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The Oxfordian ammonite succession near Liesberg BE and Péry BE, northern Switzerland

By REINHART A. GYGI¹⁾

ABSTRACT

The late Middle Jurassic to early Late Jurassic ammonite succession has been worked out in the clay pit at Andil near Liesberg BE. The unbroken, non-condensed succession with ammonites is more than 60 m thick and begins with the Lamberti Subzone and ends in the Costicardia Subzone. A somewhat higher non-condensed succession with ammonites from the Transversarium Zone to the Bifurcatus Zone occurs near Péry BE. Both sections are described and the leading ammonites illustrated.

RÉSUMÉ

La succession d'ammonites du Jurassique moyen terminal à la partie inférieure du Jurassique supérieur a été élaboré dans la marnière d'Andil près de Liesberg BE. Cette succession continue, de plus de 60 m d'épaisseur, non condensée avec des ammonites commence avec la Sous-zone à Lamberti et finit dans la Sous-zone à Costicardia. Une succession dilatée avec des ammonites de la Zone à Transversarium à la Zone à Bifurcatus existe près de Péry BE. Les affleurements sont décrits et les ammonites figurées.

ZUSAMMENFASSUNG

Die Ammonitenabfolge vom Ende des Mittleren Jura bis in den früheren Späten Jura wurde in der Tongrube Andil bei Liesberg BE bearbeitet. Die ununterbrochene, mehr als 60 m mächtige, mit Ammoniten belegte, nicht kondensierte Abfolge beginnt mit der Lamberti-Subzone und endet in der Costicardia-Subzone. Eine nicht kondensierte Abfolge mit Ammoniten von der Transversarium-Zone bis zur Bifurcatus-Zone gibt es bei Péry BE. Die Profile werden beschrieben und die leitenden Ammoniten abgebildet.

1. Introduction

The clay pit of Chestel at Liesbergmüli and the clay pit of Andil, southwest of the village of Liesberg, were long renowned for the great number of Callovian and Oxfordian ammonites that were found there. The ammonite succession in these sections was however never recorded in detail. Systematic excavations carried out over a period of several years have yielded a collection of ammonites obtained *in situ* that now makes the establishment of the succession possible. The ammonites of the Renggeri marl-clay (see GYGI & PERSOZ, 1986, p. 394: Renggeri Member) near Liesberg are rare at most horizons. The product of the excavations was therefore not great. It was generously

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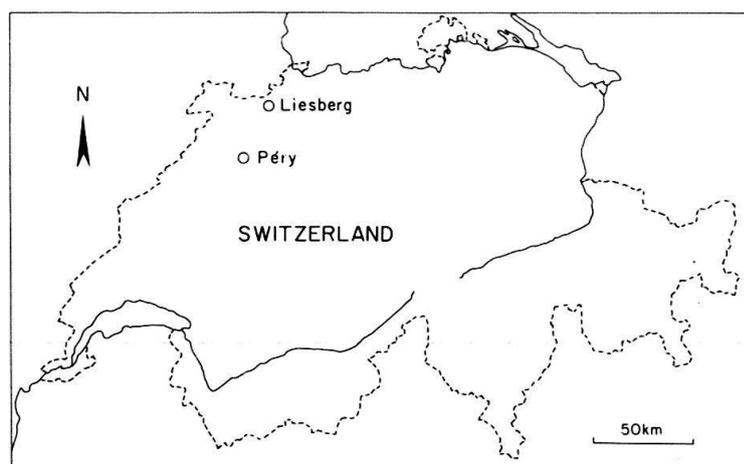


Fig. 1. Location of the sections near Liesberg and Péry in northern Switzerland.

supplemented by private collectors who gave some of their excellent specimens as a gift to the Museum of Natural History in Basel. Some of these specimens are figured here in order to document some of the ammonite subzones better. Figured specimens are from R. Himmler, Oberwil BL; B. Hostettler, Bern; B. Lange, Basel; the late K. Lüdin (given by M. & I. Braun, Basel); F. Meury, Blauen BE; P.O. Mojon, St-Imier BE; and H. & A. Zbinden, Ipsach BE. These gifts are gratefully acknowledged.

The section of the quarry of La Charuque near Péry is of interest because here most of the Middle Oxfordian sediments are present in non-condensed ammonite facies.

2. Stratigraphy and Paleogeography

The stratigraphy and the paleogeography of the Oxfordian of northern Switzerland has been worked out in various papers by the author and by GYGI & PERSOZ (1986, 1987). A few remarks will then be enough here.

In the late Middle Jurassic and in the early Late Jurassic there was a land mass in the northwest (the Ardenne-Rhenian Massif). This land supplied terrigenous (mainly argillaceous) sediment at various rates. The sediment supply rate was about zero just before the end of the Middle Jurassic. The rate slowly increased at the beginning of the Oxfordian when the lowermost few decimeters of the Renggeri marl-clay were deposited. There are iron ooids in this deposit. The ooids become rare towards the top and fade away upward completely as a consequence of the increasing rate of sedimentation. This is when sedimentation of the thick and homogenous blue-grey marl-clay of the Renggeri Member began.

There were important eustatic sea level rises in the Cordatum and in the Antecedens Subchrons (GYGI, 1986, Fig. 4, cf. HAQ et al. 1987). These had no major effect on sedimentation in the proximal realm, but in the more distal areas the sediments of the Early and of the earlier Middle Oxfordian thin out (GYGI & PERSOZ, 1986, Pl. 1, 1987, Fig. 6). A hiatus from the late Mariae Chron to the early Transversarium Chron developed in the Péry section where the thickness of the Renggeri Member is reduced

to little more than 3 m. Continuous sedimentation in the ammonite facies of the basin resumed only in the Transversarium Chron of the Middle Oxfordian. A well-exposed, non-condensed section in ammonite facies from the Antecedens Subchron to the Bifurcatus Chron is to be found at Péry.

3. The section RG 280 at Liesberg BE

The section represented in Fig. 2 begins with bed no. 2: a biocalcarenite with hummocky cross-stratification. The calcarenite consists of mainly crinoidal clasts with abundant bryozoan debris. There are marly pockets between the cross-stratified limestone beds. The whole unit is only 3.2 m thick. It is the marginal, shallow subtidal facies of the Dalle nacrée carbonate platform.

Bed 3 is a grey calcarenite to calcirudite. There are exceptionally much macrofossils. Large ostreids and pectinids are abundant, brachiopods and gastropods less common. Ammonites are present but rather rare. The surface of the bed is very

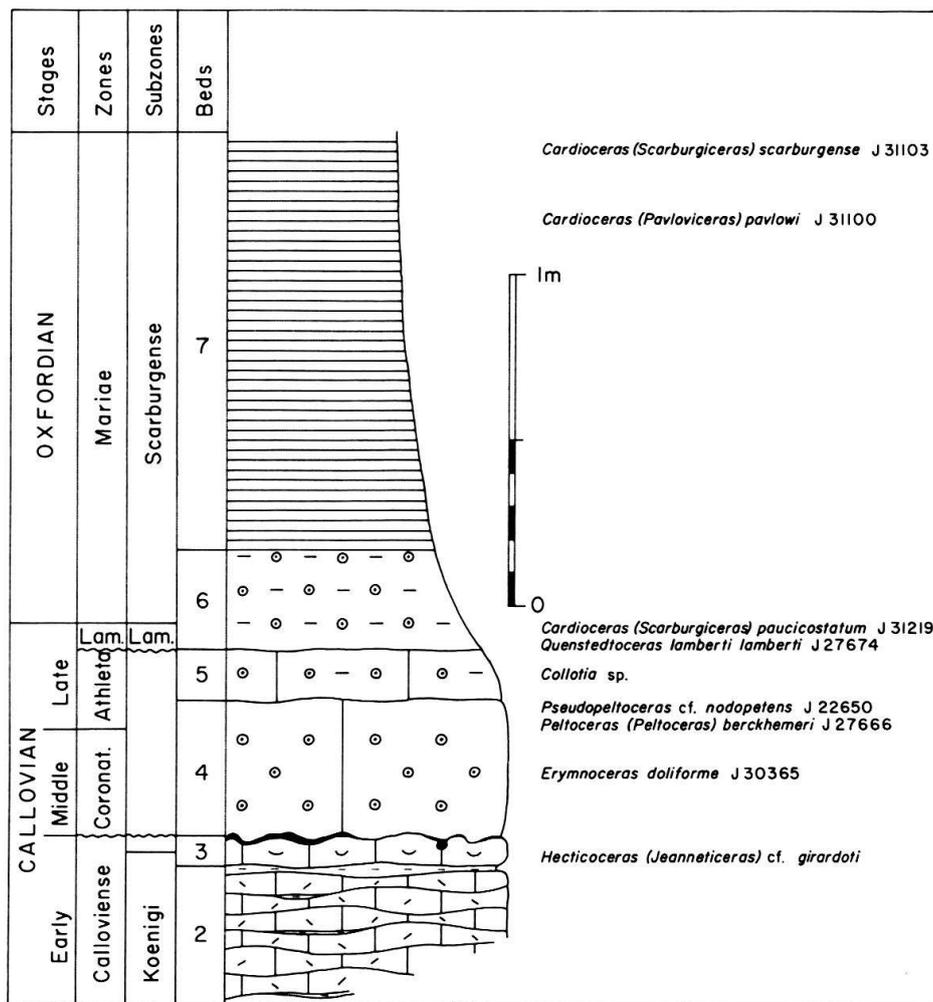


Fig. 2. Details of the lower part of section RG 280 in the clay pit at Andil near Liesberg BE. For explanation of lithological signs see GYGI & PERSOZ (1968, Plate 1).

uneven. In some places it is covered with a limonitic crust up to several centimeters thick. This is the “Lumachellenbank” of STÄUBLE (1959). The horizon has a multiphase history of formation (BITTERLI, 1979, Fig. 4). This bed marks the base of a deepening upward sequence that began after the drowning of the Dalle nacrée platform.

Bed 4 is a grey, iron-oolitic limestone up to 50 cm thick. The iron ooids have diameters of up to 1 mm and are less than 10% of the rock volume. They are irregularly dispersed in the matrix and may be concentrated in clusters indicating bioturbation. The macrofauna is dominated by ammonites. The uppermost part of the bed contains numerous large peltoceratids. The surface of the bed forms a conspicuous plane inclined at 68° to northnortheast.

Bed 5 is a violet-grey limey marl with about 20% iron ooids that are often concentrated in clusters. The upper boundary of the horizon is transitional. The ammonites in this bed include large *Collotia*.

Bed 6 is a violet-grey marl-clay with 3 to 5% iron ooids. The iron ooids fade away towards the top of the bed as the lithology grades into the blue-grey marl-clay of the Renggeri Member proper. The lowermost 10 cm of the bed are very fossiliferous with mostly ammonites and belemnites. This is the horizon of *Quenstedtoceras lamberti*, in the latest subzone of the Middle Jurassic. In the same horizon occurs *Cardioceras paucicostatum*.

Bed 7 is a homogenous mass of blue-grey marl-clay that is 67 m thick. This is the Renggeri Member proper. There are often burrows with a diameter of about 1 mm that are filled with iron sulfide. The first ammonites appear 1 m above the base of the unit. The macrofauna consists mostly of cephalopods. The ammonites are small and conserved as casts of iron sulfide. They are probably mostly full-grown since many of them have a part of the body-chamber and some have approximated last septa. There are also bivalves, gastropods, brachiopods, and crinoids. The Renggeri marl-clay was therefore deposited in aerated water. The macrofauna is most abundant in the lowermost few meters of the unit. The Renggeri marl-clay encompasses the following subzones (Fig. 3): Scarburgense, Praecordatum, Bukowskii, and Costicardia.

4. The section RG 307 at Péry BE

The partial section is shown in Fig. 4 and begins with bed 10, the Dalle nacrée Member. This is a biocalcarenite with mainly clasts of echinoderms and some of bryozoans. The depositional inclination of the bedding is to the southeast. The whole unit is an ebb-tidal deltaic deposit. The upper surface of the member is even, bored, and has a thin crust of limonite. Above is a limestone bed (no. 11) with a thickness of 15 cm. It is a bioarenitic to ruditic wackestone with iron ooids and with a rich macrofauna of mainly bivalves and echinoderms. The bed may be disintegrated into nodules with a thick limonitic crust. It corresponds to bed no. 3 near Liesberg.

Beds 12 to 18 are an alternation 0.95 m thick of iron-oolitic limestone and marl with abundant ammonites. These are the “Anceps-athleta beds” auctorum. Bed 19 is a brown-violet marly-clay 0.15 m thick with between 20 and 30% iron ooids. There are conspicuous yellow-brown spots in the groundmass. *Quenstedtoceras lamberti* (J. SOWERBY) J 31221 occurs in this horizon, along with crinoidal stem debris and pieces of fossil wood.

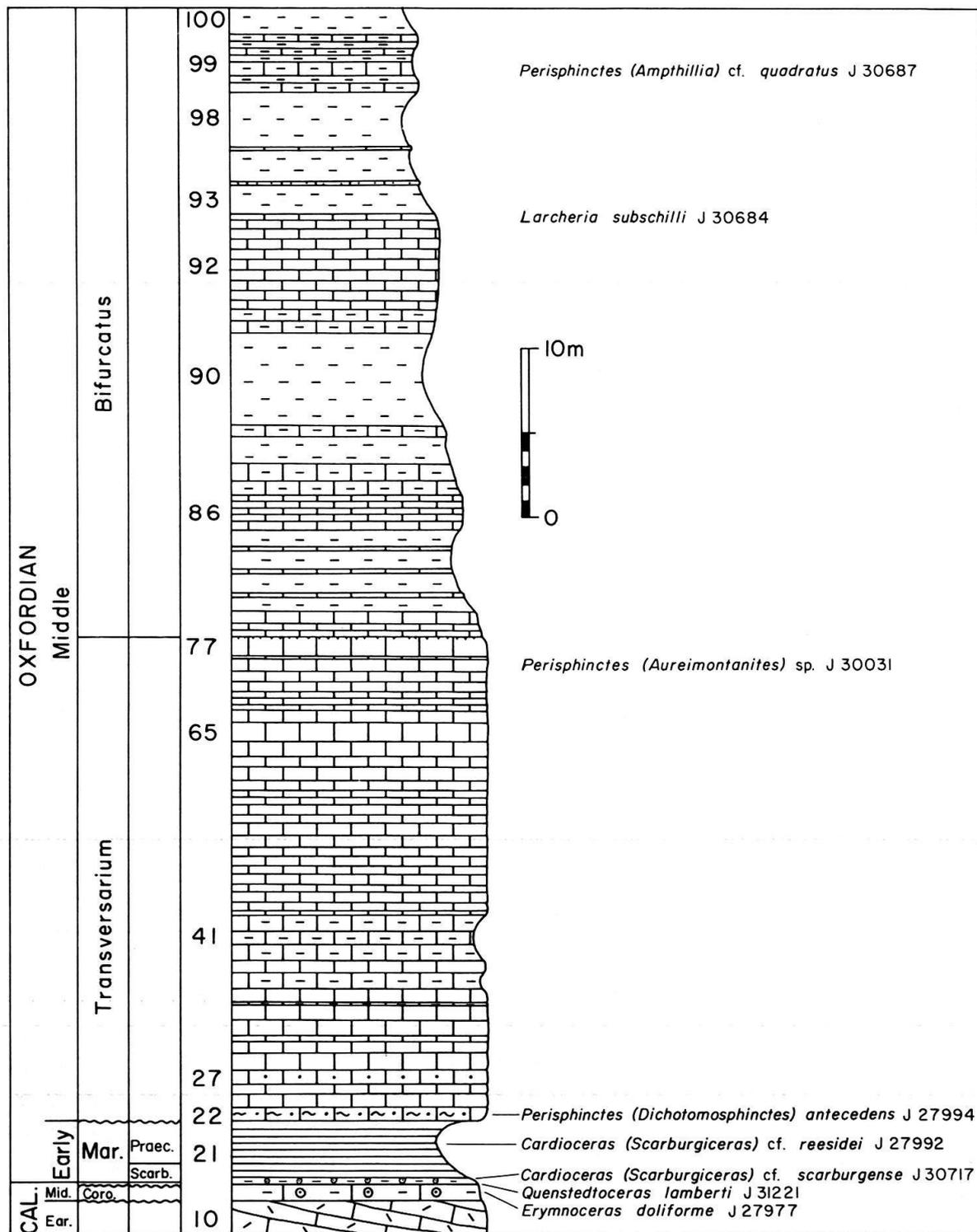


Fig. 4. Part of section RG 307 in the quarry at La Charuque near Péry BE.

Bed 20 is a brownish, dark-grey marl-clay 0.25 m thick. There are iron ooids in decreasing abundance from base to top. *Quenstedtoceras* of the *lamberti* group and *Quenstedtoceras leachi* (J. SOWERBY) in MAIRE (1937) J 30709 were found, and the first *Cardioceras* (*Scarburgiceras*) cf. *scarburgense* J 30717 occurs in the upper part of the bed. The upper boundary of the bed is transitional.

Bed 21 is a blue-grey and homogenous marl-clay, the Renggeri Member, with burrows filled with iron sulfide. *Cardioceras* (*Scarburgiceras*) cf. *reesidei* J 27992 was recovered from this unit (Pl. 6, Fig. 3).

The limestone succession of beds 22 through 77 is the Pichoux Limestone. The lowermost bed 22 contains siliceous sponges and glauconite. From this bed were obtained *Perisphinctes* (*Dichotomosphinctes*) *antecedens* SALFELD J 27994 (Pl. 5, Fig. 4) and *Cardioceras* (*Maltoniceras*) cf. *schellwieni*. The top of bed 77, the uppermost horizon of the Pichoux Limestone, is covered by a thin limonitic crust. This is the top of depositional sequence no. 1 of GYGI & PERSOZ (1986, Pl. 1).

The Effingen Member begins with bed 78. This member consists of an alternation of marl with marly limestone or more or less pure limestone. The top of the calcareous succession, bed 92, yielded *Larcheria subschilli* (LEE) J 30684. *Perisphinctes* (*Ampthillia*) cf. *quadratus* J 30687 came from the marly limestone succession, bed 99 (Pl. 7, Fig. 5).

5. Ammonite zonation

Bed 3 near Liesberg is probably a condensed deposit. *Hecticoceras* (*Jeanneticeras*) cf. *girardoti* (BONARELLI) is of the Calloviense Subzone. *Kosmoceras* (*Zugokosmokeras*) *enodatum* (NIKITIN) occurs in the same bed in the iron mine of Herznach. Bed 4 near Liesberg belongs partially to the Coronatum Zone based on the occurrence of *Erymnoceras doliforme* SAYN & ROMAN J 30365 (Pl. 2, Fig. 3). The zonal position of *Pseudopeltoceras* cf. *nodopetens* JEANNET J 22650 (Pl. 1, Fig. 3) and *Peltoceras* (*Peltoceras*) *berckhemeri* PRIESER J 27666 (Pl. 2, Fig. 2) is probably in the Athleta Zone. The ill-preserved *Collotia* sp. of horizon 5 are of the Athleta Zone.

Several *Quenstedtoceras lamberti* (J. SOWERBY) occur in the lowermost 10 cm of bed 6 near Liesberg. *Quenstedtoceras henrici* does not occur, but whether this is because of a minor hiatus in the lower Lamberti Zone or because of a primary absence of *Quenstedtoceras henrici* cannot be decided. The presence of *Cardioceras paucicostatum* LANGE in the same level as *Quenstedtoceras lamberti* does not mean that the base of bed 6 is condensed. In an excavation at Üken near the mine of Herznach (section RG 208), *Cardioceras* (*Scarburgiceras*) cf. *paucicostatum* occurs in the same level as *Quenstedtoceras ordinarium* (LECKENBY) of the Lamberti Zone (see GYGI & MARCHAND, 1982, Pl. 2, Figs. 6 and 8). This is not because of condensation.

The first well-preserved, indubitable *Cardioceras* (*Scarburgiceras*) *scarburgense* (YOUNG & BIRD) J 31103 (Pl. 3, Fig. 4) occurs at Liesberg 1.2 m above the base of the blue-grey Renggeri Member. This makes it impossible here to recognize the boundary between the Middle and the Upper Jurassic exactly. *Cardioceras* (*Scarburgiceras*) cf. *scarburgense* J 30717 (Pl. 3, Fig. 11) occurs near Péry in the lower part of bed 20 which is equivalent to bed 6 near Liesberg. The beginning of the Late Jurassic is usually recognized by the appearance of the first *Scarburgiceras scarburgense*. We therefore place

the base of the Upper Jurassic tentatively into bed 20 near Péry or into bed 6 near Liesberg, respectively (Fig. 2).

The Scarburgense and the Praecordatum Subzones can be well recognized near Liesberg (Fig. 3). The Bukowskii Subzone is represented by poor specimens of *Cardioceras* (*Scarburgiceras*) cf. *bukowskii* MAIRE (see Pl. 6, Fig. 1). It can only be presumed from crushed fragments of *Cardioceras* (*Cardioceras*) cf. *costicardia* S. BUCKMAN that the uppermost 9 m or so of the Renggeri Member near Liesberg belong to the Costicardia Subzone.

6. Conclusions

The base of the Upper Jurassic as defined by the base of the *Scarburgiceras scarburgense* Subzone lies near Liesberg within an uncondensed interval with a total thickness of 1.4 m, namely between the lower part of bed 6 with *Quenstedtoceras lamberti* and *Cardioceras paucicostatum*, and the lower Renggeri Member (bed 7, 1.2 m above the base) with *Cardioceras* (*Scarburgiceras*) *scarburgense*. The lower boundary of the Upper Jurassic is placed in the section of Liesberg tentatively at the top of the lower part of bed 6 above *Quenstedtoceras lamberti* and *Cardioceras paucicostatum*.

Acknowledgements

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Plate 1

- Fig. 1. *Quenstedtoceras lamberti* (J. SOWERBY) J 27674, Lamberti Zone, Lamberti Subzone, Lamberti Bed, section RG 280, bed 6, lowermost part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 2. *Quenstedtoceras* cf. *lamberti* (J. SOWERBY) J 31134, Lamberti Zone, Lamberti Subzone, Lamberti Bed, section RG 280, bed 6, lowermost part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 3. *Pseudopeltoceras* cf. *nodopetens* JEANNET J 22650, probably Athleta Zone, "Anceps-athleta Bed", section RG 280, bed 4, Liesberg BE, clay pit of Andil, leg. B. Paganini, $\times 0.5$. Wholly septate.



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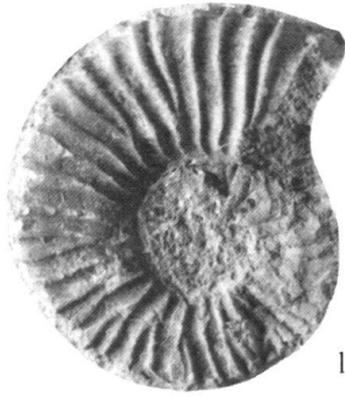
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Plate 2

- Fig. 1. *Peltoceratoides cf. athletoides* (LAHUSEN) J 31218, Lamberti Zone, Lamberti Bed, section RG 280, bed 6, lowermost part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 2. *Peltoceras (Peltoceras) berckhemeri* PRIESER J 27666, Athleta Zone, "Anceps-athleta Bed", section RG 280, bed 4, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1. Wholly septate.
- Fig. 3. *Erymnoceras doliforme* SAYN & ROMAN J 30365, Coronatum Zone, "Anceps-athleta Bed", section RG 280, bed 4, Liesberg BE, clay pit of Andil, leg. F. Meury, × 1.
- Fig. 4. *Rursiceras cf. retractum* PRIESER J 31217, Lamberti Zone, Lamberti Bed, section RG 280, bed 6, lowermost part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 5. *Erymnoceras doliforme* SAYN & ROMAN J 27977, Coronatum Zone, "Anceps-athleta Bed", section RG 307, Péry BE, quarry of La Charuque, leg. H. Zbinden, × 1. Wholly septate.



1



2



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4



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Plate 3

- Fig. 1. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 31106, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.6 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 2. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 31109, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.5 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 3. *Properisphinctes?* sp. J 31119, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1. Wholly septate.
- Fig. 4. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 31103, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 5. *Cardioceras (Scarburgiceras) woodhamense* ARKELL J 31104, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.5 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 6. *Hecticoceras (Brightia) socini* (NOETLING) J 31105, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.5 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 7. *Hecticoceras (Brightia) kautzschii* (NOETLING) J 31102, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 8. *Cardioceras (Pavloviceras) pavlowi* (R. DOUVILLÉ) J 31100, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.0 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 9. *Cardioceras (Scarburgiceras) cf. paucicostatum* LANGE J 31220, Lamberti Zone, Lamberti Subzone, Lamberti Bed, section RG 280, bed 6, lower part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 10. *Quenstedtoceras leachi* (J. SOWERBY) in MAIRE (1937, Pl. 2, Fig. 18) J 30709, Lamberti Zone, Lamberti Subzone, ferriferous-oolitic marl-clay at the base of the Renggeri marl-clay, section RG 307, bed 20, Péry BE, quarry of La Charuque, leg. R. & S. Gygi, × 1.
- Fig. 11. *Cardioceras (Scarburgiceras) cf. scarburgense* (YOUNG & BIRD) J 30717, Mariae Zone, Scarburgense Subzone, ferriferous-oolitic marl-clay at the base of the Renggeri marl-clay, section RG 307, bed 20, Péry BE, quarry of La Charuque, leg. R. & S. Gygi, × 1.
- Fig. 12. *Cardioceras (Scarburgiceras) paucicostatum* LANGE J 31221, Lamberti Zone, Lamberti Subzone, Lamberti Bed, section RG 307, bed 19, Péry BE, quarry of La Charuque, leg. R. & S. Gygi, × 1.
- Fig. 13. *Quenstedtoceras lamberti* (J. SOWERBY) J 31233, Lamberti Zone, Lamberti Subzone, ferriferous-oolitic marl-clay at the base of the Renggeri marl-clay, section RG 307, bed 20, Péry BE, quarry of La Charuque, leg. R. & S. Gygi, × 1.
- Fig. 14. *Cardioceras (Scarburgiceras) paucicostatum* LANGE J 31219, Lamberti Zone, Lamberti Subzone, Lamberti Bed, section RG 280, bed 6, lower part, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.

An arrow indicates the beginning of the body-chamber.

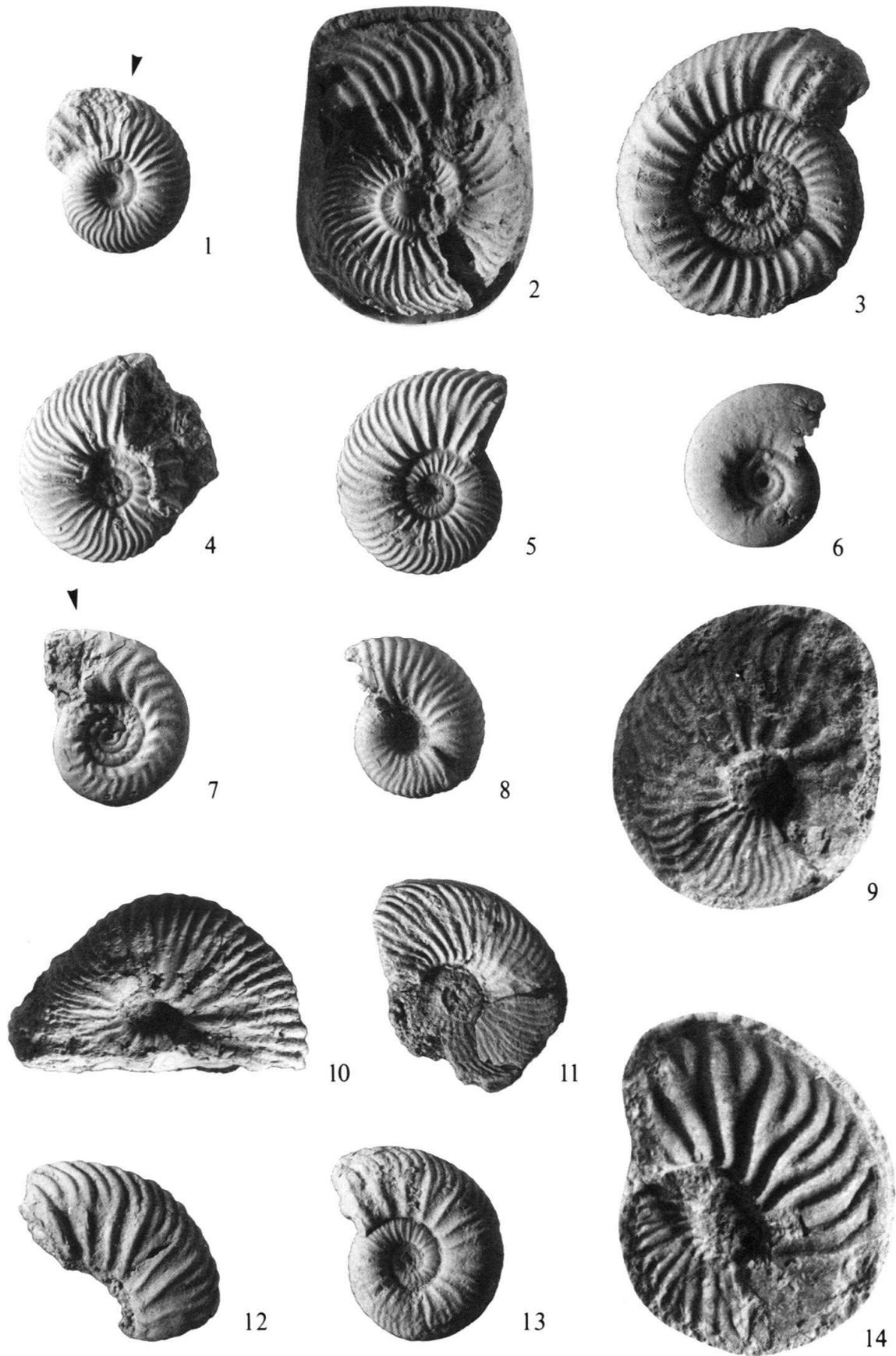


Plate 4

- Fig. 1. *Perisphinctes matheyi* DE LORIO J 31128, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, ca. 25 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 2. *Perisphinctes matheyi* DE LORIO J 31136, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 26 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 3. *Perisphinctes matheyi* DE LORIO J 30978, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 30 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 4. *Scaphitodites scaphitoides* (COQUAND) J 30979, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 18 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 5. *Hecticoceras (Sublunuloceras) bonarellii* DE LORIO J 31227, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 20 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 6. *Hecticoceras (Sublunuloceras bonarellii)* DE LORIO J 31124, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 3 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 7. *Cardioceras (Pavloiceras) mariae* (D'ORBIGNY) J 30951, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 8. *Cardioceras (Scarburgiceras) praecordatum* R. DOUVILLÉ J 31114, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 3.5 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 9. *Grossouvria miranda* (DE LORIO) J 31121, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 10. *Cardioceras (Pavloiceras) pavlowi* (R. DOUVILLÉ) J 31107, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 1.8 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 11. *Hecticoceras (Brightia) syriacum* HAAS J 30712, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2.3 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, × 1.
- Fig. 12. *Properisphinctes bernensis* (DE LORIO) J 31226, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 3 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 13. *Taramelliceras (Richeiceras) dupasquieri* (DE LORIO) J 31116, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 14. *Properisphinctes bernensis* (DE LORIO) J 31225, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2.3 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 15. *Properisphinctes bernensis* (DE LORIO) J 31123, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2.1 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 16. *Properisphinctes bernensis* (DE LORIO) J 31118, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.
- Fig. 17. *Taramelliceras (Richeiceras) richei* (DE LORIO) J 31222, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, × 1.

(continued p. 194)

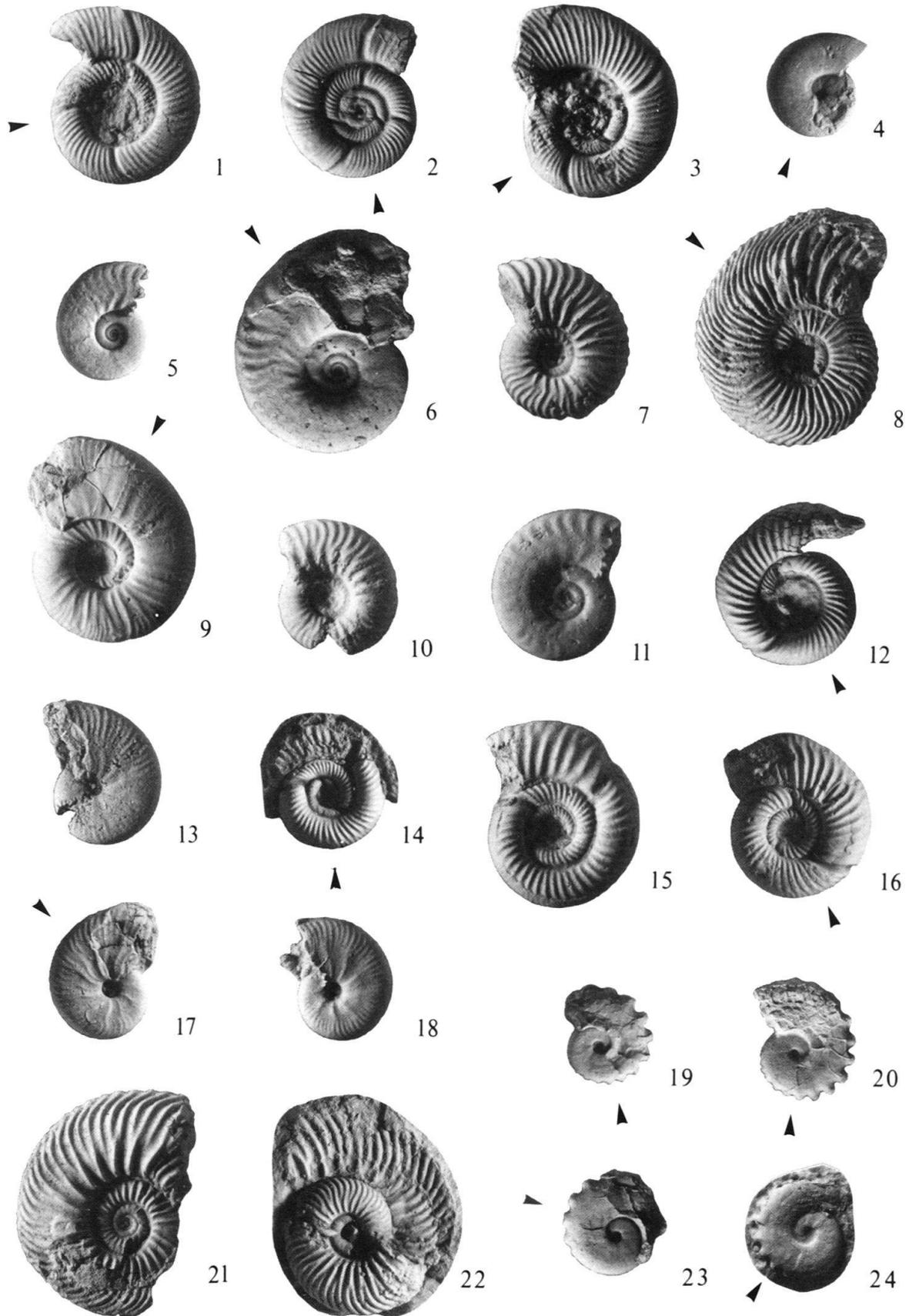


Plate 5

- Fig. 1. *Properisphinctes bernensis* (DE LORIO) J 31228, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 25 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, $\times 1$.
- Fig. 2. *Peltoceratoides* sp. J 31135, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 26 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 3. *Cardioceras (Scarburgiceras) praecordatum* R. DOUVILLÉ J 30949, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 27 m above the base, Liesberg BE, clay pit of Andil, leg. R. Himmler, $\times 1$.
- Fig. 4. *Perisphinctes (Dichotomosphinctes) antecedens* SALFELD J 27994, Transversarium Zone, Antecedens Subzone, basal bed of the Pichoux limestone, section RG 307, bed 22, Péry BE, quarry of La Charuque, leg. H. & A. Zbinden, $\times 1$.

An arrow indicates the beginning of the body-chamber.

Plate 4 (continued)

- Fig. 18. *Taramelliceras (Richeiceras) richei* (DE LORIO) J 31115, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 19. *Creniceras renggeri* (OPPEL) J 31224, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2.1 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 20. *Creniceras renggeri* (OPPEL) J 31112, Mariae Zone, Praecordatum Subzone, Renggeri marl-clay, section RG 280, bed 7, 3.5 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 21. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 31122, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 22. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 30981, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. Gygi, $\times 1$.
- Fig. 23. *Creniceras renggeri* (OPPEL) J 31117, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 24. *Creniceras renggeri* (OPPEL) J 27604, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, 2.2 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.

An arrow indicates the beginning of the body-chamber.



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Plate 6

- Fig. 1. *Cardioceras (Scarburgiceras)* aff. *bukowskii* MAIRE J 31131, Cordatum Zone, Bukowskii Subzone, Renggeri marl-clay, section RG 280, bed 7, ca. 47 m above the base, Liesberg BE, clay pit of Andil, leg. R. & S. Gygi, $\times 1$.
- Fig. 2. *Creniceras renggeri* (OPPEL) J 31089, Mariae Zone, Renggeri marl-clay, section RG 280, bed 7, lowermost part, Liesberg BE, clay pit of Andil, leg. H. Zbinden, $\times 1$.
- Fig. 3. *Cardioceras (Scarburgiceras)* cf. *reesidei* MAIRE J 27992, Cordatum Zone, Bukowskii Subzone, Renggeri marl-clay, section RG 307, bed 21, Péry BE, quarry of La Charuque, leg. H. Zbinden, $\times 1$.
- Fig. 4. *Cardioceras (Scarburgiceras) praecordatum* R. DOUVILLÉ J 30679, Mariae Zone, Praecordatum Subzone, landslide of Renggeri marl-clay, Les Effondras near Rebévelier JU, leg. H. & A. Zbinden, $\times 1$.
- Fig. 5. *Cardioceras (Scarburgiceras) scarburgense* (YOUNG & BIRD) J 31229, Mariae Zone, Scarburgense Subzone, Renggeri marl-clay, section RG 280, bed 7, lowermost part, Liesberg BE, clay pit of Andil, leg. K. Lüdin, $\times 1$.
- Fig. 6. *Perisphinctes (Perisphinctes)* cf. *alatus* ENAY J 31230, Transversarium Zone, Antecedens Subzone, basal bed of the Pichoux limestone, section RG 307, bed 22, Péry BE, quarry of La Charuque, leg. H. & A. Zbinden, $\times 0.5$.

An arrow indicates the beginning of the body-chamber.



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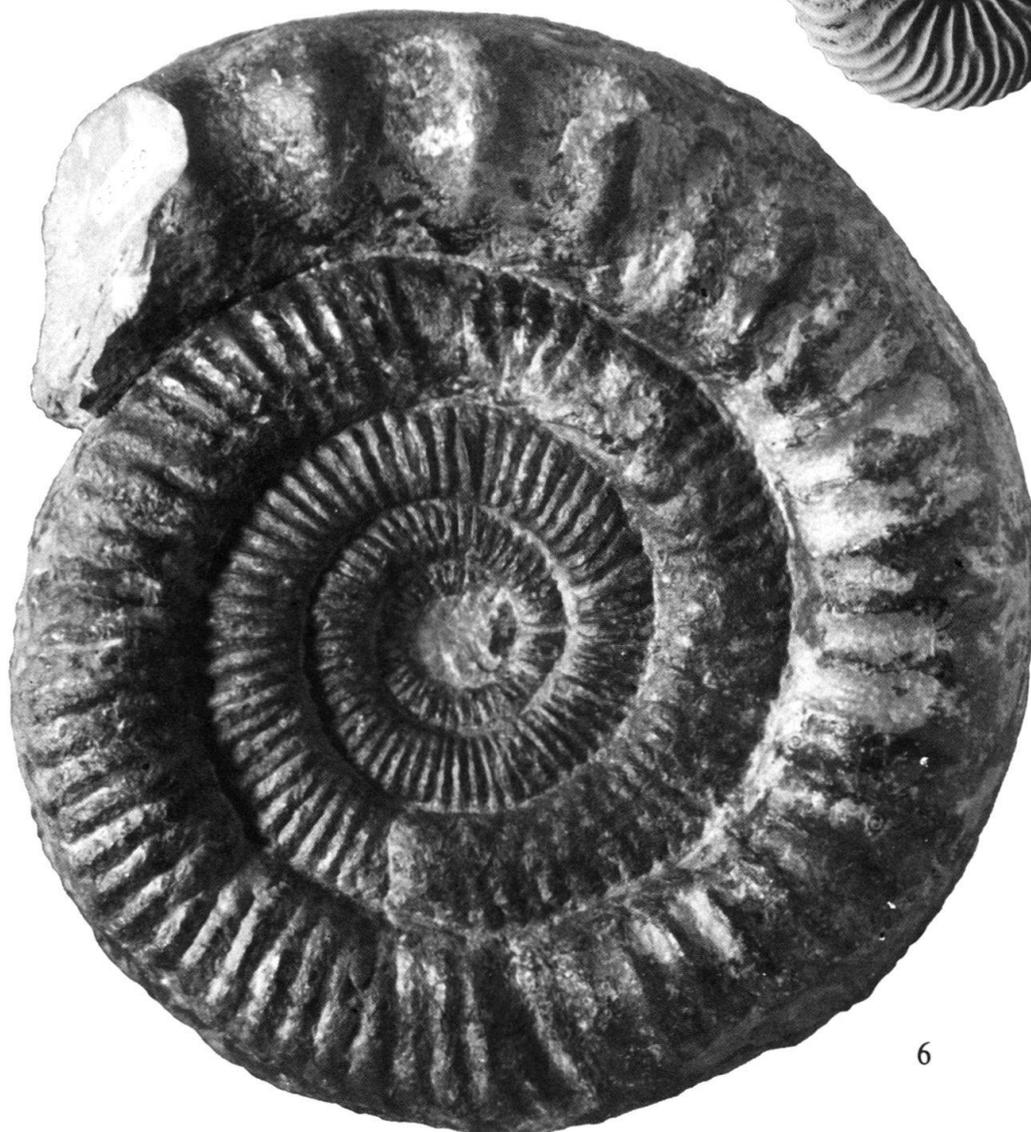
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Plate 7

- Fig. 1. *Cardioceras (Scarburgiceras) bukowskii* MAIRE J 30948, Cordatum Zone, Bukowskii Subzone, out of a brook northwest of La Cornée near Rebévelier JU, leg. B. Lange, × 1.
- Fig. 2. *Cardioceras (Scarburgiceras) cf. bukowskii* MAIRE J 31232, Cordatum Zone, Bukowskii Subzone, out of a brook northwest of La Cornée near Rebévelier JU, leg. B. Lange, × 1.
- Fig. 3. *Cardioceras (Scarburgiceras) bukowskii* MAIRE J 30947, Cordatum Zone, Bukowskii Subzone, out of a brook northwest of La Cornée near Rebévelier JU, leg. B. Lange, × 1.
- Fig. 4. *Cardioceras (Cardioceras) cf. costicardia* S. BUCKMAN J 31231, Cordatum Zone, Costicardia Subzone, out of a brook northwest of La Cornée near Rebévelier JU, leg. B. Lange, × 1.
- Fig. 5. *Perisphinctes (Amphillia) cf. quadratus* ENAY J 30687, Bifurcatus Zone, lower Effingen Member, section RG 307, succession no. 99, Péry BE, quarry of La Charuque, leg. B. Hostettler, × 0.5.



