli, 1993).

Quarry (Kříž, 1992). *Urnochitina urna* dominated assemblages are well documented from several middle and upper Přídolí sections in Bohemia (Paris *et al.*, 1981, Kříž *et al.*, 1986) as well as in the Přídolí of the Montagne Noire (Assemblage II, De Bock, 1982). *Eisenackitina bohemia* is a significant species for Lochkovian correlation of all these three areas. In contrast to the Montagne Noire (Assemblage IIIa), the common occurrence of *Urnochitina urna* and *Eisenackitina bohemia* have not been observed in Sardinia. This absence is probably due to an incomplete local stratigraphic record.

Assemblages from Sardinia and the Prague Basin show low species diversity and comparable chitinozoan preservation corresponding to the same

depositional environment. Minor differences are manifested in particular by the lower chitinozoan abundance recorded in the Sardinian assemblages. While Ludlow and Přídolí micritic limestones in the Prague Basin commonly contain tens or even hundreds of specimens per gram of rock, the contemporaneous rocks in Sardinia contain up to seven specimens (an average two) in the same weight of sediment. The scarcity of chitinozoans could be caused by the increased rate of sedimentation.

CONCLUSIONS

Following the previous documentation on macrofauna (bivalves, graptolites) and conodonts,

chitinozoan biostratigraphy supports the upper Silurian and early Devonian age of dispersed isolated limestone bodies in S-W Sardinia.

Chitinozoan assemblages from Sardinia show close resemblance to contemporaneous assemblages from the Prague Basin and the Montagne Noire. The principal common features are:

- dominant occurrence of *Urnochitina urna* in the Pírdolí;
- appearance of *Eisenackitina bohémica* in the lowermost Devonian;
- low species diversity.

These results correspond to numerous previous evidences indicating the close paleogeographic relationship between Sardinia, the Prague Basin and Montagne Noire.

APPENDIX

Because in these last years some papers were published in joint co-operation by Czech (Prague) and Italian (Modena) teams that provided in the field to compile independent lists of layers and the displaced isolate blocks of U. Silurian-E. Devonian biomicritic limestone from SW Sardinia it seems to us appropriate to report in this paper a key of correspondence between these ones.

Czech people attributed a number for each tested locality according to the progressive time of their checking Sardinian section or isolate displaced blocks. On the other hand Italian people use a short monogram containing the first two, three or four letters of the beginning of each locality-name followed by the monogram of the sections checked followed by the letters BK (= block) in the case of the isolate displaced block, then the progressive number. As an example, for the Czech people the numbers 1, 2, 3, 4; 5, 6, 7, 8, 9, etc. correspond to the Locality or section: 1 = Sentiero Fluminimaggiore (SF), 2 = Galemme (GALE), 3 = Mason Porcus (MP), 5 = Su Nuargi (SN), 6 = Sant Antonio Donigala (SAD), 8 = Fontanamare (FTM) and so on. Again the isolate displaced block 11 checked along the Fluminimaggiore path (Sentiero Fluminimaggiore) was labelled by the Italian team as SF-BK 11 and by Czech ones as 1/11. The layer no. 3 of the Mason Porcus section is for Czechs 3/3 and for Italians MP3; A displaced block presumably from that level was labelled by Italian people as MP-BK 3 and by Czech ones such as Block 3/3.

Below is reported the key to understand the different labelling used by the two teams.

SIL./DEV. localities	Italian labelling	Czech labelling
Argiola	ARG	11
Barbusi	BAR	14
Corti Baccas	CB	7
Fontanamare	FTM	8
Galemme	GALE	2
Genna Quadroxii	GQX	9
Mason Porcus	MP	3
Roia is Tintionis	RT	4
S. Antonio Donigala	SAD	6
Sedda De S'Ortu	SDS	12
Xea S'Antonio (Sentiero Fluminimaggiore)	SF	1

<i>Su Nuargi</i>	SN	5
<i>Terra Murus</i>	TM	10

The localities recorded in the present paper are in italic.

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REFERENCES

- ACHAB, A. & ASSELIN, E., 1993, Upper Silurian and Lower Devonian chitinozoan microfaunas in the Chaleurs Group, Eastern Canada: Special Papers in Palaeontology, 48: 7-15.
- DE BOCK, F., 1982, Présence de chitinozoaires dans le passage siluro-dévonien de la Montagne Noire sud-orientale (Hérault, France): Geobios, 15: 845-871.
- EISENACK, A., 1934, Neue Mikrofossilien des baltischen Silurs. III. Neue Mikrofossilien des böhmischen Silurs. I: Paläontologische Zeitschrift, 16: 52-76.
- CHLUPÁČ, I., LUKES, P., PARIS, F. & SCHÖNLAUB, P., 1985, The Lochkovian-Pragian Boundary in the Lower Devonian of the Barrandian Area (Czechoslovakia): Jb. Geol. Bundesanst., 128: 9-41.
- KŘÍŽ, J., 1992, Silurian Field Excursions: Prague Basin (Barrandian) Bohemia (ed. M.G. Bassett): National Museum of Wales, Geological Series no. 13: 1-111.
- , JAEGER, H., PARIS, F. & SCHÖNLAUB, P., 1986, Pírdolí-the Fourth subdivision of the Silurian system: Jb. Geol. Bundesanst., 129: 291-360.
- , & SERPAGLI, E., 1993, Upper Silurian and lowermost Devonian Bivalvia of Bohemian type from South-Western Sardinia: Boll. Soc. Paleont. Ital., 32 (3): 289-347.
- LAUFELD, S., 1974, Silurian Chitinozoa from Gotland: Fossils and Strata, 5: 1-130.
- PARIS, F., 1981, Les Chitinozoaires dans le Paléozoïque du sud-ouest de l'Europe (Cadre géologique-Étude systématique-Biostratigraphie): Mém. Soc. géol. minéral. Bretagne, 24: 1-412.
- , LAUFELD, S. & CHLUPÁČ, I., 1981, Chitinozoa of the Silurian-Devonian boundary stratotypes in Bohemia: Sver. geol. Unders., Ser. Ca, 51: 1-29.
- VERNIERS, J., NESTOR, V., PARIS, F., DUFKA, P., SUTHERLAND, S. & VAN GROOTEL, G., 1995, A global Chitinozoa biozonation for the Silurian: Geol. Mag., 132 (6): 651-666.

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