Ann. Naturhist. Mus. Wien	103 A	23–73	Wien, März 2002

Gastropods from the Lower Cretaceous of Vorarlberg, Austria. A systematic review

by Heinz A. KOLLMANN[1]

(With 1 text-figure and 6 plates)

(Manuscript submitted on December 19th 2001,
the revised manuscript on Januray 31st 2002)

Abstract

This paper gives a synopsis and systematic revision of Lower Cretaceous gastropods of the Helvetic Zone in Vorarlberg, Austria. All investigated specimens are parts of public collections. Besides types and reference specimens, hitherto scientifically not investigated material is documented and mostly figured. The assemblage of the Upper Valanginan to Lower Hauterivian Kieselkalk Formation (mainly Gemsmättli Member) yielded 18 taxa. From the Barremian to Early Aptian Schrattenkalk Formation, 13 taxa are described, whereas 2 taxa stem from the Aptian Luitere Bed of the Gams Formation and 14 taxa from the Albian Garschella Formation. Due to the poor preservation, many taxa are specifically indeterminable. The assemblages closely resemble contemporary ones of the Swiss Jura, the Haute Savoie and the Anglo-Parisian Basin. Two new species are introduced: *Pyrgotrochus concavus* (fam. Pleurotomariidae) and *Pseudonerinea vaceki* (fam. Ceritellidae).

Zusammenfassung

Aus der Unterkreide des Helvetikums von Vorarlberg beschriebene, in Fossillisten erwähnte und bisher unbeschriebene Gastropodentaxa aus öffentlichen Sammlungen werden systematisch revidiert, beschrieben und größtenteils abgebildet. Die Kieselkalk Formation (höheres Valanginium- frühes Hautervium) lieferte 18 Taxa. 13 Taxa sind aus der Schrattenkalk Formation (Barremium-frühes Aptium) bekannt, 2 Taxa aus der Luitere Schicht der Gams Formation (Aptium) und 14 Taxa aus der Garschella Formation (Albium). Wegen der ungünstigen Erhaltung sind viele Formen spezifisch nicht bestimmbar. Die Gastropoden zeigen enge Beziehungen zu gleich alten Assemblages des Schweizer Jura, der Haute Savoie und des Anglo-Pariser Beckens. Zwei Arten, *Pyrgotrochus concavus* (Fam. Pleurotomariidae) und *Pseudonerinea vaceki* (Fam. Ceritellidae) werden neu beschrieben.

Introduction

Lower Cretaceous gastropod faunas of the Helvetic Zone of Vorarlberg, Austria, have been mentioned in various publications. ZITTEL, 1868, was first to list a fauna from the "Gault sandstone" of a locality on the north bend of the Bregenzer Ache at the road between Bezau and Andelsbuch. Besides ammonites, brachiopods and bivalves, Zittel, lit. cit., listed 11 gastropod taxa, among them 5 pleurotomariids, *Turritella*, *Pterocera*, *Avellana*, *Solarium*, *Straparolus* and *Turbo*.

[1] Dr. Heinz A. Kollmann, Naturhistorisches Museum, Postfach 417, A-1014 Wien. – Österreich. E-mail: heinz.kollmann@nhm-wien.ac.at

In the first monograph on the Cretaceous of Vorarlberg, VACEK, 1879, described several molluscs systematically, among them gastropods of ZITTEL´s collection. Types and the reference material to this publication are kept in the Bayerische Staatssammlung für Paläontologie und historische Geologie in Munich and the Austrian Geological Survey in Vienna. HEIM, BAUMBERGER & FUSSENEGGER, 1933, and HEIM, SEITZ & FUSSENEGGER, 1934, included gastropods into faunal lists. The reference material to these two publications, which has been collected by Siegfried FUSSENEGGER, is kept in the Vorarlberger Naturschau, Dornbirn. It has been re-identified by Georg FRIEBE for the "Data bank of fossils in Austrian collections" of the Austrian Academy of Sciences. The Vorarlberger Naturschau also holds additional material that has not been treated in the above-mentioned publications. Finally, CZABALAY, 1994, has described molluscs from the Schrattenkalk Formation of Vorarlberg.

The present study is based on material in public collections. It began as a investigation for the Catalogus Fossilium Austriae published by the Austrian Academy of Sciences. Most taxa, however, have never been described or figured before. It therefore seemed appropriate to discuss the taxa in more detail than the catalogue would allow. The systematic accuracy was improved by comparison with material from France, especially from the collection d´ORBIGNY at the Muséum National d´Histoire Naturelle, Paris, which is currently being investigated in the course of a systematic revision of the Cretaceous gastropods of the Paléontologie Francaise by d´ORBIGNY, 1842-43.

A large number of specimens is preserved as internal moulds. They are assigned tentatively to species when the shell form or remains of the sculpture are in agreement with them. Even indeterminable specimens were documented when they probably belonged to a taxon not represented by better preserved material. They are described here with open nomenclature because they contribute to the composition and diversity of the assemblages.

All previously described or mentioned specimens except these of CZABALAY, 1994, could be studied and figured. The specimens of CZABALAY, lit. cit. are sufficiently well documented and the author refers to that publication. Taxa are only briefly characterized. The synonymy list gives only the first descriptions and previous recordings from Vorarlberg; other relevant synonymies are quoted in the discussion.

Litho- and biostratigraphy of gastropod-bearing formations

Kieselkalk Formation. The litho- and biostratigraphy of the Kieselkalk Formation has been described in detail by Wyssling, 1986. The gastropod fauna originates mainly from the Gemsmättli Member of the Breiterberg. It forms the base of the Kieselkalk Formation (WYSSLING, 1986) and is condensated and highly fossiliferous. Due to the steepness of the rock surface, collecting on the Breiterberg is only possible in the rock debris. The biostratigraphic position of the gastropods is known from the accompanying ammonites. WYSSLING, 1986, has given a stratigraphic range from the Upper Valanginian characterized by olcostphanids (radiatus zone) to the basal Lower Hauterivian with *Breistrofferia* species.

Schrattenkalk Formation. In the lithostratigraphic subdivision, the Urgon-Kalk (Urgonian Limestone) of VACEK, 1879, is synonymous with the Schrattenkalk Formation. CSASZAR, OBERHAUSER & LOBITZER, 1987, give a facies analysis of the Upper Ill Gorge section at Feldkirch and of the Rhomberg quarry. This subdivision has not be applied to the Bezeck, from which VACEK, lit. cit., described gastropods. Based on calcareous algae

and Orbitolinidae (Foraminifera), BODROGI, 1987, gives an early Barrêmian to lower Aptian age for Schrattenkalk localities.

Gams Formation, Luitere Bed. VACEK, 1879, was the first to date the fossiliferous Luitere Bed on the Margarethen Kapf and consequently expanded the stratigraphic range of the "Gault" into the Aptian. FÖLLMI & OUWEHAND, 1987, have limited the stratigraphic range of the Luitere bed of Vorarlberg to the higher Lower Aptian.

Garschella Formation. Together with the Aptian Luitere Bed (see above), this formation represents the "Gault" by ZITTEL, 1868, and VACEK, 1879. FÖLLMI & OUWEHAND, lit. cit., subdivided the formation into various beds. These authors defined the Garschella Formation as a series of glauconite- and apatite-bearing sandstones with phosphoritic layers. They overlie the Schrattenkalk, Drusberg- and Mittagspitz Formation. The Garschella Formation is topped by the Seewer Kalk Formation.

Localities

The localities of the Kieselkalk Formation and the Schrattenkalk Formation mentioned in this paper are shown on the map by HEIM, BAUMBERGER & FUSSENEGGER, 1933, pl. 2. HEIM, SEITZ & FUSSENEGGER, 1934, pl. 1, have given the position of localities of the Luitere Bed and the Garschella Formation. It is therefore referred to these papers for the description and position of the localities.

Abbreviations in the text

The following abbreviations have been used in the text: Specimens of the Vorarlberger Naturschau are marked by VN: together with the collection number, those of the Geologische Bundesanstalt by GBA: and of the Bayerische Staatssammlung für Geologie und Paläontologie by BSP. The Laboratoire de Paléontologie at the Muséum National d´Histoire Naturelle, Paris, is symbolized by LPMP. MAFI has been used as symbol for the Hungarian Geological Survey.

Symbols for dimensions: H: total height; LW: Height of last whorl; B: greatest thickness of shell at a right angle to H. A: shell angle; (est): estimated values of incomplete specimens. Measurements other than the shell angle are given in mm.

Systematic description

Order EUOMPHALINA

Superfamily EUOMPHALOIDEA

Family Euomphalidae DE KONINCK, 1881

Genus *Discohelix* DUNKER, 1847

Discohelix martinianum (d´ORBIGNY)

Plate 5, Figures 77 - 79

1843 *Solarium Martinianum* d´ORBIGNY, p. 204, pl. 181, fig. 9-14
1863 *Straparolus Martinianus* d´ORBIGNY - PICTET & CAMPICHE, p. 557
1879 *Straparolus* nov.sp. (cf. *Solarium margaritanum* d´ORBIGNY) - VACEK, p. 695
1933 *Discohelix* cf. *martiniana* d´ORBIGNY - HEIM, BAUMBERGER & FUSSENEGGER, p. 207

Material. Reference material to VACEK, 1879: 1 external mould (GBA 1879/01/231). Reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1879: 1 internal mould from the Fluhereck (VN: P 371); 1 internal mould with shell remains around apex from the Lädtobel, Ebnit (VN: P12937). 1 external mould (VN: P 8938) of basal part from the same locality and a sculpture mould from Klaus – Plattenwald (VN: P 11302 are doubtful.

Dimensions. Internal mould from Klaus-Plattenwald: H: 9.6; B: 8.8

Description. Discoidal internal moulds, adapically depressed, with deeply canaliculate sutures. Whorls adapically concave in early whorls, moderately convex in later ones, Externally strong, acute rib with prominent tubercles. Sculpture consisting of lattice of spiral ribs and prosocline collabral ribs forming nodes at intersections. External side convex, with spiral ribs and partially strongly varicose collabral ribs. Abapical side broad umbilicate, whorls convex, sculpture like on external side.

Remarks. The sculpture of ontogenetically early whorls agrees with the type specimen of *Solarium martinianum* d´ORBIGNY, 1843, from Clar in the commune Escragnolles (Alpes-Maritimes, France) kept at the LPMP. In *Delphinula dupiniana* d´ORBIGNY, 1843, p. 194, pl. 178, fig. 10-13, the umbilicus is not as wide and the whorl side is almost flat.

Distribution. Albian of South France and Haute Savoie.

Distribution in Vorarlberg. Garschella Formation, Selun Member.

Order ARCHAEOGASTROPODA

Suborder DOCOGLOSSA

Superfamily PATELLOIDEA

Family Acmaeidae

Genus *Scurria* GRAY, 1847

? *Scurria* sp.

Plate 4, Figures 41 - 42

Material. 1 specimen, ?Unterklien (GBA: 2001/002/002)

Description. Shell cap-shaped, with almost circular aperture. Apex rounded, subcentral. Sides slightly convex, with irregular growth lines.

Remarks. The shell is assigned to *Scurria* because of the cap shape, the almost circular opening and the smoothness of the surface. *Scurria assymetrica* COSSMANN, 1916, p. 30, pl. 3, fig. 21–23, is higher.

Distribution in Vorarlberg. Schrattenkalk Formation

Suborder VETIGASTROPODA

Superfamily PLEUROTOMARIOIDEA

Family Pleurotomaridae

Genus *Leptomaria* EUDES-DESLONGCHAMPS, 1866

Leptomaria wrighti (COX)

Plate 1, Figures 1, 2

1861 *Pleurotomaria neocomiensis* LORIOL - VACEK, p. 684 (pars, non d´ORBIGNY, 1843, p. 240, pl. 188, fig. 8 -12).
1960 *Bathrotomaria wrighti* COX, p. 400, pl. 45, fig. 4a-d.

Material. Reference material to VACEK, 1879: 2 specimens from the Breiterberg, close to Bad Haslach (BSP 1867-XII-527 and 528).

Dimensions. H: 30; B: 39; LW: 21; A: 80°.

Description. Shells of medium size, broad conical, sides of spire convex. Whorls with moderately inclined, convex ramps, abapically flat to concave. Selenizone positioned in abapical half of flat portion. Sculpture of spiral threads all over the whorl, riblets on the ramp and prosocline collabral threads on the abapical portions. Periphery bulging. Base moderately convex; nodes at intersections between weak spiral and collabral ribs.

Remarks. VACEK, 1879, lit. cit., assigned these specimens to *Pleurotomaria neocomiensis*. His identification was obviously based on LORIOL, 1861, p. 240, pl. 3, fig. 4. (d´ORBIGNY, 1843, who is first author of the species, is only mentioned in brackets). LORIOL, lit. cit., has figured inadequately preserved internal moulds. *Pl. neocomiensis* d´ORBIGNY, 1843, p. 240, pl. 188, fig. 8 - 2, does not possess riblets, the selenizone is positioned on an angulation and the periphery is rounded (own observations on the original material of the collection d´ORBIGNY, LPMP). Systematically, this species belongs therefore to *Bathrotomaria*.

The specimens from Vorarlberg are assigned to *Leptomaria wrighti* (COX) because of the sculpture of spiral and collabral threads and riblets on the sutural ramp. According to COX, lit. cit., the base is smooth except for growth lines. The lack of collabral and spiral ribs may be due to the erosion of the outermost shell layers. Because of the position of the selenizone well abapically of the angulation of the whorls, the species is not positioned in *Bathrotomaria* as was done by COX, 1960, but in *Leptomaria*.

Distribution. COX, 1960, lit. cit., has recorded the species from the Hauterivian Claxby Ironstone of the Nettleton Top Mine, Lincolnshire, England

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Leptomaria gibsi (J. SOWERBY)

Plate 5, Figures 70 - 75.

1821 *Trochus gibsi* J. SOWERBY, p. 139, pl. 278, fig. 1
1879 *Pleurotomaria* cf. *Rhodani* PICTET- VACEK, p. 695
1934 *Nummocalcar* cf. *dentatum* HEIM, BAUMBERGER & FUSSENEGGER, p. 199
1934 *Pleurotomaria* sp. HEIM, BAUMBERGER & FUSSENEGGER, p. 207

Material. Reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1934: 1 internal mould with parts of the shell preserved from the Fluhereck (VN, P 10182), 1 equally

preserved mould from Klien (VN, P 12097), 1 doubtful internal mould from Klaus-Plattenwald (VN, P 12008); reference material to Vacek, 1879: 4 internal moulds and a plastillin mould of an external mould from Bezau (BSP 1867-XII-116; 1867-XII-522 to 526)

Dimensions of P 12097 (VN): H: 14.2; B: 19.7; LW: 9.0; A: 90°.

Description. Mould low conical. Sutural ramp of whorls broad, convex, moderately inclined. Whorl sides abapically more inclined, concave in internal moulds. Selenizone abapically of mid-whorl, broad, concave, delimited by strong ribs. Sculpture of regular collabral and spiral threads. Position of selenizone in internal moulds indicated by angulation Collabral sculpture in plaster mould from Bezau (GBA) stronger than in other specimens.

Periphery of last whorl acute, bulging. Base moderately convex, nodes at intersection between alternating weak and very weak spiral ribs and regular collabral threads. Umbilicus narrow, margin rounded.

Remarks. The species is positioned in *Leptomaria* because of the selenizone abapically of the carination of the whorl. Specimens agree well with *L. gibsi* (J. Sowerby) and the synonymous *Pl. gurgitis* d´Orbigny, 1843, p. 249, pl. 192, fig. 4 - 6, non Brongniart, 1822, pl. 9, fig. 7. Pictet & Roux, 1849, p. 237, pl. 23, fig. 2a,b, and Pictet & Campiche, 1863, p. 442, have correctly remarked that Brongniart´s figure does not show a pleurotomariid but is synonymous with *"Solarium" conoideum* Sowerby, 1812. Pictet & Campiche, 1863, p. 441, recognized the synonymy of *Pl. gurgitis* d´Orbigny with *Pl. gibsi* Sowerby.

Pleurotomaria rhodani, quoted by Vacek, 1879, lit.cit., as established by Pictet, has in fact been described by d´Orbigny, 1843, p. 250, pl. 192, fig. 7, 8. Pictet & Roux, 1849, p. 242, pl. 24, fig. 1a-g, figured an indeterminable specimen under this name. In d´Orbigny´s figures, the whorls are higher than in the specimens from Vorarlberg.

Distribution. Lower middle Albian occurrences of the London Basin are given by Cox, 1960, p.398. d´Orbigny, 1843, p. 250, recorded the species from the Paris Basin and the Provence, Pictet & Campiche, 1863, p. 443, from the Haute Savoie.

Distribution in Vorarlberg. Garschella Formation

Genus *Bathrotomaria* Cox, 1956

Bathrotomaria robinaldi (d´Orbigny)

Plate 1, Figures 3 - 4

1843 *Pleurotomaria robinaldi* d´Orbigny, p. 243, pl. 190, fig. 5-8
1879 *Pleurotomaria phidias* d´Orbigny - Vacek, p. 741

Material. Reference material to Vacek, 1879: 1 large internal mould with shell fragments from the Breiterberg, close to Bad Haslach (GBA 1879/01/77. An internal mould from the Breiterberg (VN, P 1606) is doubtful.

Dimensions. H: 80 (est: 90; B: 90; LW: 48; A: 65°. The dimensions of the doubtful mould are: H: 45, B: 47; LW: 23; A: 70°.

Description. Mould large and broad trochiform, whorls high, moderately convex. Sculpture of closely spaced spiral ribs. Selenizone on indistinct carination at mid-whorl. Base slightly convex to concave, umbilicus moderately broad, with rounded shoulder. Inside umbilicus coarse growth lines.

Remarks. The species is assigned to *Bathrotomaria robinaldi* (d´ORBIGNY) because of the convex whorls and the lack of sculpture except for growth lines on the flat base. d´ORBIGNY, lit. cit., figures a small specimen. The specimen figured by PERON, 1900, pl. 3, fig. 8, agrees in size with that of Vorarlberg. In specimens of the collection PERON kept in the LPMP, the selenizone is located on a carination at mid-whorl. The species is therefore assigned to the genus *Bathrotomaria*.

d´ORBIGNY, 1850, p. 70, briefly characterized but did not figure *Pleurotomaria phidias*, to which VACEK, 1879, lit. cit., assigned the specimen from Vorarlberg. d´ORBIGNY distinguishes this species from *Pl. pailletteana* d´ORBIGNY by its smaller umbilicus. Additionally, specimens of *Pl. pailletteana* of the collection d´ORBIGNY show spiral ribs within the umbilicus.

Distribution. Hauterivian of the Paris Basin.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

***Bathrotomaria* aff. *swinnertoni* COX**

Plate 1, Figures 5 - 6

1879 *Pleurotomaria neocomiensis* VACEK, p. 741 (pars, non d´ORBIGNY)
cf. 1960 *Bathrotomaria swinnertoni* COX, p. 401, pl. 45, fig. 2a,b; 3.

Material. Reference material to VACEK, 1879: 1 specimen from the Breiterberg, close to Bad Haslach (GBA 1879/01/79)

Dimensions. H: 2.9 (estimated: 3.2); B: 2.7; LW: 1.78; A: 75°.

Description. Shell of medium size, high coniform. Inner whorl face broad, inclination strong in early whorls, decreasing with ontogeny. Selenizone positioned on angulation. Outer whorl face moderately convex. Sculpture rudimentarily preserved, consisting of noded riblets on inner whorl face and of noded spiral ribs on outer whorl face. Periphery subangular; shell at base not preserved. Umbilicus narrow. Whorls broad elliptic in cross section.

Remarks. VACEK, 1879, lit. cit., assigned the specimen to *Pleurotomaria neocomiensis* d´ORBIGNY. The shell is higher than in *P. neocomiensis*, the inner whorl face is much more accentuated and bears riblets.

The whorl profile and the preserved sculpture indicate a close affinity with *Bathrotomaria swinnertoni* COX, 1960, lit. cit. The determination is tentative because of the rudimentarily preserved sculpture. The specimen figured by COX, lit. cit., fig. 2, is smaller. As in early ontogenetic stages of the specimen from the Breiterberg, close to Bad Haslach, its inner whorl face is strongly inclined.

Distribution. COX, lit. cit., has described *B. swinnertoni* from the Hauterivian Claxby Ironstone of the Nettleton Top Mine, Lincolnshire, England.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member.

Bathrotomaria sp. indet.
Plate 1, Figure 7

1933 *Pleurotomaria saleviana* Heim, Baumberger & Fussenegger, p. 205

Material. Reference material to Heim, Baumberger & Fussenegger, 1933: 1 internal mould from the Breiterberg, close to Bad Haslach (VN: P 10374)

Dimensions. H: 26.6; B: 35.5; LW: 28.5; A: 90°

Description. Large, broad trochiform mould. Early whorls convex; last whorl with broad, moderately inclined and convex inner whorl face. Traces of selenizone on carination. Outer whorl face almost parallel to shell axis, slightly convex. Periphery obtusely rounded. Base moderately convex, umbilicus broad, without distinct shoulder.

Remarks. The mould is specifically indeterminable. It resembles *B. neocomiensis* (d´Orbigny, 1843, p. 240, pl. 188, fig. 8 - 12) by its angular whorls and the subangular periphery. *Pleurotomaria saleviana* Loriol, 1861, p. 37, pl. 3, fig. 8, can be excluded because its shell is broader, the whorls are lower and not angular, and the base is more convex. This species is founded on an indeterminable specimen.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Genus *Pyrgotrochus* P. Fischer, 1885

Pyrgotrochus concavus n. sp.
Plate 1, Figures 8 - 12

1933 *Pleurotomaria neocomiensis* d´Orbigny - Heim, Baumberger & Fussenegger, p. 204.

Material. Reference material to Heim, Baumberger & Fussenegger, 1933: 1 specimen from the Breiterberg, close to Bad Haslach (VN, P 10382). 3 additional specimens of the same locality (VN : P 15438, P 16017, P 16021, P 16021).

Name: After the concave whorl face

Types. Holotype: P 16021, Paratypoids: P 15438, P 16017

Dimensions.

	H	H (est.)	B	LW	A
Holotype	34.0		34.6	18.3	60°
Paratypoid 1	30.0	40	32.0	17.2	58°
Paratypoid 2	44. 6		37.2	20.0	70°
Paratypoid 4 (VN)	44.0		48.1	19.3	65° (est.)

Type locality: Breiterberg, close to Bad Haslach

Stratum typicum. Kieselkalk Bed, Gemsmättli Member

Diagnosis. High conical form with concave whorls. Sculpture of spiral and collabral threads, periphery bulging, base flat, anomphalous.

Description. Shells large, side of spire slightly convex. Whorls strongly to moderately concave, bulging abapically. Sutures narrow canaliculate. Selenizone situated in the middle of whorl, flat, accompanied by strong rib on each side. Besides ribs limiting the selenizone, sculpture consisting of 6 spiral ribs on inner whorl face and 7 ribs on outer whorl face, all noded at intersection with delicate collabral ribs.

Last whorl strongly bulging. Periphery acute. Base almost flat, anomphalous, in holotype with strong, bent growth lines and traces of spiral threads. Paratypoid (P 15438) with densely spaced spiral threads. Aperture resembling low parallelogram, columella oblique.

Remarks. High conical specimens with concave whorls as well as broad conical specimens with shallow concave whorls are included in this species. They agree by their sculpture, their anomphalous condition, flat base and low aperture. HEIM, BAUMBERGER & FUSSENEGGER, lit. cit., determined a comparatively broad specimen (VN: P 10382) as *P. neocomiensis*. This species has a broad umbilicus and the selenizone is positioned on an angulation. Its systematic position is therefore in *Bathrotomaria*.

***Pyrgotrochus* cf. *concavus* n. sp.**

Plate 1, Figure 13

1879 *Pleurotomaria pseudoelegans* PICTET & CAMPICHE - VACEK, p. 741
1933 *Pleurotomaria Favrina* LORIOL - HEIM, BAUMBERGER & FUSSENEGGER, p. 204

Material. GBA: 1879/01/76. 2 specimens from the Breiterberg, close to Bad Haslach, reference material to VACEK, 1979; reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1933, from the debris at the Breiterberg (VN, P 10383)

Dimensions.

	H	H (est.)	B	LW	A
GBA/1	36.0	41	39.4	21.5	60°
GBA/2	24.3		25.7	15.3	60°

Description. Shells broad trochiform, whorls moderately concave. Selenizone flat, with lunulae, positioned in middle of whorl between two ribbons. Sculpture consisting of approximately 8 spiral threads on the inner whorl face and 15 on the outer whorl face, forming nodes at the intersections with irregular collabral ribs. Sculpture in some parts weak or totally lacking. Periphery bulging, acute in the internal mould.

Base slightly convex. In larger specimen basal shell not preserved, central hole filled by calcite. Smaller specimen anomphalous. Aperture resembling parallelogram.

Remarks. The sculpture is almost the same as in *Pyrgotrochus concavus* n. sp. and the overall morphology of the shell falls within the variability of this species. The deposition of calcite in the central hole of the larger specimen shows that the shell was anomphalous. The most striking difference to *P. concavatus* n. sp. is the higher aperture. The preservation is not good and the two shells are therefore described with open nomenclature.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Pyrgotrochus cf. *lemani* (Loriol)
Plate 2, Figures 14 - 16

? 1861 *Pleurotomaria Lemani* Loriol, p. 3, pl. 3, fig. 9
? 1863 *Pleurotomaria Lemani* Loriol - Pictet & Campiche, p. 421
? 1879 *Pleurotomaria Lemani* Loriol - Vacek, p. 740
1879 *Pleurotomaria Favrina* Loriol - Vacek, p. 741
? 1933 *Pleurotomaria Lemani* Loriol - Heim, Baumberger & Fussenegger, p. 204

Material: Reference material of Vacek, 1879, from the Breiterberg, close to Bad Haslach (one small internal mould (GBA 1879/01/75) and one large specimen with the shell preserved (GBA 1879/01/78); reference material of Heim, Baumberger & Fussenegger, which is a doubtful internal mould (VN: P10371)

Dimensions. GBA 1879/01/78: H: 42 (est.: 46); B: 41.5; LW: 22.2; A: 50. Internal mould, P 10371: H: 46; B: 43; A: 35°

Description. Shell high conical, whorls slightly concave, with numerous smooth spiral ribs. Selenizone at mid-whorl, with rounded top. Periphery of last whorl acute. External half of base flat, internal half moderately concave, with sculpture of spiral threads.

Remarks. Both the internal mould and the shell are high spired and possess moderately concave whorls. The characteristic change of the base from convex to concave is reproduced on the adapical end of the mould. These characters and the traces of spiral threads on the whorl face mentioned by Pictet & Campiche, 1863, lit. cit., allow keeping the determination by Heim, Baumberger & Fussenegger, 1933, with some reservation.

Distribution. Mont Salève, Haute Savoie, France

Distribution in Vorarlberg. According to Heim, Baumberger & Fussenegger, 1933, the specimens were collected in a block of debris originating from the base of the Kieselkalk Formation. Their biostrigraphic position may be deeper in the section than *P. concavus* n. sp.

Pleurotomariidae of unknown systematic position

Pleurotomariidae, indet. 1
Plate 2, Figure 17

1933 *Pleurotomaria bourgeti* Heim, Baumberger & Fussenegger, p. 205

Material. Reference material to Heim, Baumberger & Fussenegger, 1933: 1 internal mould, Breiterberg, close to Bad Haslach (VN: P 10375)

Dimensions. H: 28; B: 33.2; LW: 13.7; A: 110°

Description. Large, low conical mould. Whorls low, whorl face convex. Periphery of last whorl angular. Base slightly convex, ?broad umbilicate. Impressions of sculpture in the umbilicus show noded spiral ribs and growth lines.

Remarks. The selenizone is not preserved but the impression of the sculpture is that of a pleurotomariid. *Pleurotomaria bourgeti* Agassiz is a manuscript name. It was applied

by LORIOL, 1861, pl. 3, fig. 5 - 7, to mostly indeterminable internal moulds. According to fig. 3 the periphery is rounded. Fig. 6a shows a sculpture of densely spaced spiral and collabral threads. The specimen assigned by HEIM, BAUMBERGER & FUSSENEGGER, lit. cit., to this species is indeterminable. Its periphery is, however, distinctly angulate and an assignment to *Pl. bourgeti* LORIOL can be excluded.

Distribution in Vorarlberg. Base of the Kieselkalk Formation

Pleurotomariidae, indet. 2
Plate 5, Fig. 76

1979 *Solarium granosum* d´ORBIGNY - VACEK, p. 696

Material: Reference material to VACEK, 1979: 1 internal mould from St. Antoni, close to Feldkirch (GBA: 1879/01/258)

Dimensions. H: 10; B: 23.3; LW: 9; A: 115°

Description. Internal mould depressed. Whorls moderately convex, sutural ledges broad canaliculate. Indistinct ridge at mid-whorl indicating position of selenizone. Periphery acute, bulging. Base moderately convex, umbilicate, with traces of noded spiral ribs.

Remarks. The mould is in fact similar to that of *"Solarium" granosum* SOWERBY. In this species, the sculpture of the base consists of densely spaced nodes. They are arranged exclusively along strongly opisthocyrt growth lines, whereas the mould possesses noded spiral ribs which are common in pleurotomariids.

Distribution in Vorarlberg. Garschella Formation

Superfamily FISSURELLOIDEA

Family Fissurellidae

Genus *Fissurella* BRUGUIÈRE, 1789

***Fissurella* sp.**
Plate 4, Figures 39 - 40

Material. 1 eroded specimen, ? Unterklien (GBA: 2002/002/001)

Dimensions. H: 5.2; Largest diameter: 11.0; Smallest diameter: 7; Distance anterior margin to apex: 7.2 mm

Description. High patelliform shell; aperture broad elliptic, margin in a plane. Apex subcentral, with elongate opening. Sides moderately convex; broad anterior depression with flat radial rib in the symmetry plane. Outside depression densely positioned, weak radial ribs.

Remarks. The assignment to *Fissurella* is tentative. A specific assignment is not possible.

Distribution in Vorarlberg. Schrattenkalk Formation

Superfamily TROCHOIDEA

Family Ataphridae

Genus and subgenus *Ataphrus* Gabb, 1869

Ataphrus (Ataphrus) reductus Cossmann

Plate 4, Figures 43 - 45

1900 *Ataphrus reductus* Cossmann, p. 12, pl. 2, fig. 16 - 19, 21

Material. 6 specimens, ?Unterklien (GBA: 2002/002/003)

Dimensions.	H	B	LW
	1.1	2.0	1.0
	0.9	1.2	0.8

Description. Shells small, depressed turbiniform. Whorls smooth, slightly convex; suture slightly grooved. Last whorl increasing rapidly in breadth. Periphery rounded; base convex, anomphalous to narrow umbilicate. Aperture broad elliptic; columella concave, abapically very broad.

Remarks. The shells agree by their depressed form with the *Ataphrus reductus* Cossmann. Besides the original description, this author has documented this species in Cossmann 1916, p. 27, pl. 2, fig. 34 - 36, and Cossmann, 1918, p. 386, textfig. 23. In the material from Vorarlberg the broadening of the lip is preserved in some specimens. It does not show a groove like the specimen in Cossmann, 1918, textfig. 23.

Distribution. Limestones in Urgonian facies of south France. Barremian

Distribution in Vorarlberg. Schrattenkalk Formation

Family Trochidae

Subfamily Angariinae

Genus *Palangaria* Mongin, 1985

cf. *Palangaria* sp.

Plate 6, Figure 96

1934 *Natica* cf. *cornueliana* Heim, Baumberger & Fussenegger, 207

Material. Reference material to Heim, Baumberger & Fussenegger. 1 internal mould from the Fluhereck, W Ebnit, with a small portion of the shell preserved (VN: P 10183)

Dimensions. H: 21.2; B: 18.5; LW: 17.6; A: 80°

Description. Mould of medium size, naticiform. Spire incomplete, elevated. Whorls with broad sutural ramp delimited by rounded shoulder, abapically convex; sculpture of narrow-spaced ribs which are nodose at intersection with prosocline growth lines. Last whorl globose, shell lacking in adapical portion. Umbilicate, margin of umbilicus

unknown. Sculpture of irregular ribs and ribbons, irregular prosocline growth lines. Aperture not preserved.

Remarks. Various large, broad naticiform shells with an elevated spire, a narrow base and a broad umbilicus have been described from the Cretaceous. The sculpture consists of spiral ribs and prosocline growth lines. The aperture is broad, the acute columella is oblique or concave. The specimens have been assigned to the following genera:

- *Vanikoropsis* MEEK, 1876. COSSMANN, 1925, p. 41, assigned *Narica cretacea* d´ORBIGNY, 1843, p. 170, pl. 175, fig. 7-10, to this genus, which was first described from the United States. In *N. cretacea* the adapical portion of the whorls is flattened but lacks a distinct ramp. The umbilicus is broad, the aperture broad and the columella high and oblique. SOHL, 1967, p. B22 has discussed *Vanikoropsis*. His figures show that the aperture is not as high as in *N. cretacea*. This is mostly due to the columella, which is much lower and concave. The holotype of the type species, *V. tuoyemana* (MEEK & HAYDEN), figured in pl. 5, fig. 15 - 16, is incomplete. Other species of *Vanikoropsis* possess only a narrow umbilical slit. *N. cretacea* therefore does not belong to *Vanikoropsis*. FABRE, 1940, p. 252, pl. 6, fig. 3, has assigned this species to *Vanikoro* QUOY & GAIMARD ("*Vanikoroa*"). This is not justified because of the elevated spire and the broad umbilicus.
- *Palangaria* MONGIN, 1985, p. 11. Type species: *Delphinula leoncei* DONCIEUX, 1903, p. 305, pl. 1., fig. 22-22a. MONGIN, lit. cit., shows that early ontogenetic whorls are flattened at the suture and that a ramp delimited by an angulate shoulder is developed on the last whorl. The genus differs from *Hanaispira* by the lack of a canaliculate suture, a moderately concave columella and a narrow base.
- *Hanaispira* KASE, 1984, p. 102. Type species is *H. annularis* STOLICZKA , 1868, p. 377, pl. 25, fig. 3, from India. The suture is deep canaliculate and the whorls possess a distinct sutural ramp. The aperture is broad elliptic, the columella concave. KASE, lit. cit., has given several species from Asia, Africa, Europe and North America. In some of them the systematic position remains to be clarified. The European species have to be excluded from this genus.

Cretaceous specimens from Europe assigned to *Vanikoropsis* and *Palangaria* represent therefore a distinct group. It differs from *Hanaispia* by its aperture, which is high and narrow at the base. Among them, "*Vanikoropsis*" species are less heavily sculptured and do not possess a distinct ramp. Besides the specimen from Vorarlberg, this applies to the following species:

- *Narica cretacea* d´ORBIGNY, lit. cit.
- *Narica genevensis* PICTET & ROUX, 1849, p. 188, pl. 18, fig. 5a-f
- *Natica* aff. *pricei* PASSENDORFER, 1929, p. 251, pl. 2, fig. 36 (non: LORIOL, 1882, p. 21, pl. 3, fig. 3-5, in which the spiral sculpture is very weak

The fact that no distinct ramp is developed in early growth stages (MONGIN, lit. cit., pl. 1, fig. 1 - 4) leads the author to assign these species only tentatively to *Palangaria*. Better preserved material will show if they represent a distinct genus.

COSSMANN, 1925, p. 40, positioned *Vanikoropsis* in the Naticoidea, while MONGIN, 1985, p. 11, assigned *Palangaria* to the archaeogastropod family Angariidae. This sys-

tamatic position is accepted because of the apertural morphology. The shell morphology of the Angarriidae genera is very diverse (see Cox, 1960).

Distribution in Vorarlberg. Garschella Formation

Subfamily Margaritinae Stolicka, 1868

Genus *Semisolarium* Cossmann, 1915

Semisolarium hugianum (Pictet & Roux)

Plate 5, Figures 81-82; Plate 6, Figures 84-85

1849 *Solarium Hugianum* Pictet & Roux, p. 221, pl. 21, fig. 8
1863 *Solarium Hugianum* Pictet & Campiche, p. 540, pl. 88, fig. 3-5
1934 *Pleurotomaria* sp. Heim, Baumberger & Fussenegger, p. 206, 209

Material. Reference material of Heim, Baumberger & Fussenegger,1934, from Feldkirch-Göfis and Plattenwald (VN: P 12552), from the Gütle power station (VN: P 12644), and from the Gopf, E of the Bregenzer Ach (VN: P 11460). An additional internal mould (VN: P 8597) and an external mould (VN: P 1163) come from Klaus-Plattenwald.

Dimensions of P 12644 (internal mould). H: 10.7; b: 14.9; LW: 8.4; A: 85°

Description. Broad turbiniform moulds of medium size. Sutural ledges narrow. Whorls with narrow sutural ramps, abapically slightly concave but flat in internal moulds. 6-7 spiral ribs, noded at intersection with prosocline collabral threads.

Last whorl 2/3 of total height, abapical rib located on bulge of periphery. Base moderately convex, with spiral rows of strong nodes and sigmoidal growth lines in internal moulds. Umbilicus broad, delimited by subangular shoulder, with traces of spiral ribs which are less prominent than those at the base.

Remarks. The sculpture is preserved in one specimen (VN: P 12552). Internal moulds agree by their outline.

Distribution. Saxonet, Haute Savoie; Ste Croix, Swiss Jura (both Albian).

Distribution in Vorarlberg. Garschella Formation.

Semisolarium moniliferum (Michelin)

Plate 6, Figures 85-86

1834 *Solarium moniliferum* Michelin, pl. 34
1843 *Solarium moniliferum* d´Orbigny, Pal.Fr., p. 197, pl. 179, fig. 8-12
1934 *Pleurotomaria* sp. Heim, Baumberger & Fussenegger, p. 202, 209

Material. Reference material to Heim, Baumberger & Fussenegger, 1934: 1 internal mould from S of the Rappenloch Bridge (VN: P 12981), 2 internal moulds from the Gütle powerstation (VN: P 6669, P 12643); 1 internal mould from Klaus-Plattenwald (VN: P 8596).

Dimensions of P 6669 (internal mould). H: 15.1; B: 19.2; LW: 10.8; A: 85°

Description. Broad turbiniform moulds of medium size. Sutural ledges broad: Whorls strongly concave, in one specimen with strong spiral ribs. Periphery of last whorl acute,

followed closely by second carina on base. Base moderately convex, noded at intersection of numerous weak spiral ribs and collabral ribs. Umbilicus broad, delimited by rectangular shoulder.

Remarks. This taxon differs from *S. hugianum* by the concave whorl face of internal moulds, the second carina close to the periphery and the more delicate ribs on the base. All morphological characters can be observed in internal moulds, which can assigned with high certainty to the species.

Distribution. The species is widely distributed in Albian strata of the Paris Basin and of Saxonet, Haute Savoie (d´ORBIGNY, 1843, p. 198; 1850, p. 130; PICTET & ROUX, 1849, p. 221)

Distribution in Vorarlberg. Garschella Formation

Semisolarium astierianum (d´ORBIGNY)
Plate 5, Figure 80

1843 *Solarium Astierianum* d´ORBIGNY, p. 196, pl. 179, fig. 5 - 7

Material. 1 internal mould, Hirschberg? (GBA: 2002/002/004)

Dimensions. H: 12.7 (est. 15); B: 17.0; LW: 12.0; A: 100°

Description. Shell broad trochiform; sutures deep canaliculate. Whorls angulated, inclined and concave adapically of carination, less inclined towards shell axis and less concave in penultimate and early last whorl, almost parallel to shell axis in ultimate portion of last whorl. Remains of spiral threads noded along prosocline growth lines. Periphery carinated. Base convex, with indistinct carination close to periphery. Umbilicus broad, delimited by angular margin. Aperture not preserved.

Remarks. The angular whorls, the noded spiral threads, the convex base and the broad umbilicus are indicative for this species. Nodes at the margin of the umbilicus figured by d´ORBIGNY, 1843, lit. cit., are not observable.

d´ORBIGNY, 1843, recorded *Semisolarium astierianum* from Albian deposits of the Provence. *Semisolarium breistrofferi* DELPEY, 1942, p.43, pl. 1, fig. 1, is only inadequately described but agrees in whorl shape with *S. astierianum* and may be synonymous.

Distribution in Vorarlberg. Garschella Formation

Family Turbinidae

? Subfamily Astraeinae

Genus "*Nummogaultina*" KOLLMANN, in prep.

"*Nummogaultina*" aff. *dentata* (DESHAYES)
Plate 6, Figure 87, 88

aff. 1842 *Delphinula dentata* DESHAYES in LEYMERIE, p. 13. Pl. 16, fig. 14
1879 *Solarium Tingrianum* PICTET & ROUX - VACEK, p. 754

Material. Refrence material to VACEK, 1879: 2 internal moulds from the Margarethenkapf, Feldkirch (GBA: 1879/01/190).

Dimensions. H: 7.0; B: 13.0; LW: 6.6; A: 110°

Description. Moderately depressed moulds; early whorls convex, last whorl with narrow, horizontal sutural ramp and inclined whorl face with traces of orthocline riblets. Periphery acute, with irregular spines. Base narrow, slightly inclined. Umbilicus broad, delimited by angular shoulder.

Remarks. DESHAYES in LEYMERIE, 1842, lit. cit., described the species based on an internal mould. This specimen is strongly depressed, does not show any sculpture and the spines on the periphery are more regular. In contrast, specimens which d´ORBIGNY, 1843, p. 201, pl. 180, fig. 5-8, described under the same name, possess riblets. This is also the case with specimens described by PICTET & ROUX, 1849, p. 212, pl. 20, fig. 4a-f. In a large specimen figured by PICTET & ROUX, lit. cit., fig. 4a,b, the angulation around the umbilicus is indistinct.

PICTET & CAMPICHE, 1863, p. 549 and 541, doubted that d´ORBIGNY´s specimens belong to the same taxon as these described by Dehayes. However, the origin of specimens of both authors from Albian deposits of the Aube allows the conclusion that the differences are due to preservation and variablity of the species.

The moulds from Vorarlberg are higher than these described by DESHAYES, lit. cit. VACEK, 1879, assigned them to *Solarium tingryanum* PICTET & ROUX, p. 215, pl. 21, fig. 1,2. This species possesses no spines, the basal portion of the whorls is broader, the umbilicus smaller and the edge around the umbilicus not as acute. Besides the higher shell, the specimens are therefore closer to *S. dentatum* DESHAYES and are assigned tentatively to this species. *Delphinula chouberti* COLLIGNON, 1972, p. 10, pl. 1, fig. 4, shows broad canaliculate sutures, tubercles on the whorls, small riblets and regular spines on the acute periphery. Internal moulds are probably similar to these of *S. dentatum*.

Solarium dentatum is considered as type of the new genus *Nummogaultina,* which will be described in the critical revision of the Paléontologie Francaise by d´ORBIGNY, currently in preparation. The generic name is therefore put in brackets.

Distribution. Haute Savoie and Paris Basin. Besides Albian localities, d´ORBIGNY, 1843, p. 401, mentions the species from Clansayes, Drôme, which would extend the stratigraphic range of the species into the Uppermost Aptian. This recording could not be verified.

Distribution in Vorarlberg. Luitere Member of the Gams Formation

Superfamily AMBERLEYOIDEA

Family Amberleyidae

Genus *Amberleya* MORRIS & LYCETT, 1851

Subgenus Eucyclus J.A. EUDES-DESLONGCHAMPS, 1860

Amberleya (Eucyclus) acuminatus (DESHAYES)

Plate 2, Figure 19

1842 *Turbo acuminatus* DESHAYES in LEYMERIE, p. 13, pl. 17, fig. 3

Material: 1 partly preserved shell from the Breiterberg, close to Bad Haslach (BSP: 1867/XII/529)

Dimensions. H: 26.4 (est.:30); B: 24.0; LW: 18.5; A: 65°

Description. Shell large, broad turbiniform. Whorls high, with broad, inclined sutural ramp, delimited by acute angulation bearing elongate nodes. Whorls abapically subcylindrical. Indefinite number of delicate spiral ribs, noded at the intersection with prosocline growth lines.

Shell of last whorl only partly preserved. Abapical whorl face concave, sloping moderately towards axis in abapical direction. Periphery angulate. Base moderately convex, anomphalous, with narrow-spaced noded spiral ribs. Aperture not preserved.

Remarks. Despite its unfavourable preservation, the specimen agrees – based on its whorl shape, the traces of sculpture, the nodes at the angulation and the spiral ribs of the base – with *Turbo acuminatus* DESHAYES. This species has been re-described by d´ORBIGNY, 1842, p. 211. Pl. 182, fig. 9-11. *Turbo acastus,* briefly characterized by d´ORBIGNY, 1850, p. 70, and re-described and figured by COTTREAU, 1934, p. 59, pl. 71, fig. 15-17, possesses not as strong nodes on the angulation but agrees in its other morphological characters with *T. acuminatus*.

Distribution. The species has been recorded before from Hauterivian deposits of the Yonne, SE Paris Basin.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Amberleya (? Eucyclus) aff. *coquandi* (PICTET & CAMPICHE)

Plate 6, Figures 89-91

1863 *Turbo Coquandi* PICTET & CAMPICHE, p. 487, pl. 85, fig. 2-3
1979 *Turbo Coquandi* PICTET & CAMPICHE - VACEK, p. 696

Material: Reference material to VACEK, 1879: 1 plaster mould from Bezau (GBA, 1879/01/260). One doubtful internal mould from of the same locality (GBA:2002/002/005)

Dimensions. H: 12.5; B: 10.7; LW: 9.7; A: 60°

Description. Broad turbiniform mould. Sutures narrow canaliculate. Whorls with flat, inclined sutural ramp, delimited by indistinct angulation, abapically convex. 3 spiral ribs on ramp, 4 ribs abapically. Spiral ribs nodular along prosocline growth lines. Base and aperture not preserved.

Remarks. The shell angle of the mould is smaller than in *T. coquandi* PICTET & CAMPICHE, 1863, lit. cit., and the number of spiral ribs is 7 whereas it is 12 according to the original description. On the other hand, the specimens agree in their convex whorls and the ramp. As the variablity is not known, the mould is assigned tentatively to *Amberleya coquandi*. *A. chassyanus* (d´ORBIGNY, 1843, p. 220, pl. 185, fig. 1-3), which agrees in its shell angle, is probably synonymous with *A. coquandi*.

The collection of the GBA keeps an internal mould from Bezau which probably belongs to the same taxon. VACEK labelled it as "*Turbo gessneri* PICTET & CAMPICHE". PICTET & CAMPICHE, 1863, p. 521, pl. 87, fig. 5-7, have only described a *Trochus gessneri,* which is not comparable because of its flat whorls. VACEK did not include the name in his fossil list.

Distribution. Jura, Switzerland

Distribution in Vorarlberg. Garschella Formation

Amberleya (Eucyclus) cf. *golezianus* (Pictet & Roux)
Plate 6, Figure 92

1849 *Turbo Golezianus* Pictet & Roux, p. 196, pl. 19, fig. 4 a,b

Material: 1 incomplete internal mould from Bezau (GBA: 2002/002/006)

Dimensions. H: 12.4 (est. 15); B. 12.5; LW: 7.9; A: 65°

Description. Mould of medium size and broad turriculate. Whorls with traces of 2 carinations, and traces of strong prosocline collabral ribs. 3 spiral ribs on periphery of last whorl and adjacent portion of base. Center smooth, probably anomphalous.

Remarks. Vacek labelled the single specimen as *Turbo* cf. *plicatilis* Deshayes. The name is not included in the faunal list of Vacek, 1879. *Turbo plicatilis* Deshayes, 1842, p. 13, pl. 17, fig. 5a,b, is extremely low-spired and belongs probably to *Cenomanella* Cossmann.

The remains of the sculpture are in agreement with the sculpture of *Turbo golezianus* Pictet & Roux, which was described based on equally inadequately preserved internal moulds. Pictet & Campiche, 1863, p. 496, emphasized the close relationship to *Turbo sanctaecrucis* Pictet & Campiche, 1863, p. 466, pl. 82, fig. 2-4. which also belongs to the subgenus *Eucyclus* of *Amberleya*.

Distribution. Haute Savoie, France

Distribution in Vorarlberg. Garschella Formation

Genus *Onkospira* Zittel, 1873

Onkospira sp. indet.
Plate 2, Figure 18

Material: 1 internal mould , debris of the Breiterberg, close to Bad Haslach (VN: P 10386)

Dimensions. H: 17.5; B: 14.0; LW: 13.0; A: 25°

Description. Broad turriculate internal mould; early whorls strongly convex, penultimate to last whorl carinated at mid-whorl, with traces of spiral ribs. Varices on penultimate and last whorl. Base convex, with traces of closely positioned spiral ribs.

Remarks. The specimen is assigned to the Amberleyidae genus *Onkospira* Zittel because of the high spire, the convex whorls and the varices. A specific determination is not possible.

Distribution in Vorarlberg. Kieselkalk Formation

Family Nododelphinulidae

Genus *Helcicanthus* Dacqué, 1938

Helicacanthus sp. indet.
Plate 6, Figure 93

1934 *Pleurotomaria* sp., Heim, Baumberger & Fussenegger, p. 241

Material: Reference material to HEIM, BAUMBERGER & FUSSENEGGER : 1 fragment from Gopf, Bregenzer Ach close to Mellau (VN: P 11460)

Description. Fragment of a moderately high, small spire. Whorls gradate, adapically with broad, inclined ramp delimited by obtuse angulation. Abapical whorl face strongly inclined, slightly concave, becoming almost parallel to shell axis with ontogeny. Indistinct traces of spiral ribs.

Remarks. The specimen does not possess a selenizone and therefore does not belong to Pleurotomariidae. The gradate whorls agree with *Turbo thurmanni* PICTET & CAMPICHE,1862, p. 482, pl. 86, fig. 4-5, which is the type species of *Helicacanthus* COSSMANN. A specific determination of the fragment is not possible.

Distribution in Vorarlberg. Garschella Formation

Suborder NERITIMORPHA

Superfamily NERITOIDEA

Family Neritidae

Subfamily Neritinae

Genus *Neritoma* MORRIS, 1849

Genus *Neridomus* MORRIS & LYCETT, 1851

Neritoma (Neridomus) dolichostoma (COSSMANN)

Plate 4 Figure 46, 47

1907 *Neritodomus dolichostoma* COSSMANN, p. 24, pl. 6, fig. 18-20

Material. 1 specimen, ?Unterklien (GBA: 2002/002/007)

Dimensions. H: 1.2 mm; B: 1.2 mm

Description. Small, globular and thick-shelled shells; Whorls smooth, almost completely overlapping earlier ones. Suture slightly grooved in the final portion of the last whorl. Aperture broad, flaring, with broad, smooth septum.

Remarks. Cossmann, 1918, p. 385, fig. 22, has documented the specimen besides the original description. Only a small number of morphological characters are relevant for distinguishing *Neridomus* species. The species from Vorarlberg is assigned to *N. dolichostoma* because of the equally oviform shell.

Distribution. Urgonian facies, South France

Distribution in Vorarlberg. Schrattenkalk Formation

Genus *Otostoma* D´ARCHIAC, 1859

Otostoma bicostata (VACEK)

Plate 4 figures 48, 49

1879 *Nerita bicostata* VACEK, p. 750, pl. 16, fig. 6

Material. The specimen figured by VACEK, 1879, from the Bezeck near Bezau (BSP: 1867-XII-516), is established herewith as lectotype. 1 additional specimen from the same locality (GBA: 1879/01/153, paralectotype)

Dimensions of lectotype: H. 3.0; B: 4.2; LW: 2.9; A: 130°

Description. Shells small, globular. Whorls before the last one incomplete, ?smooth. Suture deep canaliculate. Last whorl large, with carination in the adapical third. Prosocline collabral ribs forming nodes at the suture. Lamella of inner lip incomplete, with strong teeth. Aperture broad, allmost semicircular.

Remarks. The globular shell, the sculpture and the dentate inner lip allow an assignment to *Otostoma*.

Distribution in Vorarlberg. Schrattenkalk Formation

Subclass CAENOGASTROPODA

Superfamily PSEUDOMELANIOIDEA

Family Pseudomelaniidae

Genus and subgenus *Pseudomelania* PICTET & CAMPICHE, 1862

Pseudomelania (Pseudomelania) albensis (d´ORBIGNY)

Plate 2, Figures 20, 21

1842 *Eulima albensis* d´ORBIGNY, p. 64, pl. 155, fig. 14-15
1879 *Eulima albensis* VACEK, p. 750

Material. Reference material to VACEK, 1879: 2 small fragments from the Bezeck (GBA: 179/01/148), of which one is doubtful. 1 shell from the Breiterberg, close to Bad Haslach, Gemsmättli-Schicht (VN: P 15997)

Dimensions. H: 7.0; H. (est): 9.0; B: 2.2; LW: 2.9; A: 15°

Description. Small, narrow turriculate shells. Whorls flat, smooth, sutures indistinct. Periphery of last whorl angular, base narrow. Aperture with straight columella.

Remarks. Specimens with angular periphery agree with *Eulima albensis* d´ORBIGNY. Specimens of the Yonne departement (coll. PERON, LPMP) are of equal size. The periphery is more rounded, the aperture is elliptic and the columella concave in one fragment. It may belong to a different species.

Distribution. Hauterivian deposits of the Aube and Yonne, France (d´ORBIGNY, 1843, lit. cit., and 1850, p. 67, PERON, 1900, p. 32).

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Superfamily CERITHIOIDEA

Family Procerithiidae

Subfamily Procerithiinae

Genus *Nerineopsis* COSSMANN, 1906

Nerineopsis sp.
Plate 4, Figures 63 - 67

1879 *Turritella laevigata* LEYMERIE - VACEK, p. 750

Material: Reference material to VACEK, 1979: 4 eroded fragments from Bezeck (GBA 1879/01/150), 1 specimen from the BSP (Nr. 1867-XII-537) has been cut axially.

Dimensions. H: 14.4 (est: 17); B: 3.0; LW: 4.6; A: 7°

Description. Shells high and narrow turriculate, whorls of medium height, cylindrical, with deep grooved sutures. Traces of ?noded ribs in the middle of the whorl and delimiting the adapical sutural groove. Periphery carinate, slightly bulging. Base flat.

Remarks. The specimens are assigned to *Nerineopsis* because of the cylindrical whorls, the sutural groove and the carinate periphery. However, the shells are strongly eroded. Systematically, *Turritella laevigata* LEYMERIE, 1842, p. 14, pl. 17, fig. 9, belongs to the same genus. According to the more detailed description by d´ORBIGNY, 1842, p. 36, pl. 151, fig. 7-9, it possesses a sculpture of spiral threads and irregular, weakly opisthocyrt growth lines. In *Nerinella bruni* COSSMANN, 1916, p. 15, pl. 1, fig. 13,14, the whorls are equally high and the sutures deep. There are 7 spiral ribs on each whorl, of which the adapical one is most prominent.

Distribution in Vorarlberg. Schrattenkalk Formation

Subfamily Paracerithiinae

Genus *Cirsocerithium* COSSMANN, 1906

Cirsocerithium cf. *lallierianum* (d´ORBIGNY)
Plate 6, Figure 94

1843 *Cerithium lallierianum* d´ORBIGNY, p. 365, pl. 229, fig. 7-9

Material: 1 external and internal mould, Bezeck (GBA: 2002/002/008). An artificial mould has been made of the external mould

Dimensions of the artificial mould: H: 16.8; B: 8.7; LW: 11.2; A: 30°

Description. Mould of medium size, broad. Sutures slightly grooved. Whorls moderately convex, adapically inclined and convex, abapically almost parallel to shell axis. Two spiral ribs on earliest preserved whorls, three on the penultimate and last whorls. Whorls before last one with delicate orthocline collabral ribs. Collabral ribs moderately prosocline on last whorl, not passing to the zone bearing spiral ribs.

Whorl face is delimited by an indistinct angulation. The base is moderately convex and shows a sculpture of spiral ribs which are closer to each other in the central portion. Labrum reinforced.

Remarks. The whorls are less convex than in specimens of the Paris Basin, and the angulation delimiting the inclined, adapical portion is not as distinct. This may be due to the different preservation. KOLLMANN, 1979, p.20, pl. 3, fig. 21-24, has described specimens from the Losenstein Formation of the Eastern Alps as *Cirsocerithium* cf. *subspinosum* (LEYMERIE). In this species, spines or nodes are developed at the carination.

Distribution. Albian deposits of the SW and NW Paris Basin, Ste Croix, Jura (Switzerland), and the Eastern Alps

Distribution in Vorarlberg. Garschella Formation

Family Potamididae

Genus *Potamides* Brongniart, 1810

Subgenus *Alocaxis* Cossmann, 1889

Potamides (?Alocaxis) zitteli (Vacek)

Plate 4, Figures 50 - 53

1879 *Cerithium Zitteli* Vacek, p. 750, pl. 18, fig. 1- 1b

Material. Figured specimen and numerous other syntypes to Vacek, 1879, from Bezeck, near Bezau (BSP: 1867-XII-513; GBA:1879/01/149)

Lectotype (here designated). The specimen figured in Vacek, 1879 , BSP: BSP 1867-XII-513/1

Dimensions of lectotype. H: 3.8; B: 2.0; LW: 1.5; A: 25°

Description. Shells small, high turriculate. Sutures deep canaliculate. Whorls low, flat, or weakly imbricating. Early ontogenetic whorls with prominent rib at abapical suture and less prominent one slightly adapically of the middle of the whorl. Third rib developing later at adapical suture and fourth between the two ribs that developed first. Ribs narrow-spaced and crenulated. An additional rib may occur on last whorl. Abapical rib positioned on subangulate periphery. Base smooth, externally convex, slightly depressed towards center, anomphalous. Aperture small, columella concave, with siphonal plait. Siphonal canal short, twisted.

Remarks. The species is assigned to *Potamides* because of its sculpture, the subangular periphery, and the short, twisted canal. The assignment to *Alocaxis* is based on the smooth base and is tentative. *Procerithium (Cosmocerithium) barremicum* Cossmann, 1918, p. 362, pl. 11, fig. 5,6, possesses a flat spire like *P. zitteli* but a sculpture of three crenulated ribs. The species may fall into the variability of *P. zitteli*. *Cerithium clementinum* d´Orbigny, 1843, p. 357, pl. 228, fig. 1-3, is closely related. It possesses orthocline collabral ribs which decrease in strength with ontogeny.

Distribution in Vorarlberg. Schrattenkalk Formation

Superfamily STROMBOIDEA

Family Aporrhaidae

Aporrhaidae, indet 1

Plate 2, Figure 22

1879 *Aporrhais Emerici* Pictet & Campiche - Vacek, p. 742

Material. The reference specimen of VACEK, 1879, which is a fragment of an internal mould from the Breiterberg, close to Bad Haslach (GBA: 1879/01/83)

Dimensions. H: 69.2 (est. 85); B: 34.0; A: 25°

Description. Mould high turriculate. Whorls high, convex. Indistinct traces of a spiral sculpture. Last whorl with stout siphonal neck.

Remarks. The mould is tentatively assigned to the aporrhaids because of the high spire, the high whorls and the siphonal neck. VACEK, 1879, lit.cit., assigned the species to *Aporrhais emerici*. He gives as author PICTET & CAMPICHE, 1864, p. 620. In fact, the species had been described by d´ORBIGNY, 1843, p. 306, pl. 216, fig. 1-2 based on an internal mould as *Pterocera emerici*. This internal mould, which is kept in the PM, is indeterminable. PICTET & CAMPICHE, 1864, p. 620, changed the generic position into *Aporrhais* without new evidence.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member.

Aporrhaidae, indet. 2

Plate 6, Figure 95

1934 *Aporrhais* sp., HEIM, BAUMBERGER & FUSSENEGGER, p. 207

Material: Reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1934: 1 incomplete specimen from Fluhereck, W Ebnit (VN: P 10184)

Dimensions. 31.4; B: 13.3; LW: 23.0; A: 25°

Description. Shell high turriculate. Whorls high, moderately convex, with sutural neck. Sculpture of widely spaced, strong and orthocline collabral ribs, fading towards the sutures, and traces of closely spaced spiral threads. Opisthocline varices. Last whorl partly preserved as internal mould. Whorl face terminated adapically by single carination. Mould of whorl completely smooth.

Remarks. The whorl profile and the sculpture agree with *Rostellaria subulata* PICTET & ROUX, 1849, p. 254, pl. 25., fig. 1a-c, (non: REUSS, 1845, p. 46, pl. 9, 8a-d). d´ORBIGNY, 1850, p. 132, renamed this Albian species into *R. subsubulata*. Like the specimen from Vorarlberg it posseses moderately convex whorls and a single carination on the periphery of the last whorl. The convex whorls and the carination of the last whorl support a systematic position in *Dimorphosoma* GARDNER, 1876, p. 396. A distinct generic and specific determination is not possible.

Distribution in Vorarlberg. Garschella Formation

Family Colombellinidae

Genus *Colombellina* d´ORBIGNY, 1843

Colombellina maxima DE LORIOL

Plate 2, Figures 23, 24

1861 *Colombellina maxima* LORIOL, p. 48, pl. 5, fig. 2-4
1879 *Columbellina maxima* LORIOL - VACEK, p. 741
1933 *Fusus neocomiensis* d´ORBIGNY - HEIM, BAUMBERGER & FUSSENEGGER, p. 204

Material. Reference material to VACEK, 1879: 1 internal mould from Breiterberg, close to Bad Haslach (GBA:1879/01/82) and another one from the same locality (BSP: 1867-XII-530). Reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1933: 1 internal mould from the Breiterberg (VN: P 10351)

Dimensions (BSP: 1867-XII-530). H: 36.1 (est: 38); B: 20.0; LW: 26.2; A: 50°

Description. Moulds of medium size and variably broad. Whorls with broad, moderately inclined sutural ramp, delimited by rectangular shoulder. Sculpture of weak spiral ribs and acute, prosocline ribs, forming strong tubercles on shoulder. Last whorl with broad siphonal neck. Collabral ribs expiring towards base. Aperture high, with straight, high columella. Siphonal canal narrow.

Remarks. One of the moulds is broader than the others and shows the high variability of the species. Following VACEK, 1879, lit. cit., the moulds are assigned to *C. maxima* LORIOL, 1861. Like the material from Vorarlberg, this species has been described on internal moulds. Among specimens assigned by PICTET & CAMPICHE, 1862, 107, pl. 96, fig. 8-10, to this taxon, fig. 10 shows 2 noded carinations on the base and may represent another taxon.

Distribution. Haute Savoie and Swiss Jura. PICTET & CAMPICHE, 1862, lit. cit., give a stratigraphic range from "Neocomian to Urgonian"

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Family Strombidae

Genus *Harpagodes* GILL, 1870

Harpagodes cf. *desori* (PICTET & CAMPICHE)

Plate 3, Figures 37, 38

1879 *Pterocera pelagi* d´ORBIGNY - VACEK, p. 741
1994 *Harpagodes pelagi* (BRONGNIART) - CZABALAY, pl. 4, fig. 5

Material. Reference material to VACEK, 1879: 1 fragmentary internal mould from the Breiterberg, close to Bad Haslach (GBA: 1879/01/81). One small mould from the same locality probably represents early whorls of this species (GBA: 2002/002/009)

Dimensions. H: 69; B: 48; LW: 60; A: 90°

Description. Internal mould large, subcylindrical. Spire low, early whorls convex, last preserved whorl with inclined ramp becoming increasingly flat towards aperture. Convexity of whorls increasing with ontogeny.

Remarks. The internal mould resembles by its lack of carinations early growth stages of *Pterocera desori* (PICTET & CAMPICHE, 1864, p. 575, pl. 90, fig. 3-4*)* from Amance, Hte Marne, kept at the LPMP. d´ORBIGNY, 1843, p. 304, pl. 212, described these specimens as *P. pelagi* BRONGNIART. Carinations are only developed in the final growth stages of the last whorl, whereas they are already developed in earlier stages of *H. pelagi*. The assignment is, however, uncertain.

Distribution. Hauterivian of the Paris Basin, lower Aptian of the Swiss Jura according to PICTET & CAMPICHE, 1862, p. 574.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Superfamily NATICOIDEA

Family Naticidae

Subfamily Gyrodinae

Genus *Gyrodes* CONRAD, 1860

Gyrodes gaultinus (d´ORBIGNY)

Plate 6, Figures 97, 98

1843 *Natica Gaultina* d´ORBIGNY, p. 156, pl. 173, fig. 3-4
1879 *Natica Favrina* PICTET & ROUX - VACEK, p. 754
1934 *Natica cornueliana* d´ORBIGNY - HEIM, BAUMBERGER & FUSSENEGGER, p. 213
1934 *Natica* cf. *cornueliana* d´ORBIGNY - HEIM, BAUMBERGER & FUSSENEGGER, p. 229

Material. Reference material to VACEK, 1879: 1 incomplete internal mould from Margarethenkapf, near Feldkirch (GBA: 1879/01/189); reference material to HEIM, BAUMBERGER & FUSSENEGGER, 1944: 1 incomplete shell from the Margarethenkapf (VN: P 8300), 1 internal mould from Klaus-Plattenwald (VN: P 10278)

Dimensions. H: 24.5; B: 23.4; LW: 24.2; A: 115°

Description. Shell and mould globular, low-spired. Whorls strongly convex, with narrow, flat sutural ramp bearing growth lines. Ramp delimited by angular shoulder. Base in both specimens preserved as internal mould. Margin of moderately broad umbilicus narrowly rounded. Whorls almost semicircular in cross section. Aperture not preserved.

Remarks. The narrow ramp and the moderately broad umbilicus with its rounded margin are diagnostic for *Gyrodes gaultinus* (d´ORBIGNY). *Natica favrina* PICTET & ROUX, 1849, p. 181, pl. 17, fig. 4, to which VACEK, lit. cit., has assigned specimens does not possess a sutural ramp and the umbilicus is smaller. According to the type material at the LPMP, *Natica cornueliana* d´ORBIGNY, 1843, p. 150, pl. 170, fig. 4-5, is anomphalous or only narrow umbilicate and therefore has to be excluded.

Distribution. Recordings from the Paris Basin (d´ORBIGNY, 1843, p. 156; 1850, p. 129), the Haute Savoie (PICTET & ROUX, 1849, p. 184, pl. 18, fig. 1), the Swiss Jura (PICTET & CAMPICHE, 1862, p. 388) and the Eastern Alps (KOLLMANN, 1978, p. 174, pl. 1, fig. 1-6, are of Albian age. PICTET & CAMPICHE, 1862, p. 390, 391, extend the stratigraphic range into the Upper Aptian.

Distribution in Vorarlberg. Luitere Member, Gams Formation (late Lower Aptian)

Subfamily Globulariinae

Genus *Pictavia* COSSMANN, 1925

Pictavia cf. *laevigata* (Deshayes)
Plate 2, Figures 25, 26

1842 *Ampullaria laevigata* Deshayes in Leymerie, p. 13, pl. 16, fig. 10
1842 *Natica Clementina* d´Orbigny, p. 154, pl. 172, fig. 4
1933 Natica laevigata d´Orbigny - Heim, Baumberger & Fussenegger, p. 205

Material: Reference material to Heim, Baumberger & Fussenegger, 1934: 1 internal mould from the Breiterberg, close to Bad Haslach (VN: P 10433)

Dimensions. H: 16.0; B: 13.1; LW: 14.2; A: 75°

Description. Mould small, oviform. Whorls convex. Last whorl 90 % of total height, with narrow flat zone at suture. Aperture broad, columellar and parietal lip equal in length.

Remarks. The mould agrees in its high oviform outline and the anomphalous base with *Natica laevigata* d´Orbigny, 1843, lit. cit.The preservation does not allow a definite determination.

Distribution. Hauterivian of the Paris Basin, ?Valanginian of the Swiss Jura (Pictet & Campiche, 1862, p. 373.)

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Genus *Ampullina* Bowdich, 1822

Ampullina sp.
Plate 2, Figure 29

1933 *Natica globulosa* Deshayes - Heim, Baumberger & Fussenegger, p. 205

Material. Reference material to Heim, Baumberger & Fussenegger, 1933: 1 incomplete internal mould from the Breiterberg, close to Bad Haslach (VN: P 10429). 1 large specimen with the shell mostly preserved from the Örfla Gorge, Götzis (VN: P 9931)

Dimensions. H: 9.4; B: 9; LW: 9. H: 24.3; B: 22.5; LW: 21.9; A: 90°

Description. Large, broad oviform shell; whorls convex, flattened at the adapical suture. Last whorl 90% of total height, adapical flat zone becoming broader towards aperture. Umbilicus narrow. Aperture very large, parietal lip straight, columella concave.

Comparable dimensions in small specimens. Whorls first evenly rounded, adapical flat zone developing shortly before aperture.

Remarks. Deshayes in Leymerie, 1842, p. 12, pl. 16, fig. 29, described the species which possesses spiral grooves as *Auricula globulosa*. Later, d´Orbigny, 1843, p. 132, pl. 168, fig. 9-12, assigned it to *Avellana*. Based on material of the collection Peron at the LPMP, it could be assigned to *Ringinella d´*Orbigny. The specimens of Vorarlberg are not preserved well enough for a specific assignment but they certainly do not agree with this species.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Genus *Globularia* SWAINSON, 1840

Globularia subtilis (COSSMANN)

Plate 4, Figures 54, 55

1918 *Ampullospira subtilis* COSSMANN, p. 381, textfig. 21

Material. 1 specimen from ?Unterklien (GBA: 2002/002/010)

Diemnsions. H: 1.9 mm; B: 1.9 mm; LW: 1.7 mm

Description. Shell small, globular. Spire low, number of whorls not evident. Suture of last whorl slightly grooved, Last whorl with slight adapical depression, almost totally overlapping earlier ones.

Aperture broad, angulated adapically. Parietal lip forming umbilical pouch. Columellar lip low and concave but incomplete.

Remarks. COSSMANN, lit. cit., describes the species based on a specimen which is about 3 times larger than that from Vorarlberg. The specimens agree in the adapical depression on the last whorl and the pouch, which is only indicated on the drawing given by COSSMANN, lit.cit. The stronger overlap of whorls in the specimen recorded here may be due to the earlier growth stage. The assignment to *Globularia* is mainly based on the umbilical pouch and the adapical depression of the last whorl.

Distribution. Urgonian facies of Orgon, Bouche du Rhône (Barrêmian)

Distribution in Vorarlberg. Schrattenkalk Formation

Globularia cf. *hugardiana* (d´ORBIGNY)

Plate 3, Figure 30

1843 *Natica Hugardiana* d´ORBIGNY, p. 151, pl. 171, fig. 2
1879 *Natica Hugardiana* d´ORBIGNY - VACEK, p. 741
1994 *Leviathania munieri* (CHOFFAT) - CZABALAY, pl. 4, fig. 4

Material. Reference material to VACEK, 1879: 1 internal mould from the Breiterberg, close to Bad Haslach (GBA: 1879/01/80)

Dimensions. H: 89.5 (est.: 95); B: 98.6; LW: 72.6; A: 90°

Description. Mould very large, broad. Early whorls moderately convex, sutural ledges very broad. Last whorl 8/10 of total height, strongly convex, anomphalous. Aperture very broad, inner lip concave.

Remarks. The mould is that of a large anamphalous shell belonging to *Globularia* SWAINSON. d´ ORBIGNY, lit. cit., gives a figure of a low-spired mould. In fact, all specimens of the collection d´ORBIGNY possess higher spires than the figured one and the specimen from Vorarlberg agrees in this respect. Because of the preservation, the specific assignment remains tentative.

Distribution. d´ORBIGNY, 1863, p. 152, recorded the species from Neocomian deposits of south France. In the Haute Savoie and the Swiss Jura, PICTET & CAMPICHE, 1862, p. 377, give a Valanginian to ?Hauterivian distribution

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Subclass HETEROSTROPHA
Order ALLOGASTROPODA
Superfamily NERINOIDEA
Family Ceritellidae
Genus *Ceritella* MORRIS & LYCETT, 1851

Ceritella (Ceritella) urgonensis VACEK
Plate 4, Figures 56 - 58

1879 *Ceritella urgonensis* VACEK, Vorarlberger Kreide, p. 749, pl. 18, fig. 4, 5

Material. Syntypes to VACEK, 1879: 2 syntypes including the figured specimen from Bezeck, near Bezau (BSP: 1867-XII-514). 7 additional syntypes of the same locality (GBA: 1879/01/147)

Dimensions. Lectotype (herewith determined from the two specimens of the BSP): H 10.5; (est. 14); B. 3.9; LW: 7; A: 20°

Description. Shells small, high-spired. Whorls with narrow, inclined and concave sutural ramp. Whorl face abapically slightly convex to flat. Last whorl approximately half of total height. Aperture adapically angular; columella high, slightly oblique and concave. Base moderately narrow, excavated.

Remarks. The excavation of the base is broader than figured by VACEK, 1979, lit. cit. Based on its narrow shell, the sutural ramp, the high, narrow aperture and the oblique columella the species agrees remarkably well with the type species, *Ceritella acuta* MORRIS & LYCETT. Among Lower Cretaceous species, *C. cureti* COSSMANN, 1900, p. 523, pl. 1, fig. 25-27, is broader and the aperture is lower.

Distribution in Vorarlberg. Schrattenkalk Formation

Genus *Pseudonerinea* LORIOL, 1890

Pseudonerinea vaceki n. sp.
Plate 3, Figures 31 - 36

1879 *Pseudomelania Germari* PICTET & CAMPICHE - VACEK, p. 742
1933 *Pseudomelania germani* PICTET & CAMPICHE - HEIM, BAUMBERGER & FUSSENEGGER, p. 204 or 205
1933 *Pseudomelania Jaccardi* PICTET & CAMPICHE - HEIM, SEITZ & FUSSENEGGER, p. 193, 204

Material: Reference material to VACEK, 1879: 1 Internal mould from the Breiterberg, close to Bad Haslach (GBA:1879/01/84) and to HEIM, BAUMBERGER & FUSSENEGGER, 1933, from the same locality (VN: P 10367)

Name. Dedicated to the geologist Michael VACEK, who wrote the first comprehensive monograph of the Cretaceous of Vorarlberg.

Stratum typicum. Kieselkalk Formation, Gemsmättli Member

Holotype. GBA:1879/01/84

Dimensions of holotype. H: 56; (est.70); B: 20; LW: 34.9; A: 10°

Definition. *Pseudonerinea* possessing concave whorls with an adapical bulge and an abapical carination.

Description. Shells large, high and narrow turriculate. Sutures canaliculate. Whorls concave, with strong adapical bulge, abapically angular, sloping backwards towards suture. Growth lines irregular, moderately prosocline, forming tubercles on the adapical bulge. Outer shell layers not preserved in the basal part of last whorl. Periphery rounded, base high, slightly convex. Aperture high, with low columella, base broadly excavated.

Whorls of internal moulds slightly convex, with broad sutural ledges.

Remarks. *Pseudonerinea vaceki* n.sp. has equally large shells and high whorls *as P. arigensis* PCELINTSEV, 1963, p.61, pl. 19, fig. 1-3. In this species, the abapical half of whorls is convex and the adapical half narrowly impressed. VACEK, 1879, lit, cit., and HEIM, BAUMBERGER & FUSSENEGGER, 1933, lit. cit., have assigned the specimens to *Pseudomelania germani* PICTET & CAMPICHE, 1863, p. 269, pl. 70, fig. 6-8. This species has been described exclusively based on internal moulds. The whorls are lower, convex and more tightly coiled. The basal part of the aperture is not as broad as in *P. vaceki* n. sp.

In the small specimen which HEIM, BAUMBERGER & FUSSENEGGER, 1933, lit. cit., assigned to *Pseudomelania jaccard*i PICTET & CAMPICHE, 1862, p. 268, pl. 70, fig. 3-5, the whorls except for last one are almost flat. The last whorl is slightly concave and shows prosocline growth lines. This specimen is obviously a smaller ontogenetic stage of *Pseudomelania vaceki* n. sp.

Specimens from Upware, England, which KEEPING, 1883, p. 94, pl. 3, fig. 7, described as *Nerinea* sp. seem to be closely related with *P. vaceki*.

Distribution in Vorarlberg. Kieselkalk Formation, Gemsmättli Member

Family Nerineidae

Genus *Plesioptyxis* PCHELINTSEV, 1953

Plesioptyxis aff. *essertensis* (PICTET & CAMPICHE)

Plate 4, Figures 59 - 62, Textfigure 1

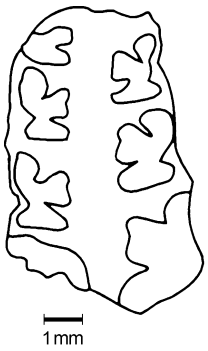
1862 *Nerinea Essertensis* PICTET & CAMPICHE, p. 242, pl. 69, fig. 1
1879 *Nerinea Essertensis* PICTET & CAMPICHE - VACEK, p. 688 (pars, see *Nerinella* sp.)

Material. 3 specimens from the Bezeck near Bezau (BSP: 1867-XII-34 to 36), one doubtful specimen from Unterklien (VN: PS 9803)

Dimensions. Small fragment from the Bezeck: H: 4.1 mm; B: 2.2. A: 20°. The dimensions of the specimen from Unterklien are: H: 18 (base incomplete); B. 7.5; A: 20°

Description. Shells small, turriculate. Whorls of medium height, strongly concave, bulging at the adapical suture. Whorl section rectangular. Long, acute and slightly upwards turned abapical columellar plait and very small adapical one. Palatal plait situated in the abapical half of the palatal region. Parietal plait long, situated in the middle of parietal region, bent.

Specimen from Unterklien are considerably larger than the others. Sutures positioned on bulges.



Textfig. 1: *Plesioptyxis* aff. *essertensis* (PICTET & CAMPICHE)

Remarks. The specimens from the Bezeck show the same plaits as *N. essertensis* PICTET & CAMPICHE, lit. cit., but they are smaller and the whorls are more strongly concave. The variablility of the species is unknown. The specimens are therefore only tentatively assigned to the species. The whorls are comparable with *Nerinea (Ptygmatis) micromorpha* COSSMANN, 1907, p. 14, pl. 2, fig. 5-8 and COSSMANN, 1916, p. 15, pl. 1, fig. 30-31. In this species, the internal plication is only vaguely known. COSSMANN, 1916, pl. 1, fig. 31, shows a large abapical columellar plait and a equally large, bent parietal plait.

The number of plaits and the small adapical columellar plait are characteristic for the genus *Plesioptyxis* PCHELINTSEV, 1953, p.165. In *Neoptyxis* PCHELINTSEV, the adapical columellar plait is much stronger. Compared with other representatives of the genus, the specimens from Vorarlberg are small.

Distribution of *P. essertensis*. Swiss Jura

Distribution in Vorarlberg. Schrattenkalk Formation

Genus *Pchelincevia* LYSSENKO & ALIEV, 1987

Pchelincevia indet.

1994 *Adiozoptyxis coquandiana* CZABALAY, pl. 5, fig. 3

Material. 1 indeterminable oblique natural section from Unterklien (MAFI)

Description. Fragment of a large nerineacean. Whorl face concave, whorl section triangular. Columellar plait large, bent upwards; parietal plait smaller, situated at the internal margin of the parietal lip; broad, triangular palatal plait. Columella hollow.

Remarks. The external side of the whorls is not known and the fragment is therefore specifically indeterminable. The high triangular whorl section, the lack of a distinct siphonal canal and the narrow central cavity of the hollow columella allow assignment to the genus *Pchelincevia* LYSSENKO & ALIEV, 1987, p. 119. LYSSENKY & ALIEV, lit. cit., determined explicitely *Nerinea gigantea* d´HOMBRE-FIRMAS - PETKOVIC, 1939, p. 74, pl. 4, fig. 1-2, textfig. 12, and not *N. gigantea* d´HOMBRE-FIRMAS, 1838, p. 207, pl. 5, fig. 1-2 as type species of this genus. In fact, the specimen by PETKOVIC, lit. cit., does not agree with the original description. *N. gigantea* was re-described by d´ORBIGNY, 1842, p. 77, pl. 158, fig. 1-2, and COSSMANN, 1807, p. 9, pl. 1, fig. 1-5. Its whorls are parallelogramme-shaped instead of triangular in section and the columella is solid. *Nerinea gigantea* PETKOVIC is closely related or synonymous with N. *renauxiana* d´ORBIGNY, 1802, p. 76, pl. 157 (the exact position can only be determined from the whorl face).

Pchelincevia represents a well-defined group. *Affiniptyxis* LYSSENKO & ALIEV, 1987, p. 119, differs in its rhombic whorl section and a plait positioned in the middle of the parietal portion. *Umbonea* PCHELINTSEV possesses an extremely broad umbilicus.

Distribution in Vorarlberg. Schrattenkalk Formation

Genus *Nerinella* SHARPE, 1850

Nerinella sp.

Plate 4, Figures 63-67

1879 *Nerinea Essertensis* PICTET & CAMPICHE - VACEK, p. 688 (pars)

Material. Reference material to VACEK, 1879: 3 specimens from the Bezeck (BSP: 1867-XII-531 to 533)

Dimensions. H: 17.7; B: 4.1; LW: 5.4; A: 10°

Description. Shells small turriculate, surface eroded. Whorls high, flat, abapically noded, in one specimen indistinct flat belt in the middle of whorl. Sutures weakly grooved. Periphery of last whorl angular; base inclined at approximately 60° to shell axis.

Whorls in axial section parallelogramme-shaped; columella recrystallized, thin. One columellar, parietal and palatal plait each. Columellar plait short, situated between abapical and median third of columella; columella adapically straight. Parietal plait long, thin. Palatal plait strong, triangular in section, situated opposite to columellar plait.

Remarks. The high whorls and the number and relative strength of internal plaits are distinctive features of *Nerinella* SHARPE. Judging from its moderate thickness, the columella was massive. The specimens differ from the type species *Nerinella dupiniana* (d´ORBIGNY) by their smooth surface and the flat whorls.

Together with others, VACEK, lit. cit., has assigned the specimens to "*Nerinea" essertensis* PICTET & CAMPICHE, 1862, p. 242, pl. 69, fig. 1. In this species, the shell angle is larger and the additional small columellar plait identifies it as as *Plesioptyxis* species (see under *P.* aff. *essertensis*).

In *Nerinella? fugax* COSSMANN, 1918, p. 352, pl. 10, fig. 22-23, the shell angle is larger. According to COSSMANN, lit. cit., the exact number of plaits is not known. A definite generic assignment is therefore not possible.

Distribution in Vorarlberg. Schrattenkalk Formation

Subclass EUTHYNEURA

Suborder OPISTHOBRANCHIA

Order CEPHALASPIDEA

Superfamily ACTEONELLOIDEA

Family Acteonellidae

Genus *Cylindrites* J. SOWERBY, 1824

Cylindrites cretaceus VACEK

Plate 4, Figures 68-69

1879 *Cylindrites cretaceus* VACEK, Vorarlberger Kreide, p. 749, pl. 18, fig. 2, 3

Material. Syntypes to VACEK, 1879, from the Bezeck near Bezau: 2 specimens including the figured (BSP: 1867-XII-511 and 512); pl. syntypes of the same locality (GBA: 1979/01/146). BSP:1867-XII-511 has been selected as lectotype.

Dimensions of the lectotype. H: 10 , B: 3.1; LW: 8.2; A: 50°

Description. Shell small. Whorls low, slightly convex. Last whorl 8/10 of total height, subcylindrical. Aperture high, narrow; deep incision between columella and parietal wall. Strong adapical plait and flat rounded abapical columellar plait.

Remarks. VACEK, 1879, p. 749, emphasized correctly that the shell outline agrees with that of *Acteonina infracretacea* OOSTER & FISCHER-OOSTER, 1871, p. 97, pl. 15, fig. 6-7, from the "Pteropodenschicht" of Veveyse de Fégire, which according to RUTSCH, 1966, p. 895, is of Beriasien age. The shells described by OOSTER & FISCHER-OOSTER are about half as large. Their abapical part incuding the columella is incomplete and they are indeterminable.

Cylindrobullina angusta PCELINTSEV, 1963, p. 68, pl. 21, fig. 4, from deposits dated as Hauterivian possesses a cylindrical last whorl. The last whorl is more loosely coiled than the others. The aperture is not known.

The incision between the columella and the parietal wall supports a position within *Cylindrites*. The columella is higher than in the type species *C. cuspidatus* SOWERBY, 1812-46, p. 77, pl. 455, fig. 1, which possesses only a single weak plait. *Cylindritis (Ptychocylindrites)* COSSMANN possesses two columellar plaits. The spire is sunken in and the adapical ramp of the last whorl bears a dentate sculpture.

Distribution in Vorarlberg. Schrattenkalk Formation

Superfamily Ringiculoidea

Family Ringiculidae

Genus *Avellana* d´ORBIGNY, 1842

Avellana subincrassata d´ORBIGNY

Plate 6, Figures 99 - 100

1879 *Avellana incrassata* d´ORBIGNY - VACEK, p. 1879

Material: Reference material to VACEK, 1879: 1 internal mould from Bezau (GBA: 1879/01/229), 6 fragments of internal moulds from the same locality (BSP: 1867-XII-125; 517-521)

Dimensions (specimen of BSP:1867-XII-125). H: 17.4; B: 15; LW: 16.7; A: 80°

Description. Moulds globular. Early whorls strongly convex. Last whorl slightly flattened adapically. Sculpture of delicate, noded spiral ribs. Aperture broad, labrum reinforced, with delicate elongate denticles interiorly. 2 columellar plaits, abapical one close to base, strong, adapical plait small, situated at the boundary towards the parietal lip. In one specimen small parietal plait visible.

Remarks. Despite their preservation, the moulds can be assigned to *Avellana subincrassata* d´ORBIGNY because of the globular shells and the adapicallly flat last whorl. The parietal plait, which is visible in one specimen, is hardly discernable even in well-preserved specimens.

d´ORBIGNY, 1842, p. 133, pl. 168, fig. 13-16, dassigned specimens to *Avellana incrassata* MANTELL. In fact, the specimens from France are globular and possess a flat adapical area, whereas *A. incrassata* MANTELL, 1822, p. 110, pl. 19, fig. 34, is more oviform. The internal plaits agree in both species. d´ORBIGNY, 1850, p. 128, correctly changed the name into *A. subincrassata* but did not comment on it.

Distribution. Among specimens of the collection d´ORBIGNY, those of Ervy (Aube) and the perte-du-Rhône belong to this species. PICTET & ROUX, 1849, p. 174, pl. 16, fig. 6a-g, record the species under the name *A. incrassata* from the perte-du-Rhône and Haute Savoie and DESTOMBES & MONGIN, 1976, pl. 1, fig. 13, from Courcelles (Aube).

Distribution in Vorarlberg. Garschella Formation

General remarks to the assemblages

Collection material has the disadvantage that assemblages have to be treated as bulks and fluctuations in the composition are not recognizable. Based on the previous chapter, the following assemblages have been recorded:

1. Kieselkalk Formation, mainly Gemsmättli Member

Leptomaria wrighti (COX)
Bathrotomaria robinaldi (d´ORBIGNY)
Bathrotomaria aff. *swinnertoni* COX
Bathrotomaria sp. indet.
Pyrgotrochus concavus n. sp.
Pyrgotrochus cf. *concavus* n. sp.
Pyrgotrochus cf. *lemani* (LORIOL)
Pleurotomariidae, indet. 1
Onkospira sp. indet
Amberleya (Eucyclus) acuminatus (DESHAYES)
Pseudomelania (Pseudomelania) albensis (d´ORBIGNY)
Aporrhaidae indet. 1
Columbellina maxima LORIOL
Harpagodes cf. desori (PICTET & CAMPICHE)
Pictavia cf. *laevigata* (SOWERBY)
Globularia cf. *hugardiana* (d´ORBIGNY)
Ampullina sp.
Pseudonerinea vaceki n. sp.

All specifically determinable taxa have been recorded before from the London-Paris Basin (d´ORBIGNY, 1842-43; PERON, 1899, COX, 1960). LORIOL, 1861, and PICTET &

ROUX, 1847-53, described some from the department of Haute Savoie in France. Several of them have been recorded from the Swiss Jura (PICTET & CAMPICHE, 1861-64). *Pseudonerinea vaceki* has been newly described. The genus *Pseudonerinea* is represented in the areas mentioned before. The lower diversity may be due to methods of collecting and the mode of preservation.

The fauna lacks groups which generally are considered as Theian (former Tethyan, KOLLMANN, in press), such as nerineaceans. Pleurotomariidae, which are generally considered as Kalaisian ("boreal" or temperate of the literature, KOLLMANN, in press) are fairly diverse. The abundance of ammonites (see lists of HEIM, BAUMBERGER & FUSSENEGGER, 1933) indicates environments that were bathymetrically deeper than those of nerineaceans, anthozoans, etc. The faunas of the French departements Yonne and Aube are generally considered as a bulk, but show quite a variety of facies. COLLETÉ et al., 1995, have compared the assemblages of various Hauterivian environments of the Paris Basin and have shown that the diversity of gastropods and echinoids is diametrical to that of the corals. We may conclude from the composition of the Gemsmättli gastropod assemblage that its depositional area belonged to the same palaeobiogeographic unit as the Anglo-Paris Basin. According to reefal structures it was part of the Theian realm in the Valanginian/Hauterivian.

2. Schrattenkalk Formation

The sedimentology of the Schrattenbach Kalk Formation was discussed by CSASZAR et al., 1989. Its depositional environments vary between a flat foreslope (Ill section) and proximal, semirestricted lagoons (Rhomberg Quarry, Unterklien). Naturally, the latter are richer in megafossils.

The following taxa have been recorded from the Schrattenkalk Formation:

Fissurella sp.
? *Scurria* sp.
Ataphrus (Ataphrus) reductus COSSMANN
Neritoma (Neridomus) dolichostoma COSSMANN
Otostoma bicostata (VACEK)
Potamides (?Alocaxis) zitteli (VACEK)
Nerineopsis sp. 1
Ceritella (Ceritella) urgonensis VACEK
Plesioptyxis aff. *essertensis* (PICTET & CAMPICHE)
Pchelincevia indet.
Nerinella sp.
Globularia subtilis (COSSMANN)
Cylindrites cretaceus VACEK

The taxa are closely related to those of the Urgonian facies of France (COSSMANN, 1907, 1916, 1918). However, COSSMANN, 1918, lists 109 species while there are only 13 known from the Schrattenkalk Formation. This is either due to more intensive collecting or to a larger variety of ecological niches in the Urgonian platform. In both the Schrattenkalk (CZASZAR et al., 1989) and the Urgonian platform (MASSE, 1979) gastropods occur mainly in deposits of proximal lagoons together with rudists. The scarci-

ty of large nerineaceans compared to Orgon (COSSMANN, lit. cit.; PETKOVIC, 1939) allows the assumption that shallow-water environments of high energy (see: KOLLMANN et al., 1991) were restricted to the Unterklien section, while other gastropod assemblages represent slightly deeper environments.

3. Luitere Member of the Gams Formation

Only "*Nummgaultina*" aff. *dentata* (DESHAYES) and *Gyrodes gaultinus* (d´ORBIGNY) have been recorded from this Member, which FÖLLMI & OUWEHAND, 1987, have dated as terminal Lower Aptian. Both taxa were originally described from the Gault facies of the Paris Basin. Together with other taxa, they were also recorded by d´ORBIGNY, 1843, from Clansayes. The agreement of the faunas supports the long-known fact that the composition of assemblages is stable under stable conditions.

4. Garschella Formation

The "Helvetic Gault" of earlier authors has yielded the following taxa:

Leptomaria gibsi (d´ORBIGNY)
Pleurotomariidae indet. 2
Discohelix martinianum (d´ORBIGNY)
Semisolarium hugianum (PICTET & ROUX)
Semisolarium moniliferum (MICHELIN)
cf. *Palangaria* sp.
Semisolarium astierianum (d´ORBIGNY)
Amberleya (? Eucyclus) aff. *coquandi* (PICTET & CAMPICHE)
Amberley (Eucyclus) cf. *golezianus* (PICTET & ROUX)
Helicacanthus sp. indet.
Cirsocerithium cf. *lallierianum* (d´ORBIGNY)
Aporrhaidae, indet. 2
cf. *Palangaria* sp.
Avellana subincrassata d´ORBIGNY

Taxa which have been determined to the genus and species level agree with species known from the Gault facies of the London-Paris Basin and from phosphatic and glauconitic sediments („greensands") of the Jura and the Provence (d´ORBIGNY, 1842-43; PICTET & CAMPICHE, 1861-64). Compared to other areas, the diversity of gastropods in the Garschella Formation is low. This is partly due to the condensation during which most shells were dissolved.

HANCOCK, 1975, considers the Gault facies as typical basinal. FÖLLMI, 1989, indicates the condensation to be a "fingerprint" of Tethyan (= Theian) currents. As mentioned under the Gemsmättli Member, the composition of marine bottom faunas below the top marine mixed layer seems to be rather uniform throughout Europe. This has also been stated for certain groups by MONGIN, 1979. By means of fossils, a differentiation between Theian and Kalaisian realms can therefore only be accomplished with top marine layer assemblages (KOLLMANN, 2001, in press). According to FÖLLMI, 1989, the

accumulation of benthos and benthos-related organisms (such as ammonites) is due to a catastrophic burial of faunal communities by bypassing palimpsest sands.

Acknowledgements

The hospitality of Prof. Jean-Claude FISCHER and Prof. Agnès RAGE during numerous research visits to the Laboratoire de Paléontologie of the Muséum National d´Histoire, Paris, is gratefully acknowledged. I am very grateful to Prof. Jean-Claude FISCHER, Muséum National d´Histoire Naturelle, Paris, for reviewing this paper and for his valuable comments concerning the systematic position of some genera. Dr. Georg FRIEBE (Vorarlberger Naturschau, Dornbirn), Dr. Gerhard SCHAIRER (Bayerische Staatssammlung für Paläontologie und historische Geologie, München) and Dr. Franz STOJASPAL (Geologische Bundesanstalt, Vienna) helped in locating fossil material and lending it to me. Dr. Rudolf OBERHAUSER has generously shared his great knowledge of the Geology of Vorarlberg with me.

Additional preparation on the material has been carried out by the technicians Franz TOPKA and Anton ENGLERT; Alice SCHUMACHER performed photographic work (all: Naturhistorisches Museum Wien).

The work was supported by the Austrian Academy of Sciences.

References

BODROGI, I. (1989): Foraminiferen, Kalkalgen und die Bostratigraphie des Schrattenkalks von Vorarlberg (Österreich). – In: J. WIEDMANN (ed.): Cretaceous of the Western Tethys. – p. 403-425, 4 pl., 7 textfigs. –Stuttgart (Schweizerbarth´sche Verlagsbuchhandlung).

BRIART, A. & CORNET, F.-L. (1865): Description minéralogique, géologique et paléontologique de la Meule de Bracquegnies. – Acad. roy. Belg., Mém. Cour. Sav. étr. **34**: 1-92, 8 pl. – Bruxelles.

BRONGNIART, A. in CUVIER,G. (1822): Description géologique des couches des environs de Paris, parmi se trouvent les gypses à ossements. – In: CUVIER,G.: Recherches sur les ossements fossiles, nouvelle ed., **2**/2: 239-648, 11pl. – Paris.

COLLETÉ, Cl., FRICOT, Cl., MATRION, M., TOMASSON, R., TREFFOT, G. (1995): La Géologie du Département de l´Aube. – 22 pp., 16 pl., 1 geological map. – Troyes (Association Géologique Auboise).

COLLIGNON, M. (1972): Les Gastéropodes et les Serpules crétacés du bassin côtier de Tarfaya (Maoc méridional). – Le Bassin côtier de Tarfaya (Maroc méridional), 3, Paléontologie. oôtes et Mém. Serv. Géol. Maroc, **228**: 9-29, 4 pl.

COSSMANN, M. (1900): Observations sur quelques coquilles crétaciques recueillies en France - La faune d´Orgon (with a note on the limestone containing Orbitolines of Orgon by A. PELLAT). – Ass. Fr. Avancement des Sciences, p. 518-532, 2 pl.

—— (1907): Le Barrémien supérieur à facies d´Urgonien de Brouzet-Les-Alais (Gard). Part 2.

—— (1916): Paléontologie. – In: DE BRUN, P., CHATELET, C. & M. COSSMANN: Le Barrémien supérieur à facies urgonien de Brouzet-les-Alais (Gard), 2. – Mém. Soc. Géol. Fr., **21**/4: 56 pp., 5 pl. – Paris.

—— (1918): Les coquilles des calcaires d´Orgon.- Bull. Soc. Géol. Fr., ser. 4, **16**: 336-431, 35 textfigs., pl. 10-17. – Paris.

—— (1925): Essais de Paléoconchologie Comparée, vol. **13**. 345 pp., 11 pl. – Paris.

COTTREAU, J. (1934):Types du Prodrôme de Paléontologie stratigraphique universelle de D´ORBIGNY, tôme 3: Néocomien. A. Néocomien inférieur ou Néocomien. – Ann. de Paléontologie, **23**: 45-80, pl. 71-75. – Paris.

—— (1937): Types du Prodrome de Paléontologie stratigraphique universelle de d´ORBIGNY. tôme 3: Néocomien. B. Néocomien supérieur ou Urgonien. – Ann.de Paléontologie, **26**: 17-84, pl. 2-7. – Paris.

COX, L.R. (1960): The British Cretaceous Pleurotomariidae. – Bull. Brit. Mus. (Nat.Hist.), Geology ser. 4/8: 385-423, pl. 44-60, 1 textfig. – London.

CZABALAY, L. (1994): Korrelation des Urgons von Ungarn (Villány- und Mecsek-Gebirge) und Österreich (Vorarlberg). – Jubiläumsschrift 20 Jahre Geologische Zusammenarbeit Österreich-Ungarn (H. LOBITZER, G. CSÁSZÁR & A. DAURER, Eds.), **2**: 209-224, 2 textfigs., 5 pl. – Wien.

CZASZAR, G., OBERHAUSER, R. & LOBITZER, H. (1989): The Schrattenkalk of Vorarlberg: An example of Urgonian sedimentation. – In: J. WIEDMANN (ed.): Cretaceous of the Western Tethys. –377-401, 12 textigs. – Stuttgart (Schweizerbarth´sche Verlagsbuchhandlung).

DELPEY, G. (1942): Études sur les gastéropodes albiens. – Ann. Univ. Grenoble, Sect. Sciences-Médecine, **18**: 35-58, 25 textfigs. – Grenoble.

DESHAYES, G.P. 1842. See: LEYMERIE, 1842

DESTOMBES, P. & D. MONGIN (1976): L´Albien moyen de Courcelles (Aube). – Bull. Inf. Géol. Bassin de Paris, **13**/2: 33-40, 2 pl. – Paris.

DONCIEUX, L. (1903): Monographie géologique et paléontologique des Corbières orientales. – Ann. Univ. Lyon, N.S., **11**: 403 pp., 8 pl. – Lyon.

FABRE, S. (1940): Le Crétacé Supérieur de la Basse-Provence Occidentale.- I. Cénomanien et Turonien. – Ann. Fac. Sci. Marseille, ser. 2, **14**: 1-353, 10 pl. – Marseille.

FITTON, W.H. 1836. See: SOWERBY, J. de C.

FÖLLMI, K.B. & P.J. OUWEHAND (1987): Garschella-Formation und Götzis-Schichten (Aptian-Coniacian): Neue stratigraphische Daten aus dem Helvetikum der Ostschweiz und des Vorarlbergs. – Eclogae Geol. Helv., **80**/1: 141-191, 13 textfig. – Basel.

GARDNER, J. S. (1875): On the Gault Aporrhaidae. – Geol.Mag., N.S. (2) **2**: 49-56, 124-130, 198-203, 291-298; pls.3, 5, 6, 7. – London.

HANCOCK, J. M. (1975): The sequence of facies in the Upper Cretaceous of Northern Europe compared with that in the Western Interior. – Geol. Assoc. Canada, Spec. Pap. **13**: 83-118, 5 textfigs., 2 tab. – Waterloo, Ont.

HEIM, A., BAUMBERGER, E. & FUSSENEGGER, S. (1933): Jura und Unterkreide in den helvetischen Alpen beiderseits des Rheins (Vorarlberg und Ostschweiz). – Denkschr. Schweiz. Naturf. Ges., **68**/2: I-IX, 155-220, 2 pl. – Zürich.

—— , SEITZ, O. & FUSSENEGGER, S. (1934): Die Mittlere Kreide in den helvetischen Alpen von Rheintal und Vorarlberg und das Problem der Kondensation. – Denkschr. Schweiz. Naturf. Ges., **69**/2: 190-245, 3 pl. – Zürich.

d´HOMBRE-FIRMAS, L.A. (1838): Notice sur la Nérinée gigantesque Nerinea gigantea, Nob. – Recueil de mém. et observ., 207-209, pl. 5. – Nimes.

KASE, T. (1984): Early Cretaceous marine and brackish-water gastropoda from Japan. – 262 pp., 31 pl. – Tokyo (National Science Museum).

KEEPING, W. (1883): The fossils and palaeontological affinities of the Neocomian deposits of Upware and Brickhill (Cambridgeshire and Bedfordshire). – x + 164 pp., 5 pl. – Cambridge.

KOLLMANN, H.A. (1978): Gastropoden aus den Losensteiner Schichten der Umgebung von Losenstein (Oberösterreich). Part 2: Naticidae, Colombellidae, Aporrhaidae, Ceritellidae, Epitoniidae (Mesogastropoda). – Ann. Naturhistor. Mus., **81**: 173-201, 5 pls. – Wien.

—— (2002, in press): Theia and Kalais – palaeobiogeographic terms replacing Tethys and Boreal. – In: MICHALIK, J. (ed.): Tethyan/Boreal Cretaceous Correlation. Mediterranean and Boreal Cretaceous palaeobiogeographic areas in Europe. – Bratislava.

—— , DECKER, K., LEMONE, D. (1991): Evolution and biostratigraphy of Tethyan Cretaceous gastropods. – Unpublished report, 90 pp., 10 pl., 14 textfig. – Wien.

—— & PEZA, L. H. (1997): *Diptyxis* OPPENHEIM (Nerineacea, Gastropoda) from the Lower Cretaceous of Albania. On the distribution of the genus *Diptyxis*. – Ann. Naturhistor. Mus. Wien, **98** A: 17-33, 2 pl. – Wien.

LORIOL, P. de (1861): Description des animaux invertébrés fossiles continus dans l´étage Néocomien moyen du Mont Salève. – 214 pp., 22 pls. – Genève-Bale.

LYSSENKO, N.I.& ALIEV, G.A. (1987): Revizija roda Diozoptyxis i novoe semejstwo gastropod. – Pal. Journ., 1987/1: 116-120, 2 textfigs. – Moskwa.

MANTELL, G. (1822): The fossils of the South Downs; Illustrations of the Geology of Sussex. – xiv + 327 p., 42 pl. – London.

MASSE, J-P. (1979): Les rudistes (Hippuritacea) du Crétacé inférieur. Approche paléoécologique. – Géobios, Mem. spec., **3**: 277-287, 7 fig. – Lyon.

MICHELIN, H. (1834): Magasin de Zoologie. – pl. 34. – Paris.

MONGIN, D. (1979): Observations paléoécologiques et biogéographiques sur les gastropodes et lamellibranches du stratotype de l´Albien. – In: Les stratotypes francais, 5: L´Albien de l´Aube, p. 407-413, textfig. 9-1. – Paris

—— (1985): Les Mollusques de l´Albien des Corbières (Sud de la France). Modes de vie et paléoécologie. Avec introduction stratigraphique par B. PEYBERNES. – p. 1-129, 4 pl. (copied report circulated by the authors). – Paris.

OOSTER, W.A. & FISCHER-OOSTER, C. von (1870-71): Protozoe Helvetica, 2: 149 pp., 19 pl. – Bern

ORBIGNY, A. d´ (1842-43): Paléontologie Francaise, Terrains Crétacés. Vol. 2: Gastéropodes. – 456 pp., pl. 149-236bis. – Paris.

—— (1850): Prodrôme de Paléontologie stratigraphique universelle, 2: 427 pp. – Paris.

PASSENDORFER, E. (1929): Étude stratigraphique et paléontologique du Crétacé de la série haut-tatrique dans les Tatras. – Trav. Serv. Géol. Pologne, **2**/4: 511-576, 6 pl. –Warzawa.

PCHELINTSEV, V.F. (1934): Some data on the Mesozoic fauna of the western Georgia. – Trudy Vsesjuznogo geologo-raswedosnogo ob´edinenija NKTP SSSR., **252**: 67 pp., 6 pl. – Leningrad, Moskwa, Nowosibirsk.

—— (1953):Fauna bryukhogikh verkhemelov´ikh otlozhenij Zakawkas´ja srednei Azii. – 391 pp., 51 pls., 47 textfigs. – Moskwa-Leningrad.

PERON, M. (1900): Etudes paléontologiques sur les terrains du département de l`Yonne. Céphalopodes et gastropodes de l´étage Néocomien. – Bull. Soc. Sci. Yonne, p. 67-153, 4 pl. – Auxerre.

PETKOVIC, K. (1939): Quelques espèces de Nerinées du Crétacé inférieur à facies urgoniens de Kosutnjak (environ de Beograd). – Ann. géol. Pénins. Balkanique, **16**: 65-76, 5 pl., 12 textfig. – Beograd.

PICTET, F.J. & CAMPICHE,G. (1861-64): Description des fossiles du terrain crétacé des environs de Sainte-Croix, 2ème partie. – Mat. Pal. Suisse, **3**: 1-752, pl. 44-98. – Genève.

—— & RENEVIER, E. (1854-58): Description des fossiles du terrain Aptien de la Perte du Rhone et des environs de Ste-Croix. – Mat. Pal. Suisse, **1**: 184 pp., 23 pls. –Genève.

—— & ROUX, W.J. (1847-53): Description des mollusques fossiles qui se trouvent dans les grès verts des environs de Ste-Croix. – 557 pp., 51 pls. – Genève.

REUSS, A.E. (1845-46): Die Versteinerungen der Böhmischen Kreideformation. – IV + 58 + 148 pp., 51 pl. – Stuttgart.

RUTSCH, R.F. (1966, Ed): Lexique stratigraphique international, Suisse. Fasc. 7c: Alpes Suisses et Tessin Méridional. – 1356 pp., 2 pl. – Paris.

SOHL, N.F. (1967): Upper Cretaceous gastropods from the Pierre Shale at Red Bird, Wyoming. – US Geol. Surv., Prof. Pap. **393**-B: B1-B46, 11 pl. – Washington, D.C.

SOWERBY, J. (continued by J. de C. SOWERBY) (1812–46): The mineral conchology of Great Britain. 7 vols. – London.

SOWERBY, J.de C. (1836): Descriptive notes respecting the shells figured in plates XI - XXIII. – In: FITTON, W.H.: Observations on some of the strata between the Chalk and the Oxford Oolite, in the south-east of England. – Transact.Geol.Soc.London, 2.ser., **4**: 103-388, pl. 11-23. – London.

STOLICZKA, F. (1868): Cretaceous fauna of southern India, II. The Gastropoda. – Mem. Geol. Serv. India, Palaeontologica Indica: xiii + 497 pp., 28 pl. – Calcutta.

VACEK, M. 1879. Ueber Vorarlberger Kreide. – Jahrb. Geol. Reichsanstalt, **79**: 659-758, pl. 13, 19, 19a. – Wien.

WOLLEMANN, A., 1909, Die Bivalven und Gastropoden des norddeutschen Gaults (Aptiens und Albiens). – Jb. Preuss. Geol. L.A., **27** (for 1906): 259-300, pl. 6-10. – Berlin

WYSSLING, G. (1986): Der frühkretazische Schelf in Vorarlberg und im Allgäu – Stratigraphie, Sedimentologie und Paläogeographie. – Jb. Geol. Bundesanstalt, **129**/1: 161-265, 50 text-figs, 1 tab., 8 pl. – Wien.

ZITTEL, K. (1868): Obere Jura und Kreide-Schichten in den Allgäuer- und Vorarlberger-Alpen (Aus einem Schreiben an Fr.v.Hauer, De Dato München 25.Dec.1867). – Verh. Geol. Reichsanstalt, 1868: 1-6. – Wien.

Plate 1

Gastropods of the Kieselkalk Formation (1)

Fig. 1, 2. *Leptomaria wrighti* (Cox), Breiterberg, close to Bad Haslach; BSP: 1867-XII-527, x 1

Fig. 3. *Bathrotomaria robinaldi* (d´Orbigny). Breiterberg, close to Bad Haslach; GBA: 1879/01/77, x 1

Fig. 4. *Bathrotomaria* cf. *robinaldi* (d´Orbigny), Internal mould, Breiterberg, close to Bad Haslach; VN: P 1606, x 1

Fig. 5, 6. *Bathrotomaria* aff. *swinnertoni* (Cox) Breiterberg, close to Bad Haslach. GBA: 1879/01/79, x 1

Fig. 7. *Bathrotomaria* sp. indet., Breiterberg, close to Bad Haslach, trail between Bad Haslach to Emserreute VN: P 10374, x 1

Fig. 8. *Pyrgotrochus concavus* n. sp., Holotype, Breiterberg, close to Bad Haslach. VN: P 16021, x 1

Fig. 9. *Pyrgotrochus concavus* n. sp., partly preserved as internal mould; Paratypoid, Breiterberg, close to Bad Haslach. VN: P 16020, x 1

Fig. 10. *Pyrgotrochus concavus* n. sp., whorls angulate, sculpture of spiral ribs. Paratypoid , Breiterberg, close to Bad Haslach. VN: P 10382, x 1

Fig. 11. *Pyrgotrochus concavus* n. sp., narrow shell angle and moderately concave whorl; Paratypoid. Breiterberg, close to Bad Haslach. VN: P 15438, x 1

Fig. 12. *Pyrgotrochus concavus* n. sp., internal mould; Paratypoid. Breiterberg, close to Bad Haslach. VN: P 16017, x 1

Fig. 13. *Pyrgotrochus* cf. *concavus* n. sp. Paratypoid. Breiterberg, close to Bad Haslach, trail between Bad Halsach and Emserreute. GBA: 1879/01/76, x 1

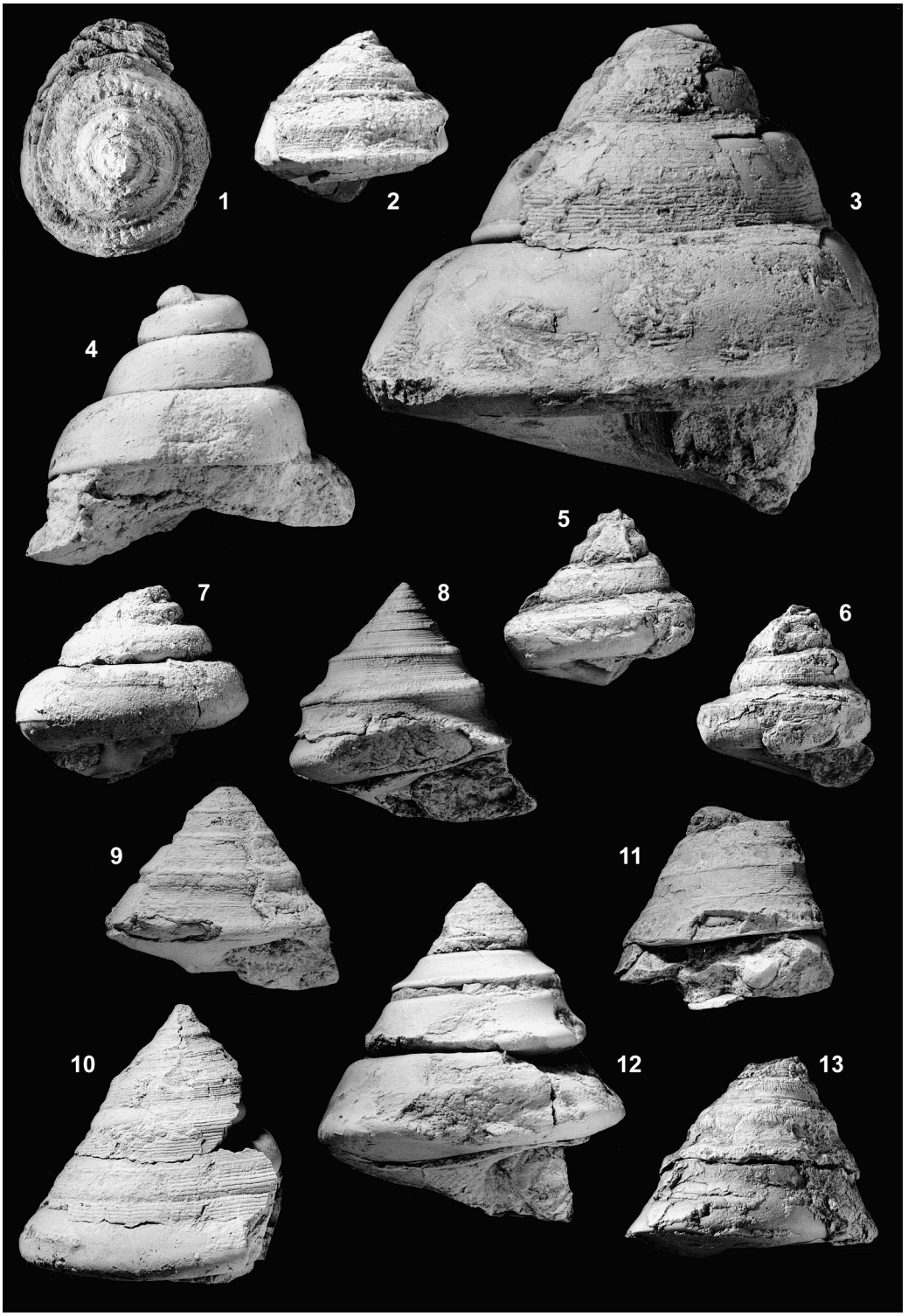

1
2
3
4
5
6
7
8
9
10
11
12
13

Plate 2

Gastropods of the Kieselkalk Formation (2)

Fig. 14, 15. *Pyrgotrochus* cf. *lemani* (LORIOL). Bad Haslach. GBA: 1879/01/78, x 1

Fig. 16. *Pyrgotrochus* cf. *lemani* (LORIOL), internal mould. From the debris of the Breiterberg, close to Bad Haslach. VN: P10371, x 1

Fig. 17. Pleurotomariidae indet 1. Breiterberg, close to Bad Haslach. VN: P 10375, x 1

Fig. 18. *Onkospira* sp. indet. Breiterberg, close to Bad Haslach, VN: P 10386, x 1.5

Fig. 19. *Amberleya (Eucyclus) acuminata* (DESHAYES). Breiterberg, close to Bad Haslach, BSP: 1867-XII-529, x 1

Fig. 20, 21. *Pseudomelania (Pseudomelania) albensis* (d´ORBIGNY). Bezeck, GBA: 1879/01/148, x 5

Fig. 22. Aporrhaidae indet. 1, Breiterberg, close to Bad Haslach. VN: P 10184, x 1,5

Fig. 23. *Colombellina maxima* LORIOL. VN: P 10351, x 1.5

Fig. 24. *Colombellina maxima* LORIOL. Breiterberg, close to Bad Haslach. BSP: 1867-XII-530, x 1

Fig. 25, 26. *Pictavia* cf. *laevigata* (DESHAYES). Breiterberg, close to Bad Haslach. VN: P 10433, x 2

Fig. 27, 28. *Ampullina* sp. Örfla Gorge, Götzis. VN: P 9931, x 1

Fig. 29. *Ampullina* sp. Breiterberg, close to Bad Haslach. VN: P 10429, x 4

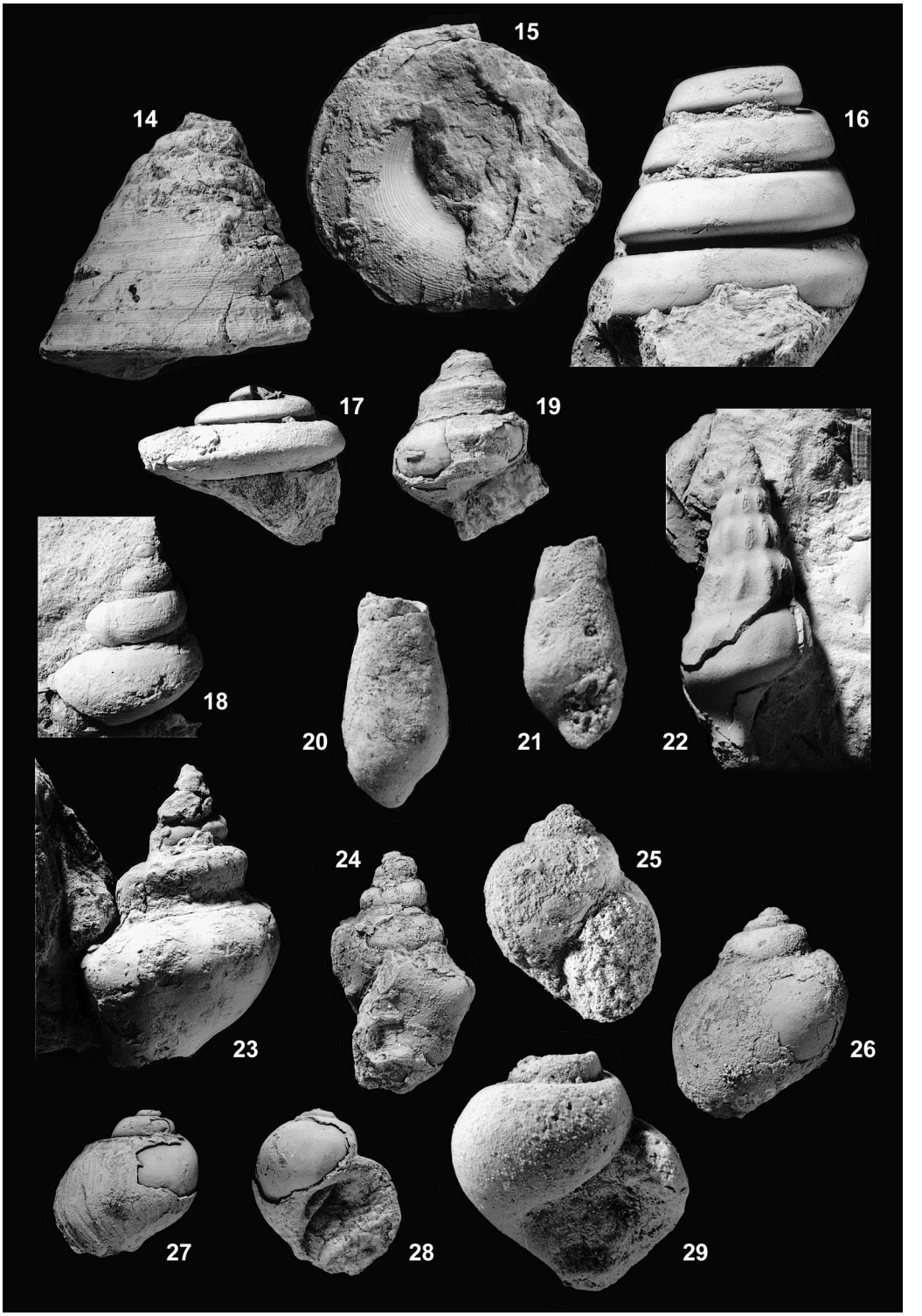

14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

Plate 3

Gastropods of the Schrattenkalk Formation (1)

Fig. 30. *Globularia* cf. *hugardiana* (d´ORBIGNY). Breiterberg, close to Bad Haslach. GBA: 1879/01/80, x 1

Fig. 31, 32. *Pseudonerinea vaceki* n. sp. Holotype. Trail Bad Haslach – Emserreute, VN: P 10367a, x 1

Fig. 33. *Pseudonerinea vaceki* n. sp. Paratypoid. Trail Bad Haslach – Emserreute, VN: P 10367b, x 1

Fig. 34, 35. *Pseudonerinea vaceki* n. sp. Paratypoid. Small specimen. Breiterberg, close to Bad Haslach, VN: P 15997, x 1

Fig. 36. *Pseudonerinea vaceki* n. sp., small specimen. Breiterberg, close to Bad Haslach; GBA: 1879/01/148, x 5

Fig. 37, 38. *Harpagodes* cf. *desori* (PICTET & CAMPICHE). Breiterberg, close to Bad Haslach, GBA: 1879/01/81, x 1

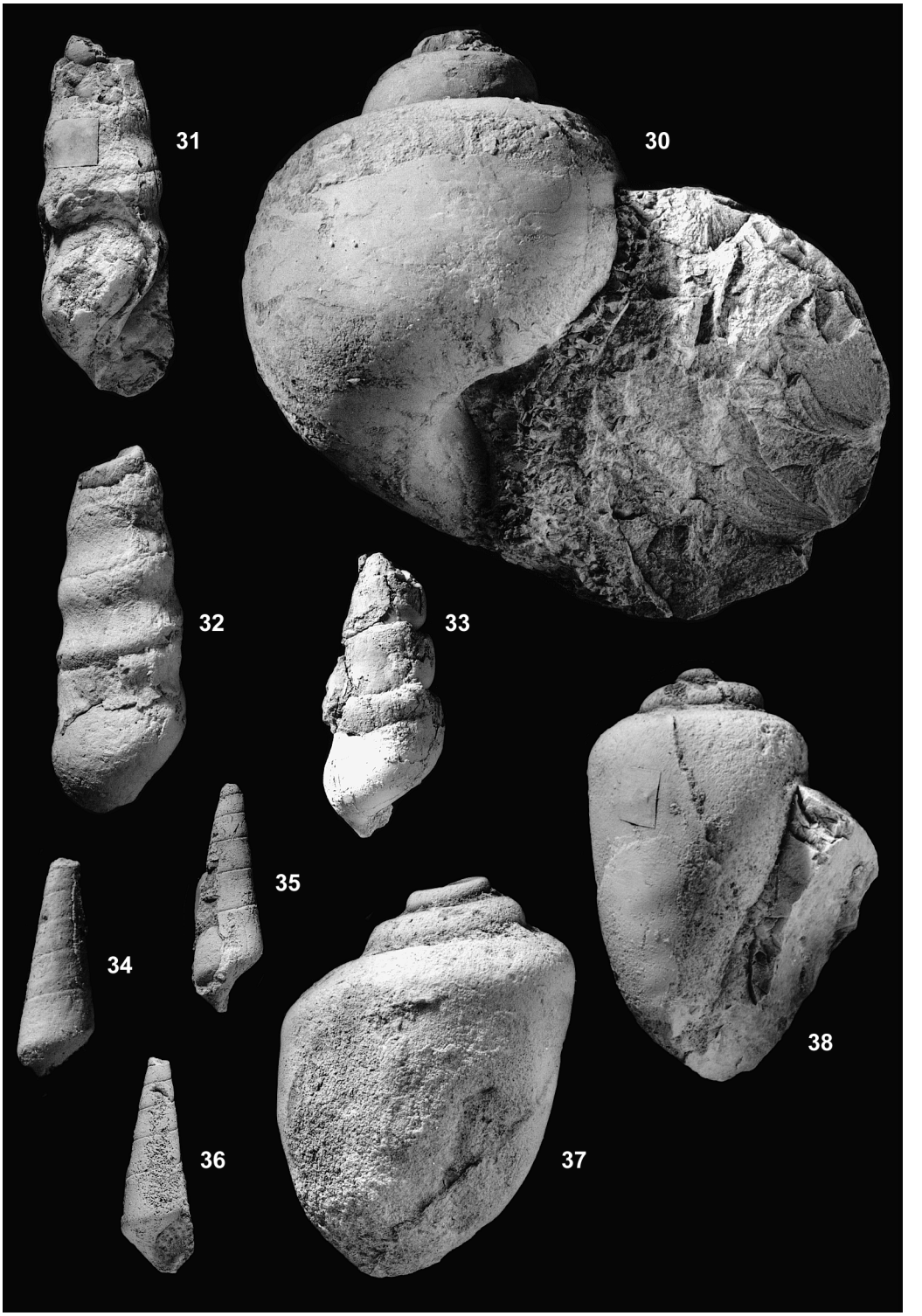

31
30
32
33
35
34
38
36
37

Plate 4

Gastropods of the Schrattenkalk Formation (2)

Fig. 39, 40. *Fissurella* sp. ?Unterklien. GBA: 2002/002/001, x 3

Fig. 41, 42. *Scurria* sp. ?Unterklien, GBA: 2002/002/002, x 5

Fig. 43, 44, 45. *Ataphrus (Ataphrus) reductus* COSSMANN, ?Unterklien, GBA: 2001/002/003, x 8

Fig. 46, 47. *Neritoma* (*Neridomus) dolichostoma* COSSMANN. ?Unterklien, GBA: 2002/002/007, x 5

Fig. 48, 49. *Otostoma bicostata* (VACEK). Bezau. Holotype. BSP: 1867-XII-516, x 6

Fig. 50. *Potamides (?Alocaxis) zitteli* (VACEK). Bezau. Lectotype. BSP: 1867-XII-513/1, x 5

Fig. 51. *Potamides (?Alocaxis) zitteli* (VACEK). Bezau. Paralectotype with 4 spiral ribs of equal strength. BSP: 1867-XII-513/2, x 5

Fig. 52. *Potamides (?Alocaxis) zitteli* (VACEK). Bezau. Paralectotype with partly preserved aperture. BSP: 1867-XII-513/3, x 10

Fig. 53. *Potamides (?Alocaxis) zitteli* (VACEK). Bezau. Paralectotype with dominant abapical spiral rib. BSP: 1867-XII-513/3, x 5

Fig. 54, 55. *Globularia subtilis* (COSSMANN). ?Unterklien, GBA: 2002/002/010, x 8

Fig. 56, 57. *Ceritella (Ceritella) urgonensis* VACEK. Bezeck near Bezau. Lectotype, Bezau. BSP: 1867-XII-514/1, x 3

Fig. 58. *Ceritella (Ceritella) urgonensis* VACEK. Bezeck near Bezau. Parlectotype with almost complete aperture. Bezau, BSP: 1867-XII-514/2, x 3

Fig. 59. *Plesioptyxis* aff. *essertensis* (PICTET & CAMPICHE). Bezeck near Bezau, BSP: 1867-XII-34, x 3

Fig. 60. *Plesioptyxis* aff. *essertensis* (PICTET & CAMPICHE). Bezeck near Bezau, BSP 1867-XII-36, x 3

Fig. 61. *Plesioptyxis* aff. *essertensis* (PICTET & CAMPICHE). Bezeck, BSP: 1867-XII-31, x 3

Fig. 62. *Plesioptyxis* aff. *essertensis* (PICTET & CAMPICHE). Unterklien VN: P 9803, x 2

Fig. 63. *Nerineopsis* sp. Bezeck near Bezau. GBA: 1879/01/150, x 3

Fig. 64. *Nerineopsis* sp. Bezeck near Bezau. GBA: 1879/01/150, x 5

Fig. 65. *Nerineopsis* sp. Bezeck near Bezau. GBA: 1879/01/150, x 5

Fig. 66. *Nerineopsis* sp. Bezeck near Bezau. GBA: 1879/01/150, x 4

Fig. 67. *Nerineopsis* sp. Axial section. Bezeck near Bezau. BSP: 1867-XII-537, x 4

Fig. 68, 69. *Cylindrites cretaceus* VACEK. Bezeck. Lectotype. BSP: 1867-XII-511, x 4

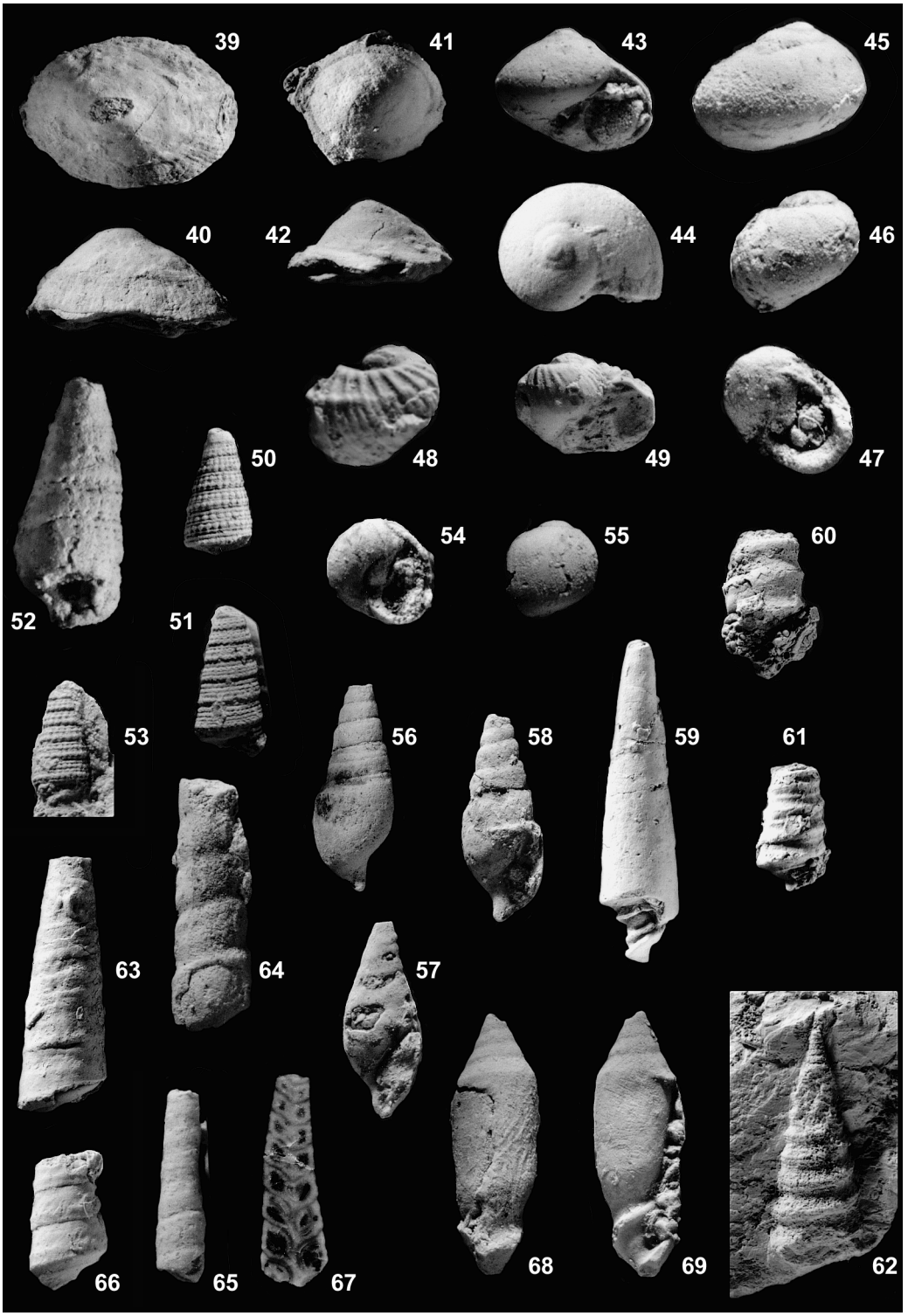

39
41
43
45
40
42
44
46
50
48
49
47
54
55
60
52
51
53
56
58
59
61
63
64
57
66
65
67
68
69
62

Plate 5

Gastropods of the Garschella Formation and the Gams Formation (1)

Fig. 70, 71. *Leptomaria gibsi* (J. SOWERBY). Klien. VN: P 12097, x 2

Fig. 72, 73. *Leptomaria gibsi* (J. SOWERBY). Fluhereck. VN: P 10182, x 2

Fig. 74, 75. *Leptomaria gibsi* (J. SOWERBY). Bezau. BSP 1867-XII-116, x 1

Fig. 76. Pleurotomariidae, sp. indet 2. St. Antoni near Feldkirch. GBA: 1879/01/258, x 1

Fig. 77. *Discohelix martinianum* (d´ORBIGNY). Moulage of external mould. VN: P 12937, x 1

Fig. 78. *Discohelix martinianum* (d´ORBIGNY). Moulage of an internal mould. Lädtobel, Ebnit. GBA: 1879/01/231, x 1

Fig. 79. *Discohelix martinianum* (d´ORBIGNY). Lädtobel, Ebnit. VN: P 8938, x 3

Fig. 80. *Semisolarium astierianum* (d´ORBIGNY) ?Hirschberg, GBA: 2002/002/004, x 1

Fig. 81, 82. *Semisolarium hugianum* (d´ORBIGNY), Feldkirch-Göfis and Plattenwald. VN: P 12552, x 2

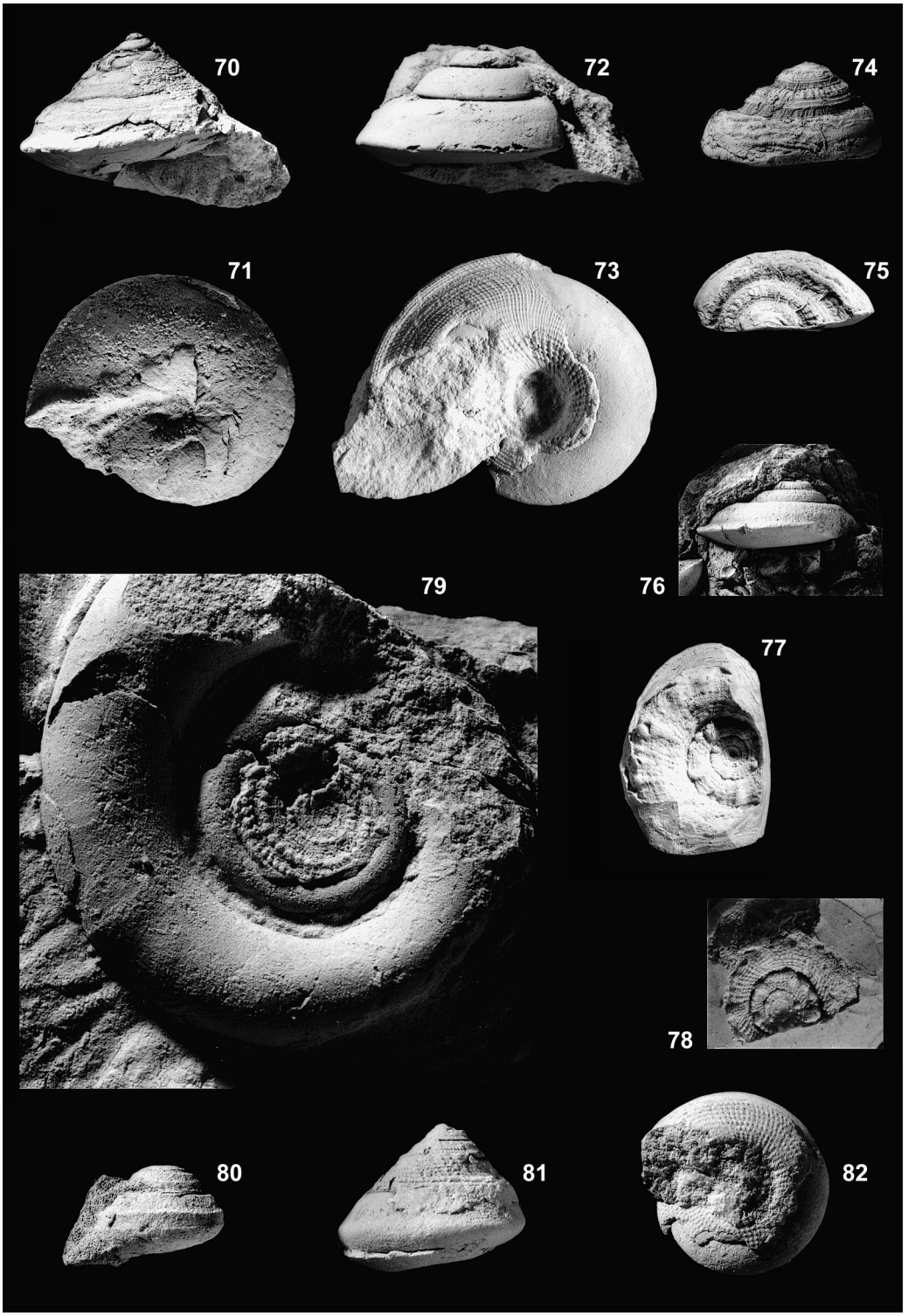

70
72
74
71
73
75
76
79
77
78
80
81
82

Plate 6

Gastropods of the Garschella Formation and the Gams Formation (2)

Fig. 83. *Semisolarium hugianum* (d´ORBIGNY), internal mould, Klaus-Plattenwald. VN: P 8597, x 2

Fig. 84. *Semisolarium moniliferum* (MICHELIN), internal mould. VN P 12981, x 2

Fig. 85. *Semisolarium moniliferum* (MICHELIN), internal mould. Klaus-Plattenwald. VN: P 8596, x 2

Fig. 86. *Semisolarium moniliferum* (MICHELIN), internal mould with with shell remains on the base. Rappenloch Bridge. VN: P 12981, x 2

Fig. 87, 88. "*Nummogaultina*" aff. *dentata* (DESHAYES). Margarethenkapf near Feldkirch. GBA: 1879/01/190, x 1

Fig. 89. *Amberleya (?Eucyclus)* aff. *coquandi* (PICTET & CAMPICHE), artificial external mould. GBA: 1879/ 01 /260, x 1

Fig. 90, 91. *Amberleya (?Eucyclus)* aff. *coquandi* (PICTET & CAMPICHE), doubtful internal mould. Bezau. GBA: 2002/002/005, x1

Fig. 92. *Amberleya (?Eucyclus)* cf. *golezianus* (PICTET & ROUX), Internal mould. Bezau. GBA: 2002/002/006, x 1

Fig. 93. *Helicacanthus* indet. Gopf, Bregenzer Ach near Mellau. VN: P 11460, x 4

Fig. 94. *Cirsocerithium* cf. *lallierianum* (d´ORBIGNY). Bezeck, GBA, x 3

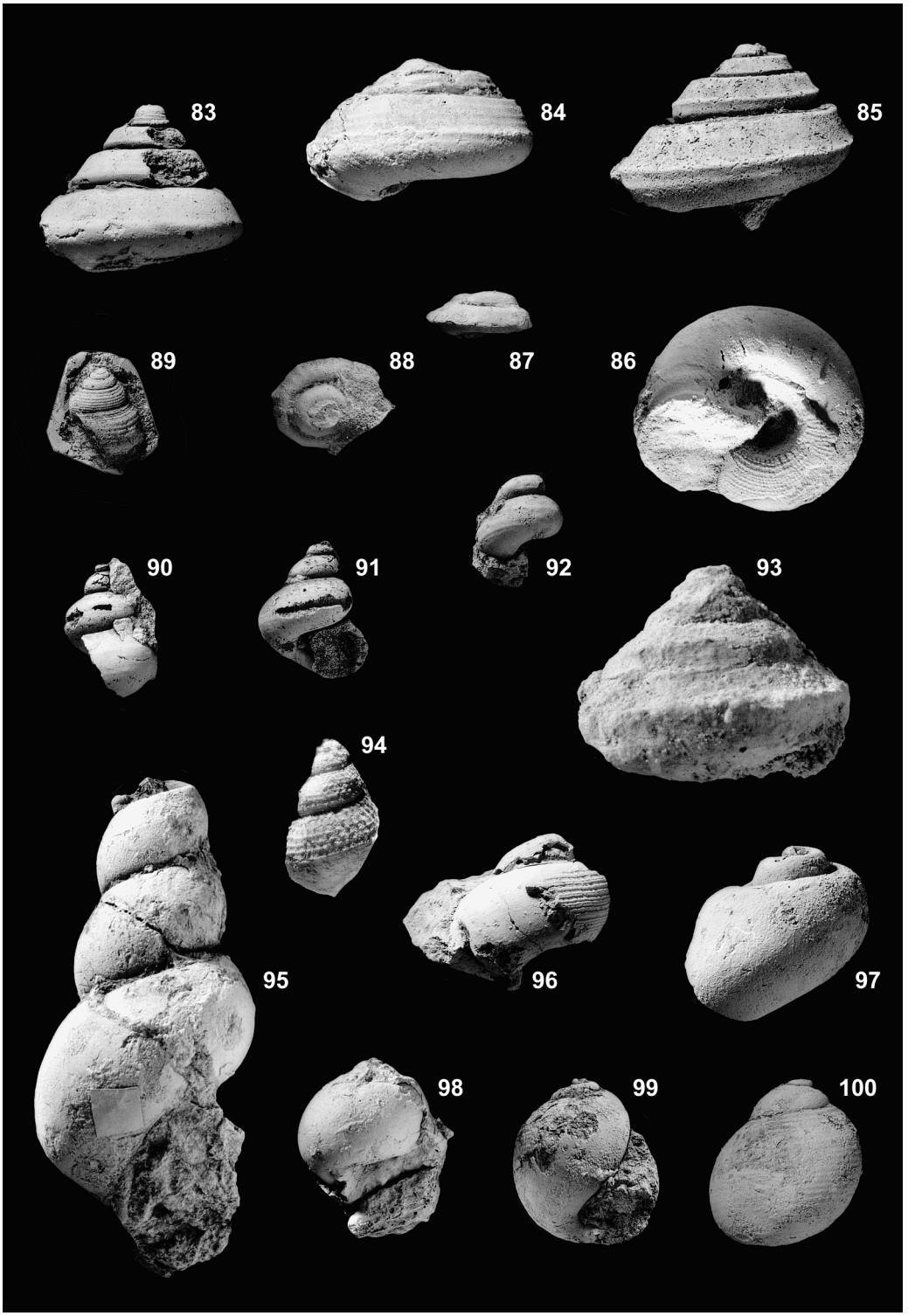
Fig. 95. Aporrhaidae, sp. 2. Fluhereck, W Ebnit. VN: P 10184, x1

Fig. 96. *Vanikoro* sp. Fluhereck, W Ebnit. VN: P 10183, x 1

Fig. 97. *Gyrodes gaultinus* (d´ORBIGNY), internal mould, Plattenwald. VN: P 10278, x 1

Fig. 98. *Gyrodes gaultinus* (d´ORBIGNY), internal mould, Margarethenkapf. VN: P 8300, x 1

Fig. 99, 100. *Avellana subincrassata* (d´ORBIGNY), internal mould. Bezau. GBA: 1879/01/517, x 2


83
84
85
89
88
87
86
90
91
92
93
94
95
96
97
98
99
100