Riv. It. Paleont. Strat.	v. 98	n. 1	pp. 3-28	tav. 1-3	Giugno 1992

LARDAROCERAS GEN. N., A NEW LATE ANISIAN AMMONOID GENUS FROM THE PREZZO LIMESTONE (SOUTHERN ALPS)

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Key-words: Ammonoidea, Ceratitaceae, Taxonomy, Biostratigraphy, Anisian, Southern Alps, Italy.

Riassunto. Viene istituito il nuovo genere *Lardaroceras* sulla base di Ammoniti raccolti negli ultimi metri del Calcare di Prezzo (Anisico), in diverse sezioni stratigrafiche. Il nuovo genere comprende due nuove specie, *L. krystyni* (specie tipo) e *L. pseudohungaricum*; inoltre una terza specie viene lasciata in nomenclatura aperta. Al genere appartengono Ceratitidi involuti e compressi, con sezione del giro subtrapezoidale caratterizzata da un netto margine periombelicale e da un ventre con carena arrotondata. L' ornamentazione è costituita da nodi ombelicali e lateroventrali, cui si aggiungono talora nodi laterali, e da coste primarie, biforcate e intercalari debolmente proverse e sinuose. La linea di sutura, molto caratteristica, è subammonitica. Le maggiori differenze tra le due specie sono date dall' ornamentazione e dalla camera di abitazione dell' individuo adulto: in *L. krystyni* sono presenti solo nodi ombelicali e lateroventrali e l' ornamentazione si riduce notevolmente sulla camera di abitazione; in *L. pseudohungaricum* sono presenti anche nodi laterali e l' ornamentazione si irrobustisce notevolmente alla fine della crescita. Sulla base della linea di sutura il nuovo genere viene inserito nella sottofamiglia *Beyrichitinae*. Viene inoltre discussa la posizione stratigrafica del nuovo genere.

Abstract. On the basis of ammonoids collected in the uppermost part of the Prezzo Limestone (Anisian), the new genus *Lardaroceras* and two new species *L. krystyni* (type species) and *L. pseudohungaricum* are described; a third one is left in open nomenclature. The genus *Lardaroceras* comprises involute and compressed ceratitids, whose subtrapezoidal whorl section is characterized by an evident periumbilical margin and a rounded ventral keel. The ornamentation is made of umbilical and lateroventral nodes, to which sometimes lateral nodes are added, and of lightly proverse and sinuous, primary, intercalatory and bifurcate ribs. The very distinctive suture line is subammonitic. The two species, *L. krystyni* and *L. pseudohungaricum*, differ mainly in the ornamentation and in the adult body chamber: the former has umbilical and lateroventral nodes and its ornamentation fades on the adult body chamber, the latter has also lateral nodes and its ornamentation strengthens in the latest stage of growth. Because of the suture line the genus is attributed to the subfamily *Beyrichitinae*. The stratigraphic significance of the new genus is also discussed.

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- Financial support was provided by MURST 40% "Biostratigrafia e Paleobiogeografia del Permiano e Triassico".

Introduction.

The Prezzo Limestone is a Middle Triassic (Anisian) Southern alpine formation well-known for its fossil content. The taxonomic groups, as referred to in the literature since last century, are ammonoids, nautiloids, bivalves, gastropods, brachiopods and conodonts. Among them ammonoids are the most important for both the number of species and individuals reported.

The first sure discovery of ammonoids in this unit is that by Benecke (1866), since then many Authors collected or described ammonoid specimens (Mojsisovics, 1880, 1882; Bittner, 1881, 1883; Varisco, 1881; Tommasi, 1894, 1901, 1913; Arthaber, 1896; Cosjin, 1928; Voelcker, 1931; Riedel, 1949; Sacchi Vialli & Vai, 1958; Assereto, 1963; Assereto & Casati, 1965, 1966; Casati & Gnaccolini, 1967; Venzo & Pelosio, 1968; Gaetani, 1969, 1979 in Jadoul et. al.; Brack & Rieber, 1986). Mainly because of the interest that the mitteleuropean scientists have shown in the Prezzo Limestone over the last century, this unusual fossil record has played an important role in the history of Middle Triassic ammonoids taxonomy and stratigraphy: some species have been described for the first time from this formation, and bio-cronostratigraphic units as the Trinodosus Zone (Mojsisovics, 1882) and the Illyrian substage of the Anisian (Pia, 1930), based on this zone, were introduced on faunas that were also recognized in this formation.

Despite the great number of papers, the information on the vertical distributions of the species is scarce: only general indications (Gaetani, 1969) or extremely punctiform information (Gaetani in Jadoul et al., 1979; Brack & Rieber, 1986) are available.

The purpose of the writer since 1986 has been the filling of this lack of knowledge with large bed-by-bed collections, at first as undergraduate (Balini, 1987), then as phD student. Firstly the most important ammonoid bearing beds have been singled out (Balini in Kovacs et al., 1990), while secondly specific taxonomical analyses have been worked out.

Stratigraphical frame.

The Prezzo Limestone (Rosenberg, 1962; Assereto & Casati, 1965) is a lithostratigraphic unit that crops out between the eastern side of Como Lake and the Giudicarie. It is made of dark grey marly limestones in 20-30 centimetres thick beds, alternating with dark grey marls and black shales in 20-50 centimetres thick beds, for a global thickness of 80 meters in the Giudicarie, the type area. The formation overlies the Angolo Limestone or the heteropic units of Camorelli Limestone and Dosso dei Morti Limestone; it is generally overlain by the Buchenstein Formation (for more details see Gaetani, 1970).

In the Giudicarie the unit is not homogeneously rich in ammonoids and, according to Gaetani (1969), two faunas with stratigraphical differentiations are distinguishable: an older one in the transition between Dosso dei Morti Limestone or Angolo

Limestone and Prezzo Limestone, characterized by *Bulogites*, *Paraceratites* and *Beyrichites*, and a younger one about 50 meters above, present in the upper 30 meters of the formation, characterized by *Judicarites*, *Paraceratites*, *Semiornites* and *Flexoptychites*. Traditionally the first fauna is referred to the Binodosus Zone while the second is referred to the Trinodosus Zone. Thus, on the basis of the ammonoids, the age of the unit is Late Pelsonian-Illyrian.

Studied sections.

The specimens described in this report have been collected by the writer in the uppermost beds of the formation in 4 localities in the Camonica Valley and the Giudicarie (Fig. 1):

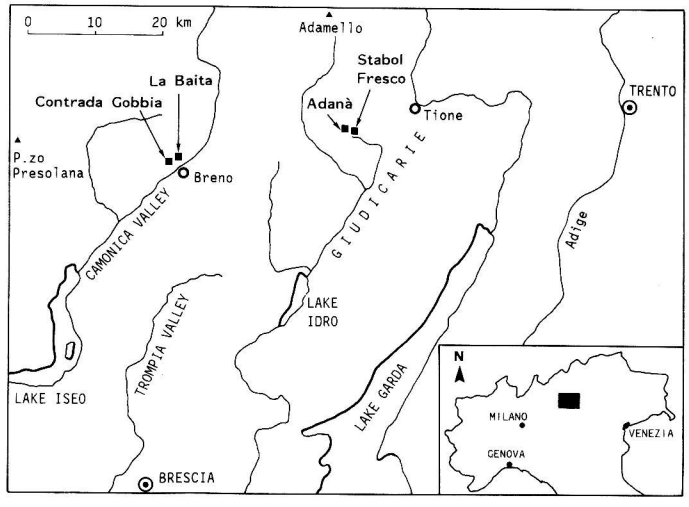

Fig. 1 - Ubication of the localities studied.

- Contrada Gobbia and La Baita sections (Fig. 2) are part of the classical Triassic Annunciata composite section near Breno (Assereto, 1963; Assereto & Casati, 1965; Jadoul et al., 1979). The outcrop conditions are similar in the two localities, some hundreds of meters apart: only the uppermost beds of the formation are exposed on the upstream of the road.

- Stabol Fresco composite section corresponds to the upper part of the section suggested by Gaetani (1970) as a reference for the unit: the section is composed of 2 segments partially overlapping (Kovacs et al., 1990, fig. 12), in the present paper only the uppermost part is shown in Fig. 2.

- Adanà section is located about 400 metres westward of the previous section, on the same side of the river Adanà. In Fig. 2 only the latest beds are shown; the whole section is laterally equivalent to Stabol Fresco II (cf. Kovacs et al., 1990, fig. 12).

Distribution of ammonoids in the sections.

The field works carried out show that the ammonoid vertical range is very restricted, while their horizontal distribution is fairly wide: practically most of the beds possesses a "personality" due to the genera and/or species and/or dominance of genera contained in it, that makes the bed distinguishable from those immediately above and below; moreover such "personalities" do not seem to change laterally notably, at least between the Camonica Valley and the Giudicarie, that is at a distance of 35 kilometres. In the uppermost meters of the formation such a pattern of distribution is well represented by the following locally recognized biohorizon, from bottom to top (Fig. 2) (not all the beds have been sampled because of the steepness of the outcrops):

1) one bed yielding an association dominated by *Bulogites* and *Reiflingites* (sensu Assereto, 1963), with rare *Paraceratites*, *Flexoptychites* and *Lardaroceras* (only one specimen): levels CG5=BT1=AD104=SF105A;

2) one lenticular level, yielding mainly *Lardaroceras krystyni* sp. n. and *Flexoptychites* with very rare *Bulogites* and *Reiflingites* (sensu Assereto, 1963): AD105=SF106A, here named *krystyni* biohorizon;

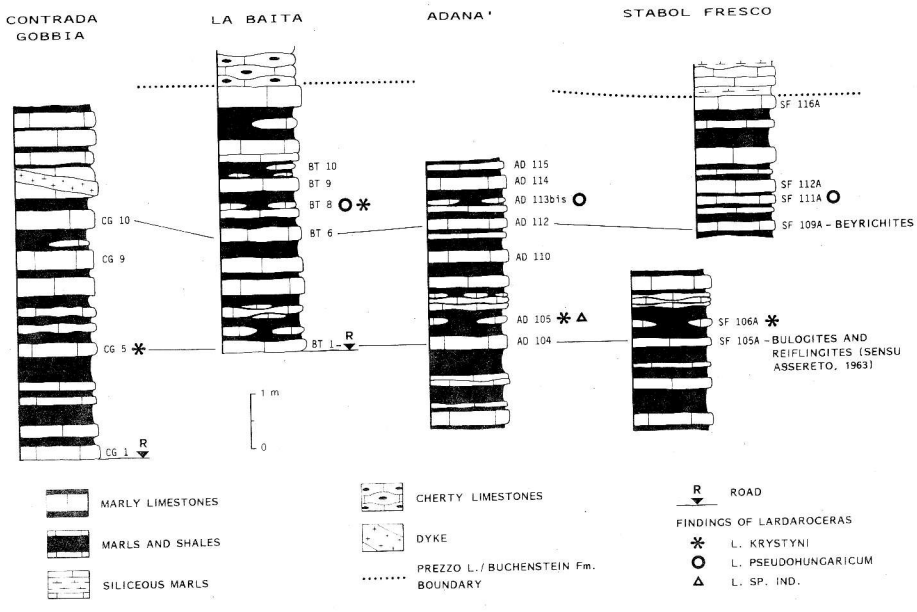

Fig. 2 - Lithostratigraphic sections of the localities studied with some of the biostratigraphic correlations. Note: in each section each bed has been distinguished, measured and labelled (i.e. CG5) with an abbreviation denoting the locality (i.e. CG) followed by a progressive number given according to the stratigraphic order (i.e. 5). Only some of the labels are shown in the figure.

3) one bed characterized by an association dominated by *Flexoptychites* and *Ceratitidae* gen. ind. sp. 1: CG9=AD110;

4) one bed yielding fauna with abundant *Beyrichites beneckei* (Mojsisovics, 1882): CG10=BT6=AD112=SF109A;

5) one bed sometimes fading into laid up lenses, with *Flexoptychites* and *Lardaroceras pseudohungaricum* sp. n.: BT8=AD113bis=SF111A, here named *pseudohungaricum* biohorizon;

- one bed almost everywhere barren: BT9=AD114=SF112A;

6) one bed containing *Ceratitidae* gen. ind. sp. 2: BT10=AD115.

Biostratigraphy.

In Kovacs, Nicora, Szabo and Balini (1990) the writer recognized the following distributions of ceratitids in the last 30 meters of the Prezzo Limestone (Kovacs et al., 1990, fig. 12 and 14): a fauna with transitional forms from *binodosus* to *trinodosus*

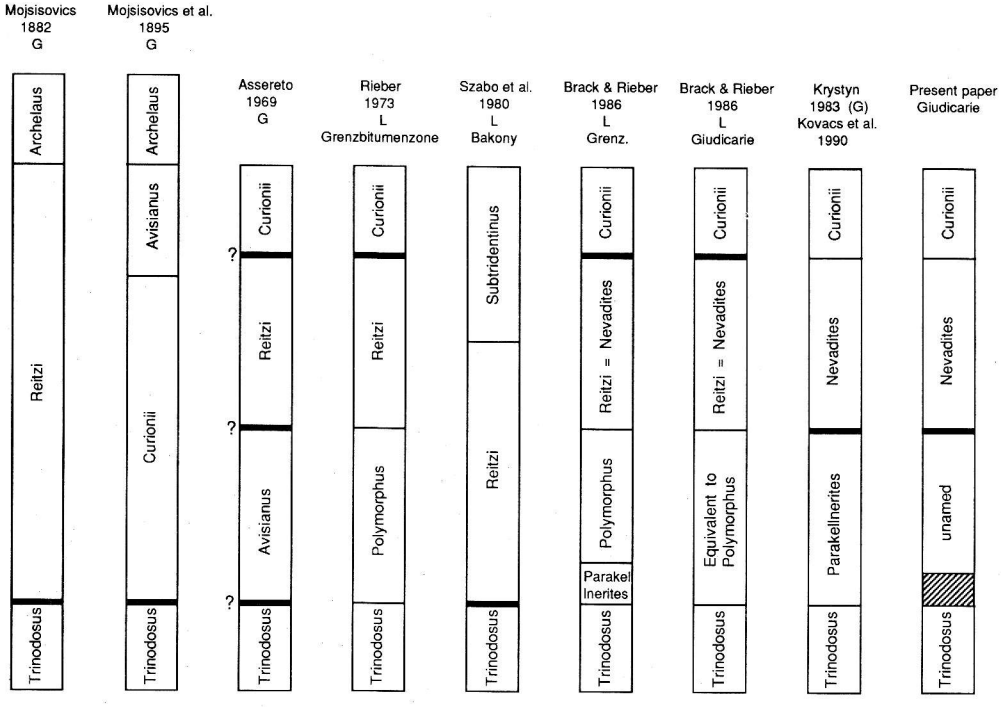

Fig. 3 - Main steps in the history of Illyrian-Lower Ladinian biostratigraphic scale, based on ammonoids, in Western Thetys.
G) General scale; L) local scale; heavy line) suggested Anisian/Ladinian boundary; striped area) position of *Lardaroceras* beds.
Note: Assereto (1969) suggested a general scale extrapolating, often on the basis of indirect correlations, the local Avisianus Zone.

above the *Judicarites* bed (SF86), then a typical *trinodosus* assemblage (SF97A), a bed with *Reiflingites* (CG5=BT1=SF105A) and the appearance of the genus *Parakellnerites* with *Parakellnerites hungaricus* and *Parakellnerites* sp. (BT6, BT8=SF111A). At that time, under these considerations the application and thus the support of Krystyn's stratigraphycal scale (Krystyn in Zapfe, 1983; Krystyn, 1983) (Fig. 3) was easy: level SF97A was referred to the Trinodosus Zone and beds yielding *Parakellnerites* were referred to the Parakellnerites Zone; the intermediate bed with *Reiflingites* remained in an uncertain attribution.

Although, at present, the taxonomical analysis of the whole collection has not yet been concluded, new collections and refinements in the data interpretation lead to modify also the biostratigraphic interpretation.

After the direct comparisons with original collections, particularly with that of Rieber (1973) from the Grenzbitumenzone, the taxonomical position of the formerly *Parakellnerites* sp. and *P. hungaricus* is modified in *Ceratitidae* gen. ind. sp. 1 and *Lardaroceras pseudohungaricum* sp. n.

New dense samplings, mainly in the Adanà section, allow to specify the general distribution of ceratitids. The "*Ceratites abichi*" bed (SF92=SF85A=AD80, not shown in Fig. 2) still contains ceratitids morphologically very similar to the Mojsisovics' *binodosus* group (1882). The interval between the "*C. abichi*" and the "*Reiflingites*" beds, the latter included, is characterized by very variable assemblages containing, often with low dominance, *Paraceratites* or very close ceratitids (trituberculate with subtrapezoidal whorl section and roundly elevated ventral side). The beds above the "*Reiflingites*" level yield (except for a single doubtful *Paraceratites* two beds above SF105A) *Lardaroceras* and other ceratitids, different from the *Paraceratites* type: they are bigger, more compressed and more evidently keeled.

These changes in the data reflect in part on the biostratigraphic classification.

On the basis of the occurrence of *Paraceratites* and similar ceratitids, the interval between the "*C. abichi*" and "*Reiflingites*" beds is surely referred to the Trinodosus Zone, with upper boundary in the "*Reiflingites*" bed or immediately above.

The overlying beds as far as the *pseudohungaricum* biohorizon, here informally named *Lardaroceras* beds, have an uncertain attribution. The denial of *Parakellnerites* findings does not allow any direct correlation of the *Lardaroceras* beds with the Polymorphus Zone (Rieber, 1973) of whom *Parakellnerites* is typical; and the possibility to demonstrate, in the Giudicarie and the Camonica Valley, the direct overlap of the Polymorphus Zone on the Trinodosus Zone fails. At present, the new taxa here established are unknown out of the studied area, thus preventing from making direct correlations with other Upper Anisian local zones as the Avisianus Zone (sensu Assereto, 1969) and the Reitzi Zone (Mojsisovics, 1882, partim).

On the other hand it does not seem suitable to the writer the correlation with the Parakellnerites Zone because it has been conceived (Krystyn, 1983) to include several local zones that cannot definitely be correlated because they were found in different localities and based on different faunas probably controlled by facies: the

Polymorphus Zone (Ticino, Switzerland) is related to a restricted basin very close to a carbonate platform and in its type area, the only one where it has been recognized, no other faunas are preserved below; the Avisianus Zone (Forno and Marmolada, Dolomites) is related to a carbonate platform and it is based on a fauna which, till now, was only found in the serac; the never formally defined *Kellnerites* Zone (Krystyn manuscript in Krystyn, 1983) is related to a condensed "Ammonitico Rosso" facies (Han Bulog, Bosnia); the Reitzi Zone (type area: Balaton highland) is strictly related to the Buchenstein facies and, in the sense of Mojsisovics (1882) as considered by Krystyn, it comprises genera (i.e. *Eoprotrachyceras*) younger than those typical of the Polymorphus and the Kellnerites Zones.

Some very indirect elements of relations are provided by the biostratigraphic position of the species showing morphological similarities to *Lardaroceras krystyni* and *L. pseudohungaricum*: of the 5 species discussed below only one (*Ceratites beyrichi* Mojsisovics, 1882) is typical of the Trinodosus Zone, one was reported from the Reitzi Zone (*Ceratites hungaricus* Mojsisovics, 1882), two were reported from the Kellnerites or from the Nevadites Zones (*Ceratites lenis* Hauer, 1896 and *Ceratites evolvens* Hauer, 1887) and one (*Ceratites inconstans* Reis, 1901), found in the Wetterstein Kalk, is of Late Anisian?-Ladinian age. Therefore, notwithstanding the biostratigraphic value of these comparisons is feeble, there exist a suggestion to consider the *Lardaroceras* beds younger than the Trinodosus Zone.

Concluding, the writer separates the *Lardaroceras* beds from the sure Trinodosus Zone, but prefers leaving them in an open nomenclature status as far as a biostratigraphical zonation is concerned.

Systematic descriptions (1)

(1) General indications.

Taxonomy. The writer refers to Tozer (1981) for the family group taxonomy. The discussions on the species will be more detailed than on the genus because most of the species were neither well described (often the type series are heterogeneous) nor revised. Only part of those that have been attributed to the basket genus *Ceratites* since last century, find place in the existing genera.

Identification of specimens. The first number indicates the inventory number of the specimen; the original number given by the writer reporting section, bed number and number of the specimen, is indicated in brackets.

Description of the sutures. The sutures are usually exposed between the venter and the periumbilical margin, thus the real number of the elements and the ontogenesis of suture are unknown. The elements of the suture are numbered starting from the venter: ventral lobe (E), 1st saddle, lateral lobe (L) or 1st lobe, 2nd saddle, 2nd lobe, 3rd saddle etc. The term auxiliary elements is sometimes used to indicate in general the elements nearer to the periumbilical margin.

Suture drawing. Conventions: the short dashed line indicates the parts of the suture where the recrystallization masks the very details, dashed line indicates the lateroventral and periumbilical margins and black dots indicate the position of the lateroventral nodes.

Dimensions. Abbreviations: D=diameter; H=max. whorl height in D; h=min. whorl height in D; U=umbilical width in D; W=whorl width in H; w=whorl width in h; SGR=spiral growth rate=((H-h)/h)x 100.

Order Ceratitida Hyatt, 1884

Superfamily *Ceratitaceae* Mojsisovics, 1879

Family *Ceratitidae* Mojsisovics, 1879

Subfamily *Beyrichitinae* Spath, 1934

Genus **Lardaroceras** gen. n.

Type species *Lardaroceras krystyni* sp. n.

Derivatio nominis. From the small village of Lardaro (Trento), on which territory the Stabol Fresco grazing zone is situated, and the Greek *keras-atos* (=horn), neuter substantive.

Diagnosis.

Involuted and compressed ceratitids from a medium to a big size with relatively small umbilicus and subtrapezoidal to slightly subrectangular whorl section. The subvertical umbilical wall is distinct from the side by an evident rounded periumbilical margin, and the ventral side has a variably elevated median part usually having the aspect of a rounded keel separated from the shoulders.

The ornamentation of the phragmocone is represented by very weak to weak, slightly proverse and sinuous primary, bifurcated and intercalatory ribs associated with umbilical, lateroventral and sometimes lateral nodes. The ribbing fades gradually from the periumbilical margin to the middle of the side, then it comes out approaching the shoulder: the primary ribs start at the umbilical nodes then they bifurcate in the same position where the intercalatory ribs appear. The umbilical rounded nodes usually stick out towards the umbilicus and, sometimes, outward. The lateroventral nodes, each one representing the external termination of one rib, are asymmetrical (the fore side is less steep than the hind) and lightly sloping on the venter, nevertheless they do not continue on the ventral side. The lateral nodes, when present, are located on the bifurcation point of the primary ribs. On the mature body chamber the ornamentation may weaken or strengthen depending on the species.

The very distinctive subammonitic suture line shows four lobes on the whorl side, three denticulated and one simple and deep. Its characteristic elements are: well developed and relatively frequent denticles between the ventral lobe (E) and the 1st saddle; weak denticles on the respectively internal side of the 1st saddle and external side of the 2nd saddle; 3rd saddle often entire; 3rd lobe asymmetric, with more denticles on its external side; 4th lobe simple and V-shaped.

Composition of the genus: *Lardaroceras krystyni* sp. n., *L. pseudohungaricum* sp. n., *L.* sp. ind.

Remarks. The writer does not include in the diagnosis of the genus some morphological features, common to its species, that have been thought without taxonomical significance on the generic rank. Because of the notable lack of data on Middle Triassic ammonoid sutures, such a similar discrimination cannot be made on them. Thus, all common features of the sutures of *L. krystyni*, *L. pseudohungaricum* and *L.* sp.

ind. have been taken into consideration. It cannot be excluded that future populationistic and/or phylogenetic analyses will refine this important character of the genus.

The classification of the sutures of the genus is not simple because of both their individual variability and the sometimes confused terminology in common use. According to the writer they are usually more frilled with respect to the typical ceratitic type, but a little less denticulated with respect to other more common intermediate forms between the ceratitic and ammonitic types. To indicate these intermediate forms several terms, sometimes not very well defined, have been suggested: subammonitic, sub-ceratitic (Spath, 1934) and semiammonitic (Krystyn & Tatzreiter, 1991). The first term ("subammonitc") is preferred because it is widely used; "sub-ceratitic" is rejected because it is used with different, probably more suitable, meaning (intermediate form between goniatitic and ceratitic types, example Bucher, 1988); and "semiammonitic" is not utilized because it refers exactly to suture lines with highly denticulated saddles but with entire tops.

Discussion. *Lardaroceras* is easy distinguishable from the existing triassic genera because it combines morphology with suture line that usually are not associated.

The morphology of *Lardaroceras* can be compared with members of the subfamily *Paraceratitinae* (family *Ceratitidae*), such as *Parakellnerites* Rieber, 1973, *Paraceratites* Hyatt, 1900 and *Eudiscoceras* Hyatt, 1877, or with representatives of the family *Hungaritidae* such as *Hungarites* Mojsisovics, 1879 and *Paraceratitoides* Parnes, 1975.

Parakellnerites is similar to *Lardaroceras* in the general shell shape (i. e. dimensions, involuteness, umbilical width, partly in the ornamentation) while there are clear differences in the details of the whorl section: an evident periumbilical margin never exists (the side slopes down gradually towards the umbilical suture) so the section is sometimes suboval, and it is more strongly keeled than *Lardaroceras. Paraceratites* is smaller, its shell has a different coiling with a higher spiral growth rate (SGR), its ornamentation is always trituberculate with the same number of umbilical and lateral nodes, except for the type species *P. elegans* (Mojsisovics, 1882) and last but not least, its suture line is ceratitic. The poorly known *Eudiscoceras* seems to have a narrower and a sharper keel, and clavi on the lateroventral margin. *Hungarites* differs because it is more evidently keeled, usually smooth and it has a ceratitic suture with more rounded outline of the saddles. *Paraceratitoides* has a narrower and sharper keel on a tabulated venter, ornamentation with ribs, only lateral and lateroventral nodes and suture line ceratitic sometimes with fewer elements.

From the suture line point of view, *Lardaroceras* is closer to the genera belonging to the subfamily *Beyrichitinae*, but the morphology is different: even the less different *Frechites* Smith, 1932 and *Parafrechites* Silberling & Nichols, 1982 are far from *Lardaroceras* in the less compressed and sometimes semioval whorl section, in the ventral side (the rounded keel is not separated from the end of the ribs) and in the regularly strong ornamentation.

As result from these comparisons, the final attribution of the new genus to a family group taxon is not univocal. A decision can be taken on the basis of the following considerations:

a) usually in ammonoid taxonomy the suture is more important than the morphology.

b) The taxonomical architecture of the superfamily *Ceratitaceae* is almost completely artificially predefined because a phylogenetical analysis exists neither of the whole superfamily nor of its elements, except for the germanic Muschelkalk ceratitids (Urlichs & Mundlos, 1980 and 1987).

c) The morphology and the weak denticulated suture of *Lardaroceras* suggest a close phylogenetical relation, as ancestor or descendant, with forms with ceratitic suture. At present, considering that *L. pseudohungaricum* is younger with respect to the main development of *L. krystyni* and that it apparently shows more simplified suture, the first relation is favoured.

In conclusion, the writer agrees to provisionally attribute *Lardaroceras* to the subfamily *Beyrichitinae* on the basis of the suture line. The subfamily *Paraceratitinae* is unwrapped because it comprises genera with ceratitic suture, although they are similar in the morphology. The family *Hungaritidae* is not considered because it comprises genera more keeled with ceratitic suture.

Age. Illyrian (Middle Triassic).

Lardaroceras krystyni sp. n.

Pl. 1, fig.1-5; Text-fig. 4A, 5A-E

Derivatio nominis. This species is dedicated to Leopold Krystyn (University of Vienna) for his valuable advice and encouragements.

Type series. Holotype: N. 6627 (AD105-1) (Pl. 1, fig. 4a-c). Paratypes (15 specimens): N. 6628 (SF106A-41), N. 6629 (SF106A-25), N. 6630 (SF106A-30), N. 6631 (AD105-6), N. 6632 (SF106A-40), N. 6633 (AD105-2/3/4/15/18), N. 6634 (SF106A-27/46/48), N. 6635 (CG5-108), N. 6636 (BT8-10).

Stratum typicum. Prezzo Limestone, *krystyni* biohorizon (Illyrian).

Locus typicus. Adanà section, Bondone Valley, Giudicarie.

Collocation. Museo di Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Milano.

Preservation of the specimens. The shell wall is recrystallized; the body chamber and, sometimes, the younger chambers of the phragmocone are filled up with sediment whereas the remaining part of the phragmocone is filled up with calcitic cements; usually the specimens coming from the AD105 and SF106A levels show a crushing of the body chamber related to sediment compacting.

During preparation the specimens almost completely loose their shell wall.

Diagnosis. *Lardaroceras* with umbilical and lateroventral nodes, the former fading already on the phragmocone. Mature body chamber tending to became smooth.

Description.

Shell geometry. The involute and compressed shell varies a little its geometry during the ontogenesis: the umbilicus becomes widen more slowly than the diameter, thus it seems to relatively narrow during the growth (31%<U/D<18%), the whorl height increases more than the width (H/W varies between 1.35 and 1.70) while the

spiral growth rate (SGR) has constant medium values (about 50%).

Whorl section. It is subtrapezoidal, sometimes slightly semioval, depending on the structure of the ventral side (Fig. 4A). The lateral side, separated from the subvertical umbilical wall and from the ventral side by evident periumbilical and lateroventral margins, is slightly convex and it is almost always inclinated towards the venter. The shape of the venter varies continuously from roundly keeled to rounded: on 13 specimens (3 are crushed) 6 show a rounded keel separated from the shoulders (Pl. 1, fig. 1b, 4c), 4 have a median blunt elevation and 3 have a rounded shouldered venter (Pl. 1, fig. 2b, 5).

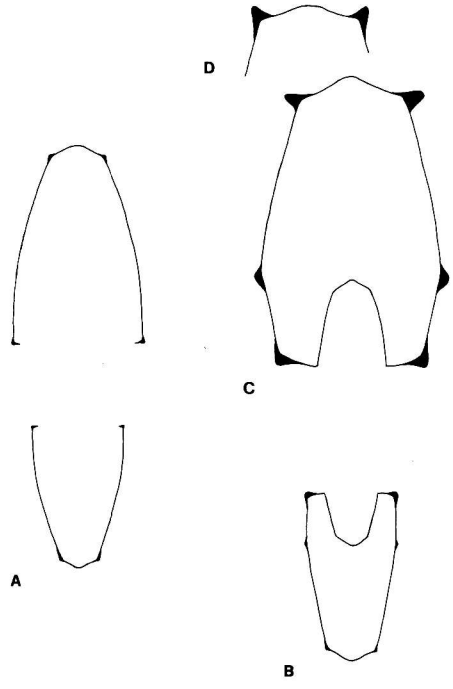

Fig. 4 - Shell sections of *Lardaroceras*. A) *L. krystyni*, holotype, N. 6627 (AD105-1), section of phragmocone (x 1). B) *L. pseudohungaricum*, paratype, N. 6638 (BT8-7), section of phragmocone (x 1). C) Same specimen, section of body chamber about 230° after section B) (x 1). D) *L. pseudohungaricum*, paratype, N. 6641 (AD113bis-1), section of body chamber (x 1).

Ornamentation. The ornamentation is made of radial ribs and two spiral series of nodes. The ribs, bifurcating between 1/3 and 1/2 of the side, the umbilical and lateroventral nodes show the course of typical *Lardaroceras*.

Ontogenetic variations of the ornamentation. During the growth the ornamentation varies lightly. On the extremely inner whorls (Pl. 1, fig. 1a), as far as 6 mm of whorl height, the ornamentation is represented by umbilical inflations similar to

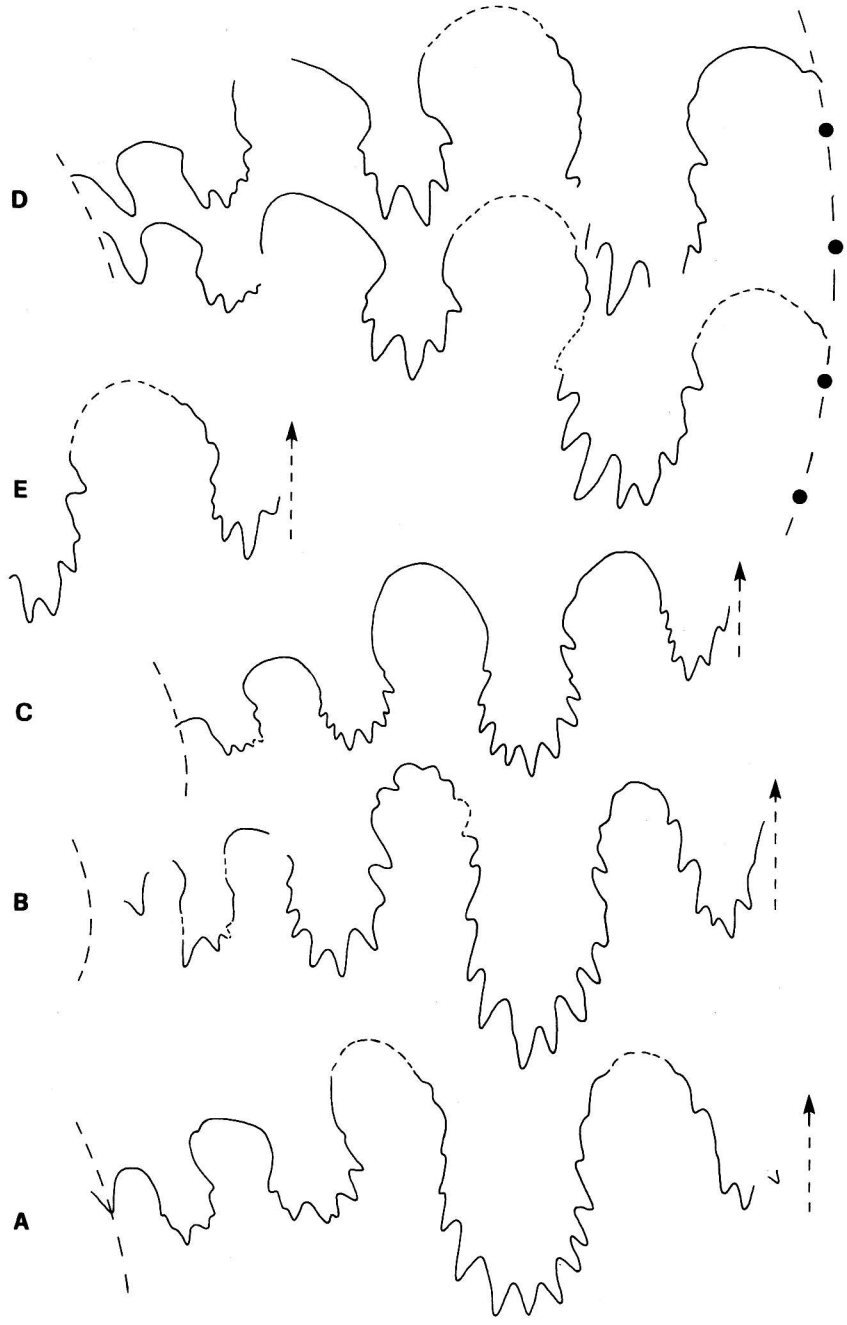

Fig. 5 - Suture lines of *Lardaroceras krystyni*. A) N. 6631 (AD105-6) example of the typical denticulation (x 9). B) N. 6630 (SF106A-30) extreme highly denticulated variant (x 6). C) N. 6629 (SF106A-25) extreme ceratitic variant (x 6). D) Holotype, N. 6627 (AD105-1) (x 4). E) Holotype, restored view of lateroventral saddle and ventral lobe of the first suture figured in D) (x 4).

bullae that vanish on the lateral side; then the radial ribs appear as a consequence of the reduction of the umbilical bullae, and, at the same time, the lateroventral nodes show up. During the following stages of growth the ribbing is constant, while some changes are related to the nodes. The umbilical nodes are constant in number, 6-7 in half a whorl, but gradually, even though there are individual differences, they tend to fade on the last whorl, also before the beginning of the mature body chamber. The lateroventral nodes, on the contrary, are more constant in dimensions and their number in half a whorl increases with the growth: they are 15-16 in small specimens (Pl. 1, fig. 1a, 2a) and 22 (Pl. 1, fig. 4) up to 27 (Pl. 1, fig. 5) in bigger equally sized specimens. It is possible to interpret the increase of individual variability of number of nodes as indirect consequence of the growth of individuals with differently sized lateroventral nodes. During the growth alternations between lateroventral nodes on both sides of the venter rarely appear and disappear, probably because of very small differences in the distance between the ribs on the sides. On the mature body chamber there is a general subduing of the ornamentation: the ribs tend to disappear (Pl. 1, fig. 4a), fading into delicate weak undulations of the shell or bundles of "growth lines"; the umbilical and lateroventral nodes, usually and sometimes respectively already weakened, decrease notably.

Suture line. The degree of complexity of the denticulation varies from specimen to specimen: from ceratitic (Fig. 5C) with entire saddles, to ammonitic (Fig. 5B) with all the saddles denticulated. The most frequent type (Fig. 5A, D, E) has weak denticulations on the internal and external side of the 1st lobe.

Dimensions:

Specimen	D	H	h	U	W	w	SGR%	U/D(%)	H/W
N.6627 (AD105-1)	52.2	24.35	16.9	10.96	13.7	10	44.08	20	1.77
same specimen	47.4	22.8	14.8	9.8	12.7	-	54.05	20	1.79
N.6629 (SF106A-25)	26	10.4	7.2	8.1	-	-	48.68	31	-
N.6630 (SF106A-30)	32.2	14.4	9.35	8.45	9.5	-	54.01	26	1.51
N.6633 (AD105-2)	78.95	38.8	25.7	14.35	-	-	51.36	18	-
N.6635 (CG5-108)	21.4	9.4	6.15	5.85	6.95	-	52.84	27	1.35

Discussion.

Several species are morphologically similar in a broad sense to *L. krystyni* as *Ceratites lenis* Hauer, 1896, *C. beyrichi* Mojsisovics, 1882, *C. inconstans* Reis, 1901, *Hungarites arthaberi* Diener, 1899 and *C. (H.) semiplicatus* Hauer, 1896. Only the first three species are similar enough to hypothesize taxonomical or phylogenetical close relationship.

"*Ceratites*" *lenis* (Hauer, 1896) is similar to *L. krystyni* in general shell shape, whorl section and ornamentation, and also, accepting the three specimens of the pri-

mary series as conspecific, it seems to show similar individual variations in the strengthening of the keel (see original pl. 6, fig. 4,6) and ontogenetic fading of all the elements of ornamentation (pl. 6, fig. 3,5,1). There are similarities in the suture line: the external lobe (E), the external side of the lateral lobe (L) and the third asymmetrical lobe fit very well with *Lardaroceras krystyni*. The differences regard the sometimes sharper keel (pl. 6, fig. 4); the egression of the umbilicus at late ontogenetical stages (in part similar to *L. pseudohungaricum*); the umbilical nodes a little more marked; the primary ribs more evidently dividing at the umbilical node and, in the suture line, the presence of more elements between the fourth saddle and the periumbilical margin.

Another similar species is "*Ceratites*" *beyrichi* (Mojsisovics, 1882): both the original description (pp. 34-35) and the figured specimen (pl. 9, fig. 4) accord with the features of *L. krystyni* except for the suture line that, for "*C.*" *beyrichi*, is ceratitic. Since the denticulation of the saddles of *Lardaroceras* is so weak that it can escape the superficial observer's notice, the writer looked for the type specimens in order to verify personally the suture line (as he did for all the species mentioned in the discussions), but the types of the species were missing, hence the original indications of Mojsisovics must be accepted (1).

Less similar seems to be "*Ceratites*" *inconstans* (Reis, 1901): the bigger specimen (pl. 3, fig. 4,5,6) shows only little differences in the narrower umbilicus and in the also narrower ventral side, but the smaller specimens (pl. 3, fig. 7, 8, 9) are more different, with respect those of the same size as *L. krystyni*, showing different ornamentation in the extremely inner whorl, before 10 mm of whorl height, where only primary ribs fading and widening out on the side are present. No comparisons of suture are possible because, as indicated by Reis (p. 80), in the original specimens it is unknown in the details.

Occurrence. This species is only known in the Prezzo Limestone in the Camonica Valley and the Giudicarie: Contrada Gobbia section (CG5, 1 specimen); La Baita section (BT8, 1 specimen); Adanà section (AD105, 7 specimens); Stabol Fresco section (SF106A, 7 specimens).

Age. Illyrian (Middle Triassic).

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(1) The type series was composed of 5 specimens (Mojsisovics, 1882, p. 35): 1 from Reutte (figured pl. 9, fig. 4, probably the type of the species, at that time deposited at Berlin, in the Museum of the University), corresponding to the specimen previously classified and figured as *Ammonites luganensis* (Merian) by Beyrich (1867; pl. 1, fig. 3), 2 from the Giudicarie and 2 from Lenna (Brembana Valley). During the research carried out in the Institutions of Berlin, Vienna and München, only two specimens with the original Mojsisovics' own hand label "*Ceratites* cf. *Beyrichi* - Sintwag b. Reutte" have been found (München, Bayerische Staatsammlung für Paläontologie). Either, although incomplete, shows morphology corresponding to "*C.*" *beyrichi* and a very well preserved ceratitic suture, therefore it should support the original description. Unfortunately these specimens were not mentioned by Mojsisovics, thus their exact relation with the type series is unknown.

Lardaroceras pseudohungaricum sp. n.

Pl. 2, fig. 1, 2; Pl. 3, fig. 1, 2; Text-fig. 4B-D, 6A-B

Sinonymy.

1990 *Parakellnerites hungaricus* - Balini in Kovacs et. al., p. 182, 184.

Derivatio nominis. The name has been chosen because of the resemblance with *Ceratites hungaricus* Mojsisovics, 1882.

Type series. Holotype: N. 6637 (BT8-5) (Pl. 2, fig. 1a-c). Paratypes (5 specimens): N. 6638 (BT8-7), N. 6639 (SF111A-1), N. 6640 (BT8-28), N. 6641 (AD113bis-1), N. 6642 (SF111A-17).

Stratum typicum. Prezzo Limestone, *pseudohungaricum* biohorizon (Illyrian).

Locus typicus. La Baita section near Breno (Camonica Valley).

Collocation. Museo di Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Milano.

Preservation of the specimens. Corresponding to that of *L. krystyni* without crushing of the body chamber.

Diagnosis. *Lardaroceras* with 3 spiral series of nodes: umbilical, lateral and lateroventral. Marked strengthening of the ornamentation on the mature body chamber.

Description.

Shell geometry and whorl section. It belongs to this species involuted (U about 25% D), compressed (H/W about 1.8) and with relatively slow spiral growth (SGR about 50%) forms. The whorl section of the phragmocone is slightly subtrapezoidal while it is subtrapezoidal to slightly subrectangular in the adult body chamber. The umbilical seam is located between the umbilical and lateral nodes of the previous whorl, but it moves, particularly at the end of the growth, towards the spiral of lateral nodes until this is overtaken (Pl. 2, fig. 1a, b). Thus the umbilicus seems to widen out during the growth. As usual in the trituberculate ceratitids, the inclination of the lateral side changes at the position of the lateral nodes: towards the umbilicus inside, and towards the venter outside. This change is a little more evident in the adult body chamber with respect to the phragmocone (Fig. 4 B-C). The ventral side, always well separated from the lateral side by a shoulder, is characterized by an evident rounded keel. The rounded keel, whose lateral sides are slightly concave, is more elevated than the lateroventral nodes on the phragmocone, while in the adult body chamber it is variably related to the lateroventral spines depending on their orientation (Fig. 4 B-C). In any case the elevation of the keel decreases gradually during the development of the mature body chamber.

Ornamentation. The ornamentation is made of radial ribs and three spiral series of nodes.

The very weakly sinuous, almost straight, ribs reflect perfectly the style of the genus on the phragmocone, except for a peculiar feature of the primary ribs that, rarely, start in couple from the same umbilical node.

The rounded umbilical nodes, about 8 in half a whorl, are protruding beyond the umbilical seam (Fig. 4 B-C). The lateral nodes are placed between 1/3 and 1/2 of the height of the side and they are supported by primary ribs: as the number of primary ribs is a little greater than that of the umbilical nodes, the number of the laterals (9) exceeds a little that of the umbilical nodes (8). The lateroventral nodes, about a score in half a whorl, correspond to the style of the genus; sometimes they alternate (Pl. 2, fig. 2b) on the opposite sides of the venter, as reported for *L. krystyni.*

Ornamentation of mature body chamber. On the adult body chamber the ribbing is stronger than on the phragmocone, and the lateral subduing of the ribs is usually restricted to the interval between the umbilical and lateral nodes. The main individual variation of the ribbing seems to regard the strengthening: it increases progressively in the specimens figured in Pl. 2, fig. 1a and 2, Pl. 3, fig. 1a, b. The developments of a couple of primary ribs from the same umbilical node are more frequent than on the phragmocone (Pl. 3, fig. 1a).

On the adult body chamber all the nodes grow stronger: while the umbilicals remain rounded, the laterals and lateroventrals become spiny. Moreover the ratio laterals/umbilicals increases a little (10/8), and the lateroventral spiny nodes tend to flatten on a plane oblique with respect to the venter. The lateroventral spiny nodes

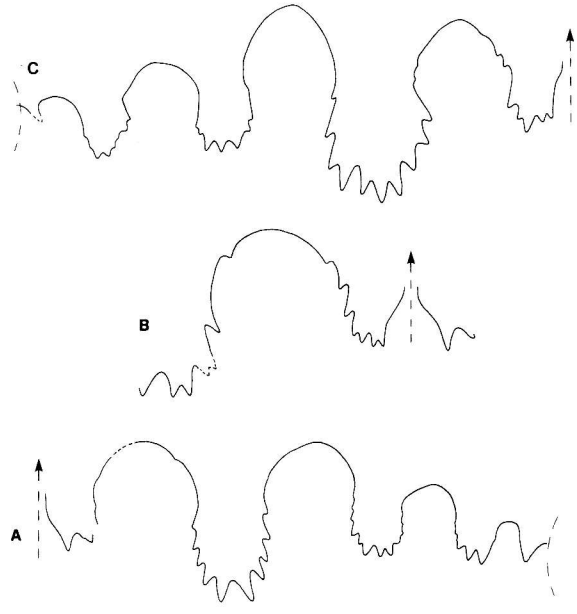

Fig. 6 - Suture lines of *Lardaroceras pseudohungaricum* and *Lardaroceras* sp. ind. A) *L. pseudohungaricum*, paratype, N. 6640 (BT8-28), suture representative of the side (x 3.5). B) Lateroventral saddle representative of the opposite side of the same specimen (x 3.5). C) *L.* sp. ind., N. 6643/2 (AD105-14), note that the narrow and deep 4th lobe is deformed (inclined) because of the presence of an umbilical node (x 3.5).

may be differently outward or upward oriented (Fig. 4B-C). They also show alternations on the sides of the venter as on the phragmocone (Pl. 2, fig. 1c).

Suture line. It seems to be less denticulated than that of *L. krystyni* with a more rounded outline of the saddles (Fig. 6A-B). Unfortunately, the recrystallization saves the details only in one case (BT8-28), thus there are not indications on the intraspecific variability.

Dimensions:

Specimen	D	H	h	U	W	w	SGR%	U/D(%)	H/W
N.6637 (BT8-5)	69.7	30.2	21	18.5	17.65	-	43	26	1.71
N.6638 (BT8-7)	-	33.1	-	-	19.7	-	-	-	-
same specimen	-	18.35	-	-	9.4	-	-	-	-
N.6639 (SF111A-1)	-	30.3	-	-	18.0	-	-	-	-
N.6640 (BT8-28)	53.3	27.2	17.7	13.4	-	9.5	53	25	1.86 (h/w)
N.6641 (AD113b-1)	-	26.25	-	-	16.45	-	-	-	-

Discussion.

As above mentioned and discussed, part of the specimens belonging to this species was previously classified by the writer (Kovacs et al., 1990) as *Parakellnerites hungaricus* (Mojsisovics, 1882). At the specific rank "*Ceratites*" *hungaricus* probably remains the species morphologically closest to *Lardaroceras pseudohungaricum*: although the original primary series is heterogenous there are similarities with the different specimens in the ventral side, in the presence of an evident periumbilical margin and in the ornamentation of the side, where sometimes the primary ribs "bifurcate" at the umbilical node (Mojsisovics, 1882, pl. 30, fig. 17: umbilical/lateral nodes (u/l) = 4/5; fig. 19: u/l= 7/9; fig. 21: u/l = 4/6). The main differences are in the umbilical width (too small in fig. 17 and too wide in fig. 19 and 21), in the spiral growth rate (too high in fig. 19 and 21), in the regularly marked ornamentation on the phragmocone and body chamber, in the sharpness of the keel (fig. 17) and in the suture line (fig. 21) ceratitic with only three saddles on the side.

Another species very similar to *L. pseudohungaricum* is "*Ceratites*" *evolvens* (Hauer, 1887). It has a similar ventral side, very weakly ornamented inner whorls (weak ribs, umbilical and lateroventral nodes) with a marked strengthening of ornamentation during the growth, starting between 25 and 30 mm of whorl height, where also lateral tubercles appear. The differences are in the very quick widening of the umbilicus (see original pl. 6, fig. 4a), in the apparently lack of umbilical "bifurcation" of primary ribs and in the narrower keel, in the suture line, ceratitic, with external lobe not very denticulated but with very similar auxiliary elements (3rd lobe asymmetrical and 4th lobe simple and deep).

On the basis of the umbilical "bifurcation" of primary ribs, some analogies can be found with some *Parakellnerites* as *P. meriani* Rieber, 1973 and with *Ceratites*

boeckhi Roth, 1871. This last species has a keel stronger than *L. pseudohungaricum* but it seems to have a subammonitic or nearly subammonitic suture. Unfortunately, it has not been possible to check it directly because the original specimen is missing.

Occurrence. Till now this species has been only recognized in the Prezzo Limestone in the Camonica Valley and the Giudicarie: La Baita section (BT8, 3 specimens); Adanà section (AD113bis, 1 specimen); Stabol Fresco section (SF111A, 2 specimens).

Age. Illyrian (Middle Triassic).

Lardaroceras sp. ind.

Pl. 3, fig. 3, 4; Text-fig. 6C

Material. Two specimens: N. 6643/1 (AD 105-5), N. 6643/2 (AD 105-14).

Collocation. Museo di Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Milano.

Preservation of the specimens. Completely corresponding to that of *L. krystyni.*

Description.

The specimens, coming from the *krystyni* biohorizon, correspond to *L. krystyni* in the general shell geometry, in the whorl section, in the features of ornamentation as the ribbing, the number and shape of umbilical and lateroventral nodes. Unlike *L. krystyni* they possess a series of lateral nodes located at 1/3 of whorl height. These very weak nodes are supported by the primary ribs and their number, about 7 in half a whorl, corresponds to the number of the umbilical nodes.

The suture line (Fig. 6C) is included in the wide field of variability of *L. krystyni.*

Discussion.

The writer prefers leaving open the determination at a specific rank of these specimens because their number is not enough in order to completely evaluate, in the sense of the intraspecific variability and/or ontogenetical variations, their morphostructural features with respect to *L. krystyni* and *L. pseudohungaricum.* They seem to be closer to *L. krystyni* than to *L. pseudohungaricum* in the morphology and suture line, but the lateral nodes point to a relation with *L. pseudohungaricum.* Unfortunately equally sized *L. pseudohungaricum* are not available for a complete comparison.

Occurrence. Prezzo Limestone, Adanà section (AD105, 2 specimens).

Age. Illyrian (Middle Triassic).

Acknowledgements.

The author particularly thanks prof. Maurizio Gaetani, who introduced him to Anisian biostratigraphy, for the valued suggestions and stimulating discussions. Sincere thanks are also extended to N. Fantini Sestini, L. Krystyn and F. Tatzreiter for the fruitful discussions on Ammonoid taxonomy and stratigraphy.

H. Jaeger (Berlin), A. Vörös (Budapest), G. Schairer (München), F. Stojaspal (GBA Vienna), H. Summesberger (Naturhistorische Museum, Vienna) and H. Rieber (Zürich), who made available classical collections and provided technical and logistic support during the visits, are acknowledged. N. Fantini Sestini, M. Gaetani, A. Nicora and C. Rossi Ronchetti read carefully and improved the manuscript.

P. Visini helped very kindly the writer with the English. G. Chiodi took the photographs, M. Minoli and S. Renesto made the drawings.

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PLATE 1

Fig. 1 - *Lardaroceras krystyni* sp. n. Paratype. Stabol Fresco 106A, N. 6628 (SF106A-41). a) Lateral view; b) ventral view; x 2.

Fig. 2 - *Lardaroceras krystyni* sp. n. Paratype. Stabol Fresco 106A, N. 6629 (SF106A-25). a) Lateral view; b) ventral view; x 1.

Fig. 3 - *Lardaroceras krystyni* sp. n. Paratype. Stabol Fresco 106A, N. 6630 (SF106A-30). a) Lateral view; b) ventral view; x 1.

Fig. 4 - *Lardaroceras krystyni* sp. n. Holotype. Adanà 105, N. 6627 (AD105-1). a) Lateral view of the complete specimen; b) lateral view of the opposite side without the last half of the body chamber; c) ventral view of the end of the phragmocone; x 1.

Fig. 5 - *Lardaroceras krystyni* sp. n. Paratype. Stabol Fresco 106A, N. 6632 (SF106A-40). Ventral view; x 1.

The white mark indicates the end of the phragmocone.

PLATE 2

Fig. 1 - *Lardaroceras pseudohungaricum* sp. n. Holotype. La Baita 8, N. 6637 (BT8-5). a,b) Lateral views; c) ventral view; x 1.

Fig. 2 - *Lardaroceras pseudohungaricum* sp. n. Paratype. La Baita 8, N. 6640 (BT8-28). a) Lateral view; b) ventral view; x 1.

The white mark indicates the end of the phragmocone.

PLATE 3

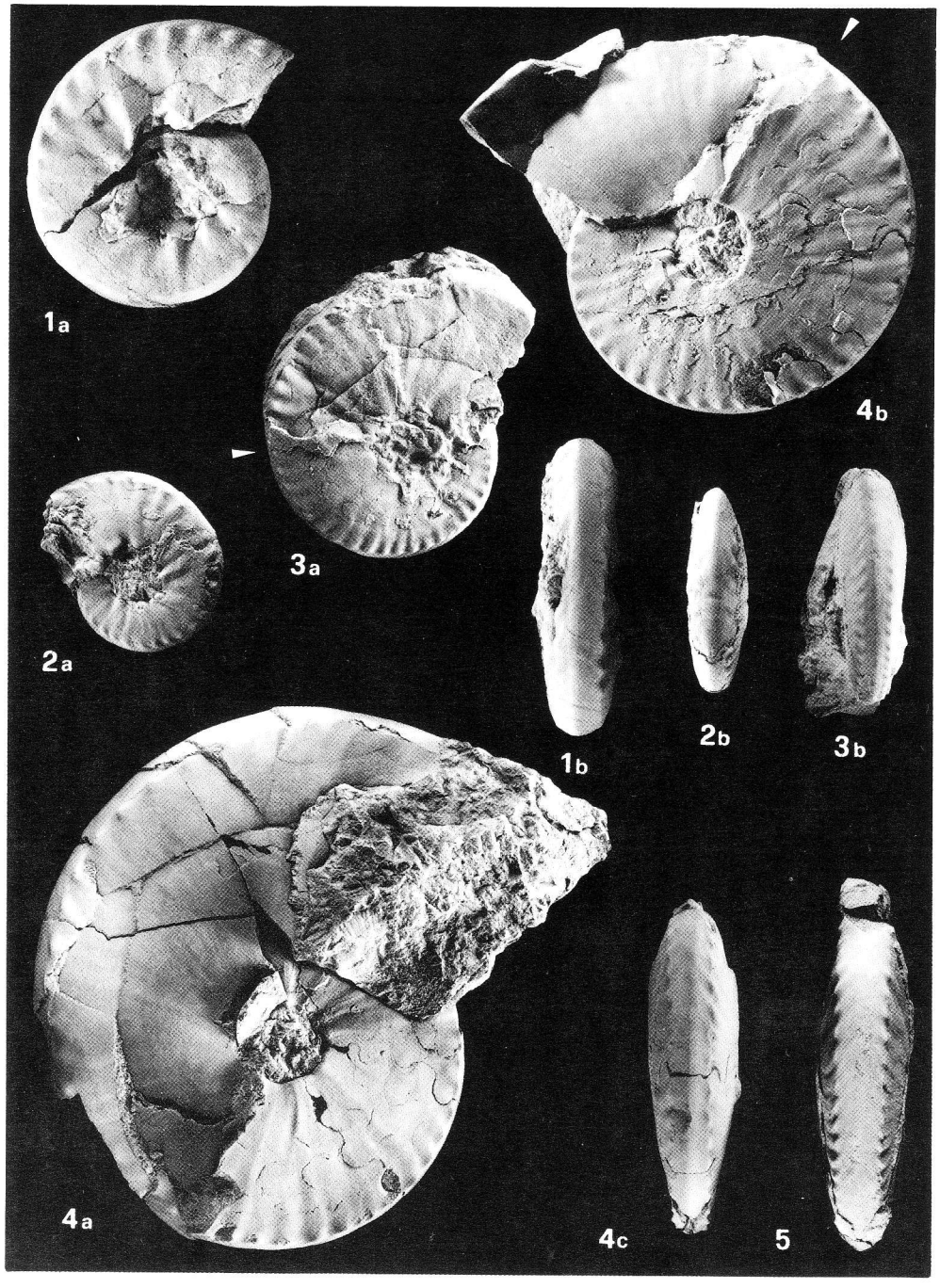
Fig. 1 - *Lardaroceras pseudohungaricum* sp. n. Paratype. La Baita 8, N. 6638 (BT8-7). a) Lateral view; b) ventral view; x 1.

Fig. 2 - *Lardaroceras pseudohungaricum* sp. n. Paratype. Stabol Fresco 111A, N. 6639 (SF111A-1). Lateral view; x 1.

Fig. 3 - *Lardaroceras* sp. ind. Adanà 105, N. 6643/1 (AD105-5). a) Lateral view; b) ventral view; x 1.

Fig. 4 - *Lardaroceras* sp. ind. Adanà 105, N. 6643/2 (AD105-14). a) Lateral view; x 1.

The white mark indicates the end of the phragmocone.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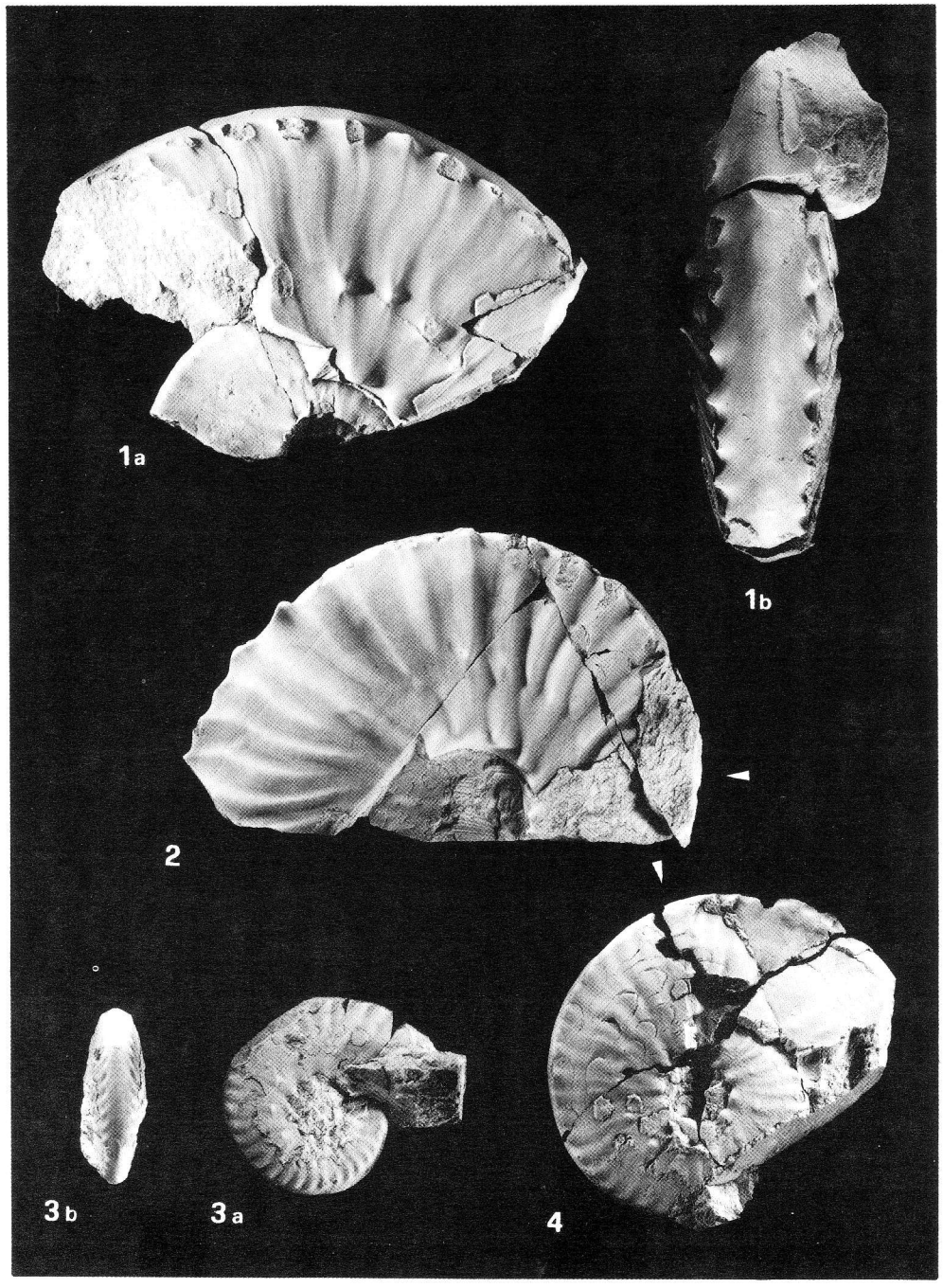
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