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Biostratigraphic remarks on Early Devonian conodonts from Corti Baccas III section (SW Sardinia)

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KEY WORDS — Conodonts, Early Devonian, Sardinia, Taxonomy, Biostratigraphy.

ABSTRACT — In this paper an Early Devonian conodont fauna obtained from limestones outcropping at the Corti Baccas near Fluminimaggiore (southwestern Sardinia) is illustrated.

The faunal association, rather poor, comprises among others Pelekysgnathus serratus *n. ssp.* A, Icriodus steinachensis *morphotype* β, Pandorinellina steinhornensis miae, Eognathodus sulcatus kindlei *and* Polygnathus pireneae *allowing the identification of the* kindlei *and* pireneae *Zones. Chronostratigraphically, part of the section has a Pragian age.*

RIASSUNTO — [Osservazioni biostratigrafiche su conodonti del Devoniano inferiore della sezione di Corti Baccas III (Sardegna sud-occidentale)] — *Viene qui illustrata una fauna a conodonti del Devoniano inferiore proveniente dai calcari di Corti Baccas vicino a Fluminimaggiore (Sardegna sud-occidentale).*

L'associazione faunistica, piuttosto scarsa, comprende tra l'altro Pelekysgnathus serratus *n. ssp.* A, Icriodus steinachensis *morfotipo* β, Pandorinellina steinhornensis miae, Eognathodus sulcatus kindlei *e* Polygnathus pireneae *e ha permesso il riconoscimento delle zone* kindlei *e* pireneae. *Dal punto di vista cronostratigrafico parte della serie è attribuibile al Pragiano.*

Investigations in the Fluminese area, southwestern Sardinia, have shown that the Devonian limestones are rich in conodonts. This record stimulated detailed studies in order to provide a better biostratigraphic control. Stratigraphically continuous successions in this area are missing because the whole area was strongly affected by tectonism several times since late Paleozoic.

This paper describes the conodonts collected from the Corti Baccas III section near the Village of Fluminimaggiore, southwestern Sardinia. The lithology consists of nodular limestones with tentaculites alternating with thin layered calcareous shale and dark grey shale. Besides the conodonts these limestones yielded a large number of others fossils. A study on the paleontological content and on the microbiofacies of this section is reported by Gnoli (1985, this volume).

The conodont fauna is of particular interest as evidenced by the recognition of the *kindlei* and *pireneae* Zones. The latter zone was already recognized in the Sulcis region (Olivieri *et al.*, 1981; Gnoli *et al.*, 1982).

COMPOSITION AND AGE OF THE CONODONT FAUNA

Approximately 71.3 Kg of limestones were dissolved in acetic acid and yielded 331 conodonts. The elements recovered are listed in Tab. 1.

The lowermost samples, A and A_1, contain poorly preserved conodonts represented in the former sample by multielement taxa *Ozarkodina r. remscheidensis* (Ziegler) and *Pseudooneotodus beckmanni* (Bischoff & Sannemann), and the latter only by *Belodella devonica* (Stauffer). The presence of *O. r. remscheidensis* would suggest a latest Pridolian to Lochkovian age. However, I am inclined to assign to them a Lochkovian age, because the examined Pa element of *O. r. remscheidensis* appears to be close similar to *O. r. remscheidensis* n. form γ *sensu* Chatterton & Perry. This morphotype occurs in Canada in the Delorme Formation at Locality 2 from beds containing the trilobite *Wanburgella* (*Anambon*) *mackenziensis* Chatterton & Perry and dated by the authors as Lochkovian in age.

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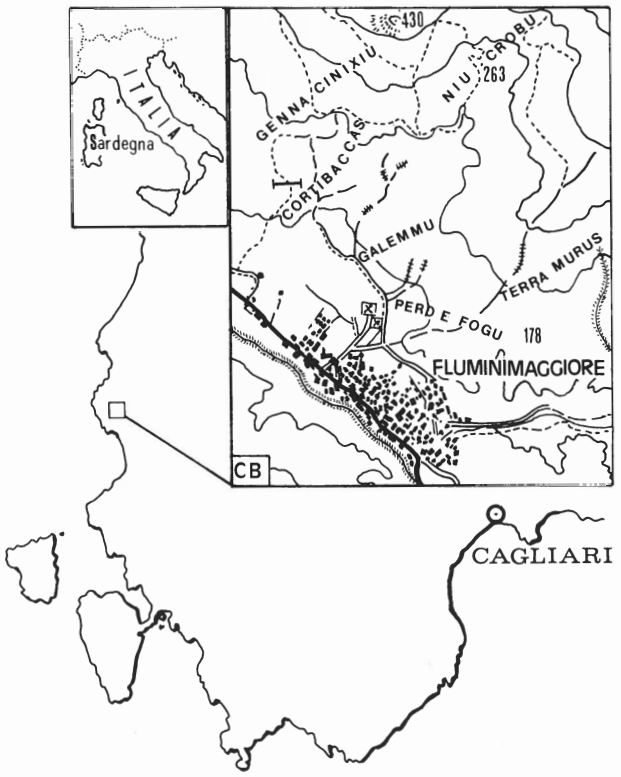


Text-fig. 1 - Location map of the Corti Baccas III section.

Samples B and B_1 collected at 5.2 and 6.5 m, respectively, above the base of the section, contain *Pelekysgnathus serratus* n. ssp. A Carls and *Icriodus steinachensis* morphotype β *sensu* Klapper & Johnson. The stratigraphic significance of *I. steinachensis* morphotype β, first described by Al-Rawi (1977, p. 56) from Triebenreuth in Frankenwald (Germany) was discussed, among others by Klapper & Johnson (1980) who stated that the range of this species is from the *sulcatus* to the *kindlei* Zones.

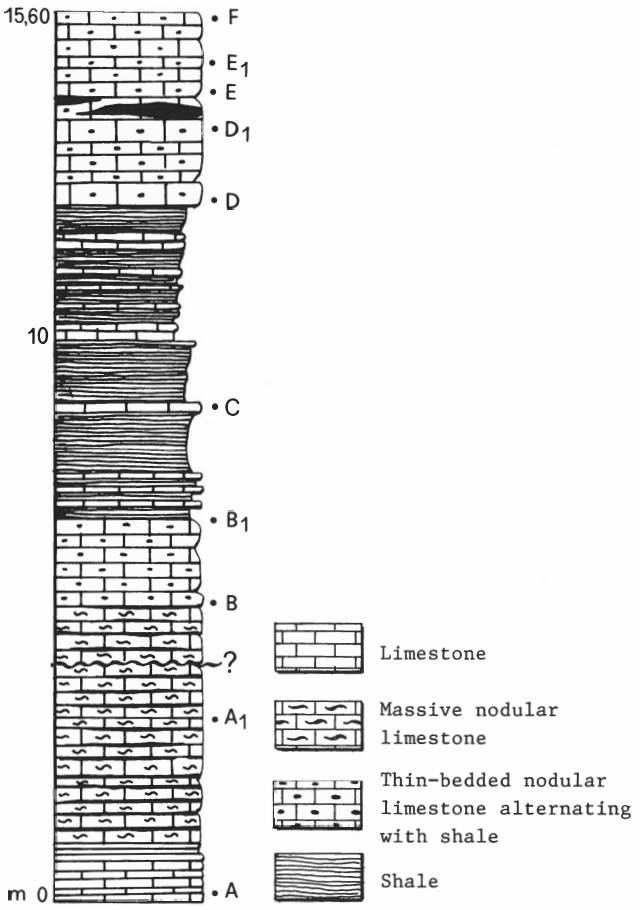
Al-Rawi reported the same morphotype associated with *Eognathodus s. sulcatus* (Philip) from the tentaculite limestones containing *Nowakia acuaria* (Reinh. Richter). According to Carls (1969, fig. 4), Al-Rawi considered this fauna indicative of the Late Gedinnian (Lochkovian). The same association occurs at Royal Creek section 1 in the Yukon and at Eureka County in Nevada corrisponding to the *sulcatus* Zone (Early Pragian age; Klapper, 1977). Klapper (in Klapper & Ziegler, 1979) correlates the fauna from Triebenreuth with the *sulcatus* Zone in Nevada. Furthermore, later discoveries of *I. steinachensis* morphotype β in Nevada at Copenhagen Canyon (Matti, Murphy & Finney, 1975) and in Alaska at Salmontrout sequence (Lane & Ormiston, 1979) associated with *Eognathodus sulcatus kindlei* allow to extend the range of this species above in the *kindlei* Zone. Always in Triebenreuth, in younger beds than *sulcatus* Zone, *I. steinachensis* morphotype β occurs together with *Pelekysgnathus serratus* n. ssp. A Carls and assigned by Al-Rawi to Late Gedinnian. *Pelekysgnathus serratus* n. ssp. A was recorded previously from Guadarrama (Spain) by Carls to range from Gedinnian to Early Siegenian.

On this evidence, the samples B and B_1 might fall in a interval corresponding to *sulcatus - kindlei* Zones.

Only one specimen of *Eognathodus s. kindlei* Lane & Ormiston was recovered in sample D associated with *Pandorinellina steinhornensis miae* (Bultynck) and *Ozarkodina e. excavata* (Branson & Mehl).

The first occurrence of *Eognathodus s. kindlei* (=*E. sulcatus* n. subsp. Klapper) defines the base of the *kindlei* Zone (Lane & Ormiston 1979, p. 45), which corresponds to the base of the *sulcatus* n. subsp. Zone in Klapper's definition (1977, p. 41). However, *E. s. kindlei* ranges up into the *pireneae* Zone in the Salmontrout sequence.

Pandorinellina s. miae occurs at Guadarrama in Spain (Bultynck, 1971) and in Alaska (Lane & Ormi-



Text-fig. 2 - Stratigraphic column of the Corti Baccas III section showing lithologies and sampled intervals.

CONODONTS	EARLY DEVONIAN										Total number of specimens
	LOCHKOV.	PRAGIAN									
	?	*kindlei* Zone					*pireneae* Z.		?		
SPECIES / SAMPLES	A	A_1	B	B_1	C	D	D_1	E	E_1	F	
Ozarkodina r. remscheidensis (Pa)	59										59
Ozarkodina r. remscheidensis (Pb)	22										22
Ozarkodina r. remscheidensis (M)	5										5
Ozarkodina r. remscheidensis (Sc)	6										6
Ozarkodina r. remscheidensis (Sb)	4										4
Pseudooneotodus beckmanni	4		6	25		8			1		44
Belodella devonica		9		1		3					13
Pelekysgnathus serratus n. ssp. A (I)			2	9							11
Pelekysgnathus serratus n. ssp. A (M_2)			1								1
Icriodus steinachensis morphotype (I)			9								9
Icriodus steinachensis morphotype (S_2)			4								4
Icriodus steinachensis morphotype (M_2)			1								1
Eognathodus sulcatus kindlei						1					1
Pandorinellina s. miae (Pa)						4	33	3			40
Pandorinellina s. miae (Pb)						3	12	4			19
Pandorinellina s. miae (M)						1	3				4
Pandorinellina s. miae (Sc)							6	4			10
Pandorinellina s. miae (Sa)							2				2
Ozarkodina e. excavata (Pa)						2	8	3	5	5	23
Ozarkodina e. excavata (Pb)						5	9				14
Ozarkodina e. excavata (M)						1	11	3	1		16
Ozarkodina e. excavata (Sc)						1	1	1			3
Ozarkodina e. excavata (Sb)						3	4	1			8
Ozarkodina e. excavata (Sa)						2	2	2			6
Polygnathus pireneae							6				
Total number of specimens per sample	100	9	23	35	-	34	97	21	7	5	331
Weight (Kg)	3.0	5.0	13	10.3	2.5	14.3	11.7	6.2	2.7	2.6	
Specimens per kilogram	33	2	2	3	-	2	8	3	3	2	

Tab. 1 - Distribution of conodonts in the Corti Baccas III section.

ston, 1979) associated with *Polygnathus dehiscens* Philip & Jackson, which latter species above the *pireneae* Zone.

It is important to note that *Pandorinellina s. miae* at the Corti Baccas III section occurs together with *E. s. kindlei*. This finding represents, probably, a downward extension of the range of this species.

Pandorinellina s. miae also occurs in the slightly younger bed (sample D_1) with *Polygnathus pireneae* (Boersma). *Polygnathus pireneae* was first recorded in the Central Pyrenees by Boersma (1974) and only successively did Lane & Ormiston (1979) exactly establish the stratigraphic significance and institute the *pireneae* Zone based on the first appearance of the nominal taxon. *P. pireneae* was recorded previously in Europe in the Römersreuther Berg from Frankenwald by Al-Rawi (1977, p. 36).

I believe that the samples from B to D belong to the *kindlei* Zone because *Polygnathus pireneae* occurs only in the overlying sample D_1. The sample E, still contains *P. s. miae* and thus probably belongs to the *pireneae* Zone.

The samples E_1 and F, near the top of the section, yielded few conodonts. Only some Pa elements of *Ozarkodina e. excavata* (Branson & Mehl), a « long range » species, are present and the characteristic taxa for definitive assignment are missing.

SYSTEMATIC PALEONTOLOGY

Only selected species firstly recorded in Sardinia or stratigraphically important are here discussed and figured.

Symbols for the skeletal elements used herein are those proposed by Klapper & Philip (1971, 1972) and Sweet & Schönlaub (1975). All figured specimens are stored in the Collections of the Institute of Paleontology.

Genus EOGNATHODUS Philip, 1965

Type-species — *Eognathodus sulcatus* Philip, 1965.

EOGNATHODUS SULCATUS KINDLEI Lane & Ormiston, 1979

Pl. 1, fig. 15a-b

1980 *Eognathodus sulcatus kindlei* Lane & Ormiston - KLAPPER & JOHNSON, p. 447, tab. 4 (*cum syn.*).

Description — Subspecies of *Eognathodus* characterized by a single row of denticles anteriorly and by a double row of denticles divided by a longitudinal trough posteriorly.

The double row continues nearly to the posterior end, where it is replaced by a single row of two denticles at the posterior end. The denticles of anterior single row appear very compressed laterally, in contrast with that of the double row. They are shaped like nodes, remarkably flat in lateral view.

The expanded part of the basal cavity is located posteriorly at mid-length without reaching the end. It continue as a narrow groove anteriorly.

Remarks — Specimen from the Corti Baccas III section, differs from *Eognathodus s. kindlei* figured by Lane & Ormiston (1979, pl. 4, figs. 1-5), in having a less developed and extensive longitudinal trough. Furthermore, it is not curved posteriorly.

Range — *kindlei* Zone - *pireneae* Zone (Lane & Ormiston, 1979, p. 45, tab. 1).

Material — 1 specimen.

Repository — Institute of Paleontology, Modena University, Micropaleontological Collection n. 21256 (figured hypotype).

EXPLANATION OF PLATE 1

All specimens are from Corti Baccas III section, Early Devonian.

Fig. 1 - *Ozarkodina r. remscheidensis* (Ziegler). Hypotype, n. 21286 x 90, lateral view of Pa element, sample A.

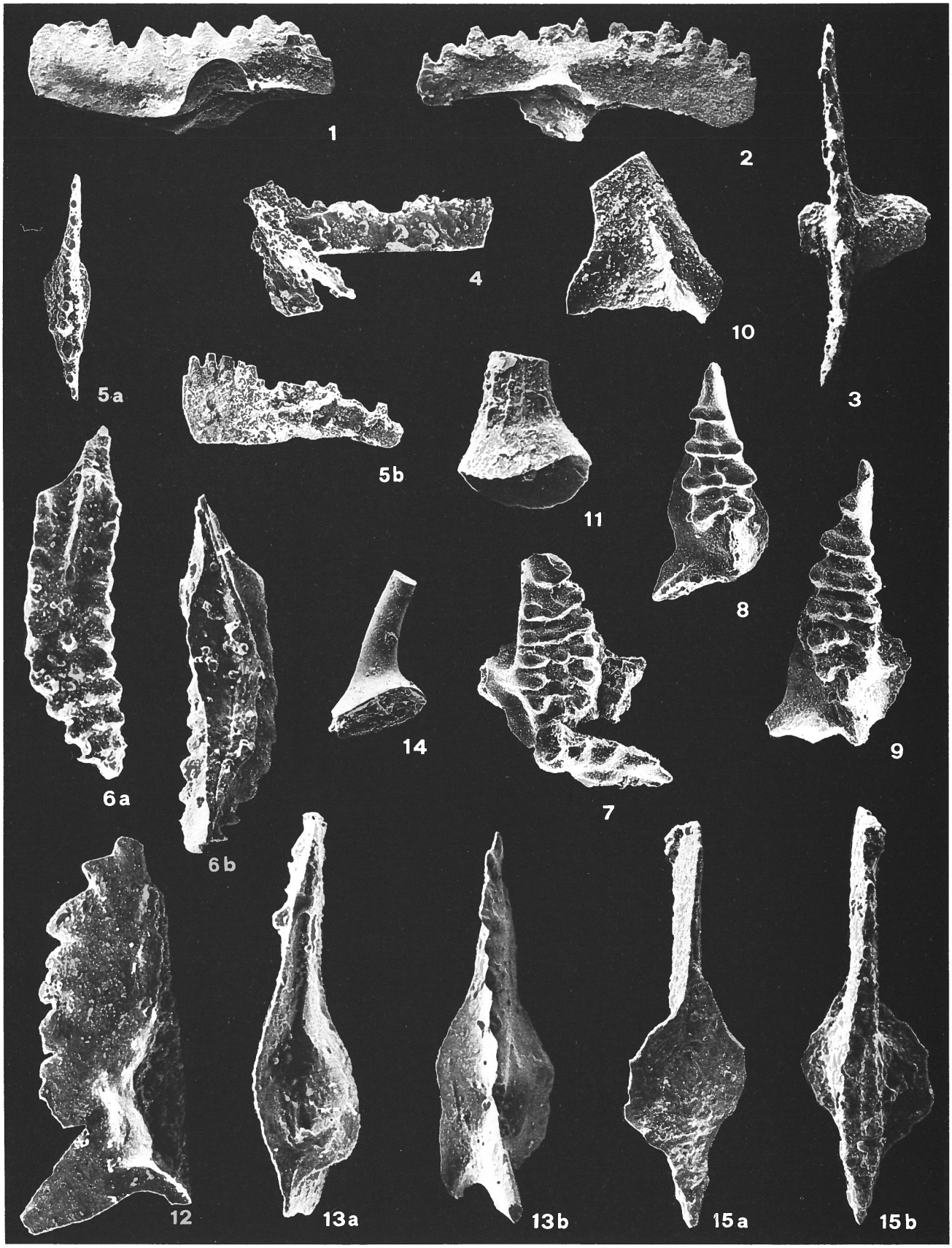
Figs. 2-4 - *Pandorinellina steinhornensis miae* (Bultynck). 2, hypotype, n. 21264, x 130, lateral view of Pa element, sample D_1; 3, hypotype, n. 21265, x 130, upper view of Pa element, sample D_1; 4, hypotype, n. 21276, x 100, lateral view of Sa element, sample D_1.

Figs. 5-6 - *Polygnathus pireneae* Boersma. 5a-b, hypotype, n. 21283 x 70, upper and lateral views of juvenile specimen, sample D_1; 6a-b, hypotype, n. 21284, x 120, upper and lower views. Adult specimen with broken blade, sample D_1.

Figs. 7-11 - *Icriodus steinachensis* Al-Rawi morphotype β Klapper & Johnson. 7, hypotype, n. 21257, x 45, upper view of I element with broken posterior process, sample B; 8, hypotype, n. 21258, x 70, upper view of I element. Juvenile specimen, sample B; 9, hypotype, n. 21529, x 60, upper view of I element, sample B; 10, hypotype, n. 21261, x 175, outer lateral view of S_2 element, sample B; 11, hypotype, n. 21263, x 175, lateral view of M_2 element, sample B.

Figs. 12-14 - *Pelekysgnathus serratus* n. ssp. A Carls. 12, hypotype, n, 21278, x 120, lateral view of I element, sample B_1; 13a-b, hypotype, n. 21279, x 120, inner and upper views of I element, sample B; 14, hypotype, n. 21282, x 90, lateral view of M_2 element, sample B.

Fig. 15a-b - *Eognathodus sulcatus kindlei* Lane & Ormiston. Hypotype, n. 21256, x 120, a, inner and b, upper views, sample D.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Genus ICRIODUS Branson & Mehl, 1938

Type-species — *Icriodus expansus* Branson & Mehl, 1938.

ICRIODUS STEINACHENSIS Al-Rawi, 1977
morphotype β *sensu* Klapper & Johnson, 1980
Pl. 1, figs. 7-11

1980 *Icriodus steinachensis* Al-Rawi - KLAPPER & JOHNSON, p. 448, pl. 2, figs. 19-22, tab. 4, (*cum syn.*).

Remarks — Klapper & Johnson (1980, p. 407) distinguish two morphotypes, η and β, based on the position of the widest part of spindle and assign to them a different range.

Except for slightly more rounded nodes in the middle row towards the posterior end, the specimens figured here are identical to those figured by Klapper & Johnson (1980, pl. 2, figs. 19-22) as *I. steinachensis* morphotype β. Recently, Murphy & Cebecioglu (1984) in a statistical study assert that *I. steinachensis* morphotype β is a variant within the *steinachensis* lineages and that η and β morphotypes have the same range. Therefore, it is not biostratigraphically useful to distinguish two morphotypes. In accord with Klapper & Johnson, I consider β morphotype important biostratigraphically.

Acodinan elements (S_2, terminology of Klapper & Philip, 1971; 1972) associated with *I. steinachensis* morphotype β have strongly developed anterior and posterior keels. An outer lateral costa is well developed in some of these S_2 elements with the triangular base.

The only specimen of M_2 element associated with *I. steinachensis* morphotype β is a simple cone with an elliptical base. Fine striations on the surface are present.

Range — *sulcatus* Zone - *kindlei* Zone (Klapper & Johnson 1980, tab. 4).

Material — 9 (I), 4 (S_2), 1 (M_2) elements.

Repository — Institute of Paleontology, Modena University, Micropaleontological Collection n. 21257-21259 (figured hypotypes of I elements), 21260 (hypotypes not figured of I elements), 21261 (figured hypotype of S_2 element), 21262 (hypotypes not figured of S_2 elements), 21263 (figured hypotype of M_2 element).

Genus PANDORINELLINA (Müller & Müller, 1957)

Type-species — *Pandorina insita* Stauffer, 1940.

PANDORINELLINA STEINHORNENSIS MIAE
(Bultynck, 1971)
Pl. 1, figs. 2-4

1980 *Pandorinellina steinhornensis miae* Bultynck - KLAPPER & JOHNSON, p. 451, tab. 5 (*cum syn.*).

Remarks — *Pandorinellina s. miae* is distinguished from the nominate subspecies by both the position and shape of the lobes. In fact, the lobes of *P. s. miae* have a less distinctly heartshaped outline, and they are more developed perpendicularly to the blade than in the typical subspecies. Furthermore, they are commonly located more anteriorly and do not reach the posterior end. There is no distinctly high denticle at mid-length. In general the Corti Baccas collections display morphologies like those of Bultynck's type collection.

In most specimens, however, the lower margin inclines downwards anteriorly so that the anterior end is the lowest point (pl. 1, fig. 2). In Corti Baccas material Sa element is replaced by a diplodellan element.

P. s. miae occurs in sample D together with *E. s. kindlei* and in sample D_1 with *Polygnathus pireneae*. This might represent a downward extension of the range of this species.

Range — ? *kindlei* Zone - *gronbergi* Zone (Klapper & Johnson 1980, tab. 5).

Material — 40 (Pa), 19 (Pb), 4 (M), 10 (Sc), 2 (Sa) elements.

Repository — Institute of Paleontology, Modena University, Micropaleontological Collection n. 21264-21265 (figured hypotypes of Pa elements), 21266-21268 (hypotypes not figured of Pa elements), 21269-21271 (hypotypes not figured of Pb elements), 21272-21273 (hypotypes not figured of M elements), 21274-21275 (hypotypes not figured of Sc elements), 21276 (figured hypotype of Sa element), 21277 (hypotype not figured of Sa element).

Genus PELEKYSGNATHUS Thomas, 1949

Type-species — *Pelekysgnathus inclinatus* Thomas, 1949.

PELEKYSGNATHUS SERRATUS n. ssp. A Carls, 1969
Pl. 1, figs. 12-14

1969 *Pelekysgnathus serratus* n. ssp. A CARLS, p. 337, pl. 2, figs. 3-4, 11-15.
1977 *Pelekysgnathus serratus* n. ssp. A Carls - AL-RAWI, p. 35.

Description — Specimens with short and high blade. They are characterized by a longitudinal row of about 6-9 denticles anterior to the cusp. The upper margin, in lateral view, is moderately arched whereas the lower one is straight or slightly convex. The denticles are compressed laterally and inclined posteriorly. The cusp or principal denticle is distinctly higher than the other denticles and compressed laterally. It is strongly inclined posteriorly and slightly reclined on the outer side. On the cusp, a prominent ridge extends from the tip downward to the lower margin. Between the cusp and last denticle a triangular cut is present.

The basal cavity tends to be uniformly very narrow in the anterior half and expands asymmetrically posteriorly. It narrows abruptly before reaching the posterior end.

The M_2 element is a unornamented cone with a circular basal cavity. It is closely to the M_2 element of *Icriodus angustoides alcoleae* Carls.

Remarks — Carls (1969, p. 337) reported this subspecies from Guadarrama in Spain. *Pelekysgnathus serratus* n. ssp. A differs from *Pelekysgnathus serratus elatus* Carls & Gandl in having only one principal denticle.

Bultynck (1976, p. 59) regards the two subspecies as synonyms. I think that the major difference between the two subspecies is in the shape of the basal cavity.

Range — *sulcatus* Zone - *kindlei* Zone.

Material — 11 (I), 1 (M_2) elements.

Repository — Institute of Paleontology, Modena University, Micropaleontological Collection n. 21278-21279 (figured hypotypes of I elements), 21280-21281 (hypotypes not figured of I elements), 21282 (figured typotype of M_2 element).

Genus POLYGNATHUS Hinde, 1879

Type-species — *Polygnathus dubius* Hinde, 1879.

POLYGNATHUS PIRENEAE Boersma, 1974

Pl. 1, figs. 5-6

1980 *Polygnathus pireneae* Boersma - KLAPPER & JOHNSON, p. 454, tabs. 4-5, (*cum syn.*).
1981 *Polygnathus pireneae* Boersma - OLIVIERI, MASTANDREA & SERPAGLI, p. 5, tab. 2.
1982 *Polygnathus pireneae* Boersma - GNOLI, MASTANDREA & OLIVIERI, p. 331.

Description — A species of *Polygnathus* with a slender platform, pointed posteriorly and curved sideways and downward. The platform is ornamented with lateral nodes parallel to the carina in the juvenile specimens. Generally in these latter the carina is elevated above the lateral nodes. In adult specimens the nodes are replaced by a short ridge perpendicular to the carina.

The free blade is high and the denticles are partly fused. A large basal cavity occupies the whole area under the platform in juvenile specimens and is more restricted in adult specimens.

Remarks — All the adult specimens of *P. pireneae* from Corti Baccas have a broken blade, however, the diagnostic characters for definitive assignment are present. The examined specimens are closely similar if not identical to *P. pireneae* which occur in the Central Pyrenees, as illustrated by Boersma (1974).

P. pireneae is the oldest known species of *Polygnathus* and its appearance defines the base of the *pireneae* Zone.

Range — *pireneae* Zone - *dehiscens* Zone (Lane & Ormiston 1979, tab. 1).

Material — 6 specimens.

Repository — Institute of Paleontology. Modena University, Micropaleontological Collection n. 21283-21284 (figured hypotype), 21285 (hypotype not figured).

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