

Aptychi from the Lower Cretaceous strata along the Río Argos (Caravaca, SE Spain)

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Key words: aptychi, Early Cretaceous, Spain.

The aptychi of the Berriasian to Barremian strata of the Río Argos succession near Caravaca (SE Spain) are described. One new subspecies is introduced, *Lamellaptychus angulocostatus gracilicostatus*, from the latest Hauterivian Ohmi Zone (ammonite zone). Like in the Eastern Alps also in Southern Spain *Punctaptychus* persists into the late Berriasian.

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Introduction

The Lower Cretaceous succession exposed along the Río Argos west of Caravaca (SE Spain) (Fig. 1) is a 1500 m thick, well-studied, composite section consisting of a cyclic alternation of olive grey marly, micritic limestone and dark grey shaly marlstone beds. The limestone consists almost entirely of coccolith and *Nannoconus* tests and their fragments. In the uppermost Barremian many turbiditic sandstones are present. The depth of deposition of the whole succession has been estimated to be c. 300 m. The succession comprises the Berriasian up to lower Aptian stages and has been subjected to biostratigraphic, sequence-stratigraphic, magnetostratigraphic and cyclostratigraphic investigations. The Berriasian to lower Aptian strata constitute one of the completest ammonite-bearing successions in the world.

Ammonites constitute 99% of the megafossil content. The remaining 1% consist of belemnites, pygopid brachiopods, irregular echinoids, and a few bivalves and gastropods. Biostratigraphic investigations (Hoedemaeker & Leereveld, 1995) were done on ammonites (Allemann et al., 1975; Hoedemaeker, 1982, 1983, 1995), belemnites (Janssen, 1997), dinoflagellate cysts (Leereveld, 1995), calpionellids (Allemann et al. 1975), calcareous nannoplankton (Grün & Allemann, 1975; Cecca et al., 1994), planktonic foraminifers (Cecca et al., 1994; Coccioni & Premoli Silva, 1994); sequence stratigraphy (Hoedemaeker & Leereveld, 1995; Hoedemaeker, 1995, in press), cyclostratigraphy of the Berriasian (ten Kate & Sprenger, 1989; Sprenger & ten Kate, 1992) and magnetostratigraphy (Hoedemaeker et al., in press) were carried out; unfortunately the succession is totally remagnetized. The brachiopods, radiolarians and benthic foraminifers are still under study and the calpionellids are being restudied. Chronostratigraphy is based on ammonite biochronozones (Hoedemaeker, 1982, 1983, 1995;

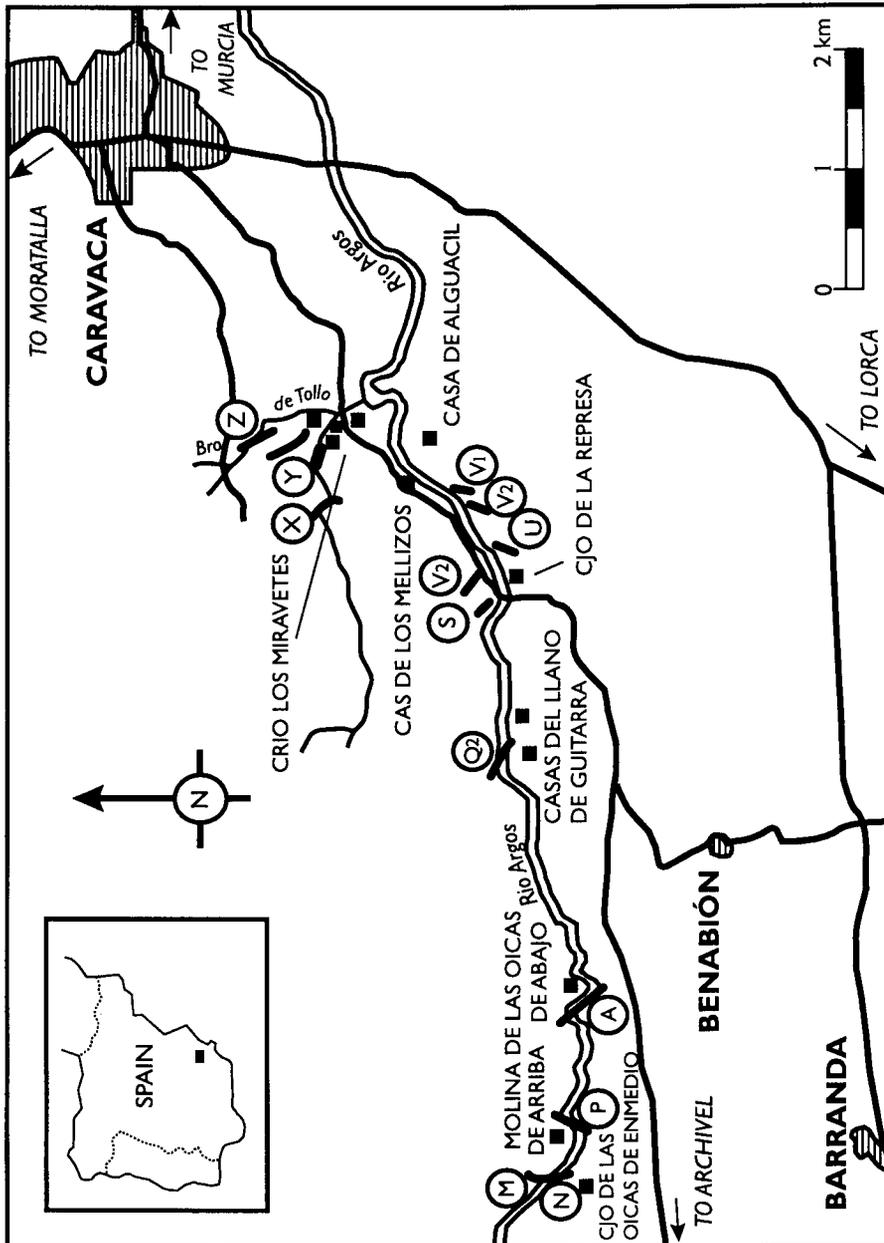


Fig. 1. Map showing the location of the main sections along the Río Argos.

Hoedemaeker & Leereveld, 1995). For the detailed lithological column, in which all beds have been given a number, the reader is referred to the paper of Hoedemaeker & Leereveld (1995).

Systematic descriptions

The terms used in the systematic descriptions are derived from Vašiček et al. (1994), where the basic morphology is elucidated by a pen-and-ink drawing (op. cit., text-fig. 26). The following parameters can be measured on the valves (Fig. 2): L - length of the valve, S - length of the harmonic margin, B - height of the valve (in old literature frequently called L_{at}).

The taxa used in the descriptions of aptychi are pure form genera, form species and form subspecies; current biological concepts cannot be applied to them.

The material is kept at the Nationaal Natuurhistorisch Museum (National Museum of Natural History) at Leiden, The Netherlands.

Genus *Punctaptychus* Trauth, 1927

Small to large, thick-walled valves. The adapical area is characterized by a punctate layer overlapping the lamellar ribs, being pronounced at the outer periphery of the valves. Oxfordian - late Berriasian, ?earliest Valanginian.

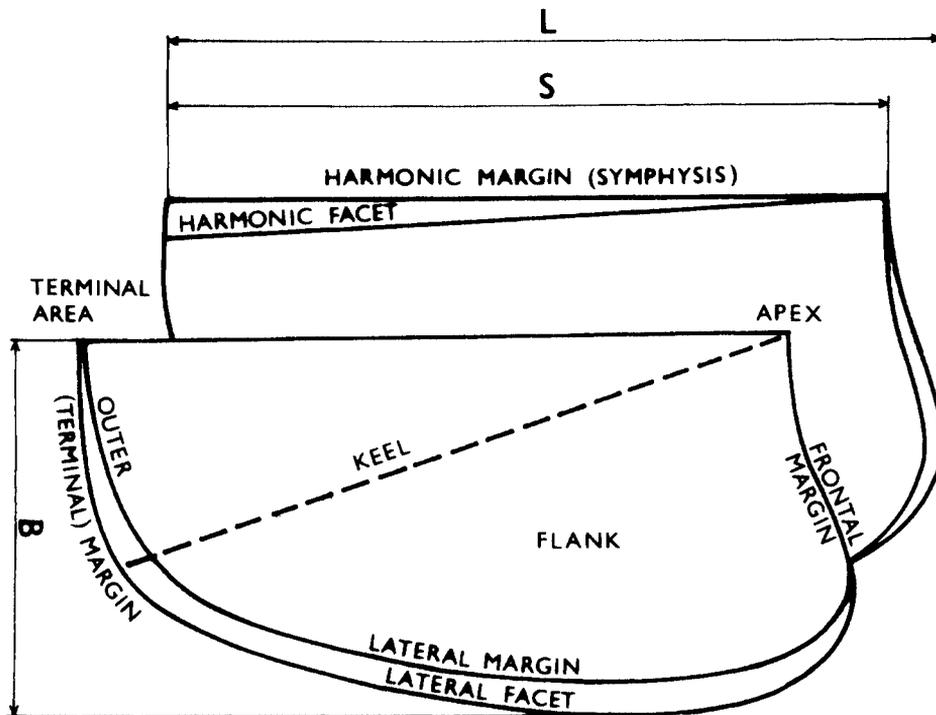


Fig. 2. Basic morphology of an aptychus and the parameters that have been measured.

Punctaptychus punctatus punctatus (Voltz, 1837)

Pl. 1, fig. 1.

1935 *Punctaptychus punctatus* (Voltz) f. typ. — Trauth, p. 315, pl. 12, figs. 1, 2, 4, non fig. 3 (= *P. p. rectecostatus*) (cum syn.).

1995 *Punctaptychus punctatus punctatus* (Voltz) — Reháková et al., p. 56, pl. 2, figs. 1-3 (cum syn.).

Material — Two valves, from beds Z207 and Z97, the latter is incomplete.

Description — Vaulted valves, medium-sized with well developed punctate layer in the area near the apex and with lamellar ribs on the periphery and on the back side of the valve. The ribs, a part of which converge along the harmonic margin, are distinctly deflected on the back side of the valve.

Measurements — The measurements of the valve from bed Z207 are: L = 24 mm, S = 22 mm, B = 11.8 mm (B/L = 0.49, B/S = 0.54).

Remarks — The closely related subspecies *P. p. rectecostatus* Cuzzi lacks the above-mentioned deflection of the ribs. However, the ribs of the specimen from bed M27 are very strongly deflected in comparison to typical *P. p. punctatus*. For this reason the specimen M27 will be referred to *P. p. cf. punctatus* (Pl. 1, fig. 2).

Distribution — In the Western Carpathians *P. p. punctatus* is well-known from the early Tithonian up to the early Berriasian (Reháková et al., 1995). This range is calibrated with calpionellid biostratigraphy.

Occurrence — *P. p. punctatus* was found in bed Z97 (Jacobi Subzone, early Berriasian) and in bed Z207 (basal Subalpina Subzone, middle Berriasian); *P. p. cf. punctatus* in bed M 27 (Subalpina Subzone, middle Berriasian).

Punctaptychus punctatus rectecostatus Cuzzi, 1962

Pl. 1, fig. 3.

1962 *Punctaptychus rectecostatus* n. sp. — Cuzzi, p. 46, pl. 17, figs. 4-6.

1973 *Punctaptychus rectecostatus* Cuzzi — Renz, p. 896 (cum syn.).

1994 *Punctaptychus punctatus rectecostatus* Cuzzi — Vašíček et al., p. 69, pl. 23, fig. 1.

1995 *Punctaptychus punctatus rectecostatus* Cuzzi — Reháková et al., p. 57, figs. 4-5 (cum syn.).

Material — Only one valve, which is not well preserved (Z189).

Description — Medium-sized valve, characterized by straight ribs.

Remarks — *P. p. punctatus* and *P. p. rectecostatus* are interconnected by a continuous series of transitions from straight to deflected ribs.

Distribution — *P. p. rectecostatus* has a similar stratigraphic range as the typical subspecies. It has to be mentioned that one valve of *P. p. rectecostatus* was found in lower Valanginian limestones in the Western Carpathians. This age is confirmed by its concurrence with *Calpionellites darderi* (Michalík et al., 1990).

Occurrence — Only one specimen of *P. p. rectecostatus* was found in bed Z189 (Grandis Zone, early Berriasian).

Punctaptychus punctatus divergens Trauth, 1935

Pl. 1, fig. 4.

1935 *Punctaptychus punctatus* (Voltz) var. n. *divergens* — Trauth, p. 321, textfig. 1 (cum syn.).

Material — A fragment of one large valve (Z3), which lacks the frontal part and a large part of the apical area.

Description — Incomplete valve with a partially preserved punctate layer and well-developed lamellar ribs in the terminal area. A part of the ribs converge towards the harmonic margin, but most of them end at the periphery of the valve below the so-called terminal apex. In this area the ribs characteristically diverge in a fanlike manner.

Remarks — The valve shows all characteristics of the species *P. punctatus*, the difference with *P. p. punctatus* and its other known subspecies being that the ribs on the surface of the valve do not run in a subparallel manner, but diverge.

Distribution — *P. p. divergens* is not a well-known subspecies. When Trauth (1935) introduced his specimens from the Lombardian and Austrian Alps, he gave them a rather wide and imprecisely demarcated range, viz. from Kimmeridgian up to Neocomian. It was found in the Kurovice locality in the Outer Carpathians (Eliáš et al., in press) only in lower Tithonian deposits and in the slump horizon in the lower Berriasian.

Occurrence — Bed Z3 (basal Jacobi Subzone, earliest Berriasian).

Punctaptychus cf. *monsalvensis* Trauth, 1935
Pl. 1, fig. 5.

1935 *Punctaptychus monsalvensis* n. n. — Trauth 1935, p. 324, textfig. 2 (cum syn.).

1962 *Punctaptychus monsalvensis* Trauth — Gasiorowski, pl. 6, fig. 1-2.

Material — Only one valve, which is almost a perfectly preserved and of rather large size (X180).

Description — A large vaulted valve with a prominent keel and a well developed punctate layer in the area surrounding the apex. Along the outer periphery of the valves and near the terminal area, however, there are prominent lamellar ribs. Around the harmonic margin, towards which a part of the ribs converge under a very small angle, the ribs are thin and closely spaced. Near the outer periphery of the valve the lamellar ribs are strong and wide apart. Most adult ribs mimic the outline of the valve; more juvenile ribs in the keel area are curved so as to assume their course along the harmonic margin. A part of the ribs end at the terminal area, whereas others slightly deflect to the harmonic margin. They tend to converge towards one point, which roughly corresponds with the terminal apex.

Measurements — The described valve has L = 50.8 mm, S = 44 mm, B = 26.6 mm (B/L = 0.52, B/S = 0.60).

Remarks — The zone of terminal bending of the adult ribs at the harmonic margin is more extensive by typical specimens of *P. monsalvensis*. The contact between the bundle of thin juvenile ribs and a set of lamellar adult ribs is rather disharmonic. The last character suggests *P. cinctus* Trauth and therefore the single Spanish valve cannot be definitely identified.

Distribution — According to Trauth (1935) typical *P. monsalvensis* occurs in the Tithonian of the Pieniny Klippen Belt (Rogoznik locality) and in Switzerland. According to Gasiorowski (1962) the species characterizes the entire Tithonian. In the Outer Car-

pathians (Kurovice locality) this species occurs sporadically in the early Tithonian.
Occurrence — Bed X180 (Picteti Subzone, latest Berriasian).

Punctaptychus cinctus Trauth 1935
Pl. 1, fig. 6.

1994 *Punctaptychus cinctus* Trauth — Vašíček et al., p. 70, pl. 23, fig. 2 (cum syn.).

Material — One not very well preserved valve (Y27).

Description — Small vaulted valve. Juvenile ribs are thin and close together. They converge to the harmonic margin, which they approach under a very small angle. Adult ribs are stronger. The last-formed ribs follow the outline of the valve. Their curvature is discordant with respect to bundle of juvenile ribs. The course of juvenile ribs is truncated by the course of the adult ribs. they mutually cover each other.

Measurements — The valve measures: L = 13.3 mm, S = 12 mm, B = 5.3 mm (B/L = 0.40, S/L = 0.44).

Distribution — Trauth (1935) assigns the species to the Tithonian. In the Outer Carpathians (Kurovice locality) *P. cinctus* occurs in the early Berriasian.

Occurrence — The only specimen comes from bed Y27 (Privasensis Subzone, middle Berriasian).

Punctaptychus sp. indet.
Pl. 1, fig. 7.

Material — A fragment of a large valve which lacks the terminal area (X182-220).

Description — Lamellar ribs in the rear half of the valve are repeatedly undulated.

Remarks — The sigmoidal curvatures of the ribs, which is the only distinctive feature of *P. p. fractocostatus*, are repeated several times on the valve, an unusual feature.

Occurrence — Bed X182 (Picteti Subzone, late Berriasian).

Genus *Lamellaptychus* Trauth, 1927

Valves with prominent lamellar ribs.

Middle Bajocian to uppermost Hauterivian.

Lamellaptychus ex gr. mortilleti noricus Trauth, 1938
Pl. 2, fig. 1.

1976 *Lamellaptychus mortilleti noricus* Trauth — Patruilius & Avram, p. 193, pl. 10, fig. 16 (cum syn.).

Material — One incomplete valve (Y122) of which the frontal part is not preserved.

Description — Large valve with a keel and weak lateral depression. The juvenile ribs which head toward the harmonic margin, make an angle c. 30° with it and join this margin with a short curve. Adult ribs towards the periphery of the valve progressively determine the outline of the valve until the last one becomes parallel to the ultimate outline.

Distribution — In the early literature *L. mortilleti noricus* is reported to range from the Tithonian up to the Neocomian. Jaksch (1968) mentions Berriasian up to early Valanginian. In the Western Carpathians it occurs in the lower Berriasian, upper Valanginian and apparently also in the lower part of the lower Valanginian.

Occurrence — The specimen mentioned above was found in bed Y122 (basal Paramimouna Subzone, late Berriasian).

Lamellaptychus sp. indet.

Pl. 1, fig. 8.

Material — One incomplete valve, which lacks its frontal part; also the terminal area is imperfectly preserved (Y127).

Description — Vaulted valve of medium size. The ribs are more or less parallel to the outline of the valve. In the poorly expressed keel area, which is very low, the first slightly curved ribs can be discerned. In the more juvenile area the ribs run straight towards the harmonic margin, which truncates them at an angle of c. 60° . Near the harmonic margin the more adults ribs show an important complication: in this area the ribs are angularly and threefoldly bent over a short distance; also the angle with the harmonic margin increases up to 90° . In close connection with the harmonic margin several radial lines spread out.

Remarks — The type of ribbing mentioned above corresponds in general to the ribbing of *L. aplanatus* (Peters, 1854), which indeed has ribs with a quite simple course. Similar complications near the harmonic margin are doubtlessly present on many species (*L. lombardicus*, *L. trauthi*, *L. ticinensis* Renz & Habicht, 1985). However, the further course of the ribs towards the apex is different and it is impossible to compare this specimen with one of the species mentioned above.

Occurrence — The described specimen comes from bed Y127 (Paramimouna Subzone, late Berriasian).

Lamellaptychus didayi (Coquand, 1841)

Pl. 2, fig. 2.

1976 *Lamellaptychus didayi* (Coquand) — Avram, p. 58, pl. 10, fig. 11 (cum. syn.).

1994 *Lamellaptychus didayi* (Coquand) — Vašíček et al., p. 74, pl. 24, fig. 6 (cum syn.).

Material — Two imperfectly preserved valves (N13, QIII4).

Description — Large valves with well developed keels and shallow lateral depressions. The ribs are prominent and widely spaced. In the lateral depression the ribs are deflected, in the area between the keel and the harmonic margin (which has the character of a slightly tordated depression) the ribs bend back in a sharply curved to sub-angular manner towards the apex. The harmonic margin truncates the ribs with an angle of c. 60° .

Measurements — Although the valve from bed QIII4 is slightly deformed parallel to the bedding plane and although the periphery of the valve is not clearly defined, it can be gathered from the imprecise measurements ($L = 28$ mm and $B = 17.2$ mm) that the specimen belongs to a wide form ($B/L = 0.61$).

Remarks — The ribbing is similar to that of *L. seranonis* (Coquand, 1841), but the eccen-

tric position of its greatest width is decisive. The valve from bed N 13 is indeed very incomplete, and its identification therefore not entirely sure.

Distribution — In the Western Carpathians the species occurs sporadically in the late Valanginian, occurs abundantly near the Valanginian/Hauterivian boundary and is especially frequent in the early Hauterivian.

Occurrence — The valves were found in the beds N13 and QIII4 (Trinodosum Subzone, late Valanginian).

Lamellaptychus angulocostatus angulocostatus (Peters, 1854)

Pl. 2, fig. 3.

1995 *Lamellaptychus angulocostatus angulocostatus* (Peters) — Vašíček & Michalík, p. 306, pl. 1, figs. 1, 5 (cum syn.).

Material — Ten, mostly incomplete, valves; the best preserved specimens are from the beds W20, W24, W30B-30E, and B57.

Description — Fairly large valves with keels, but without lateral depressions. The ribs in the area below the keel are straight, rather close to each other and run sub-parallel to the harmonic margin. The angular chevron formed by the ribs close to the keel may in some cases be accentuated by a radial line, which runs across the angular points. In the area between the chevron and the harmonic margin the ribs are deflected, slightly curved towards the terminal apex.

Remarks — The distinguishing features of the subspecies within the framework of the species *L. angulocostatus* are discussed in Vašíček & Michalík (1995). The main features of *L. angulocostatus angulocostatus* are the absence or only indistinct presence of a lateral depression, the straight course of the ribs on the flanks, which are parallel with the symphysal margin, and the tendency of the last ribs to become rounded.

Distribution — The typical subspecies is exclusively known from the late Hauterivian in the entire Mediterranean area.

Occurrence — *L. a. angulocostatus* occurs mainly in section W, at least from bed W20 to W34 (Balearis and Ohmi Zones) and in bed B57 (Sayni Zone); probably also in bed A138 (top of Ligatus Zone) and F141-156 (Balearis and Ohmi Zones, all late Hauterivian).

Lamellaptychus angulocostatus aff. *angulocostatus* (Peters, 1854)

Pl. 1, fig. 9.

Material — Fragment of a small valve (W31-34).

Description — The basic morphology is approximately the same as for the typical subspecies. The main difference is the more complicated course of the ribs: close to the characteristic main angular bending of the ribs there is (close to the keel) a clearly perceptible secondary sigmoidal plication.

Remarks — On account of the incompleteness of the specimen it is not sure, whether we are dealing with an anomalous growth or with a subspecific feature.

Occurrence — The only specimen comes from bed W31-34 (Ohmi Zone, latest Hauterivian), where it occurs together with a typical representative of *L. angulocostatus angulocostatus*.

Lamellaptychus angulocostatus radiatus Trauth, 1938

Pl. 2, fig. 4.

1995 *Lamellaptychus angulocostatus radiatus* Trauth — Vašíček & Michalík, p. 1, figs. 7-9 (cum syn.).

Material — Five incomplete valves; the subspecific features are best seen on the specimens from bed W5, W31 and W30B-30E.

Description — The whole morphology, including the course of the ribs, corresponds to the subspecies *L. angulocostatus angulocostatus*. However, with suitable lighting fine radial lines can be discerned in the zone between the keel and the harmonic margin, which might obscure the course of the lamellar ribs.

Distribution — The subspecies has the same distribution as *L. a. angulocostatus*, viz. late Hauterivian.

Occurrence — *L. angulocostatus radiatus* is present in beds W 5-31 (top Ligatus Zone to Ohmi Zone, late Hauterivian).

Lamellaptychus angulocostatus angulicostatus (Pictet & Loriol, 1858)

Pl. 2, fig. 5.

1995 *Lamellaptychus angulocostatus angulicostatus* (Pictet & Loriol) — Vašíček et al., p. 308, pl. 1, figs. 2-4 (cum syn.).

Material — Five valves, of which the most complete ones are from beds W30-30B, A144, C142D.

Description — The valves are of various sizes and have a distinctive keel and a shallow lateral depression. In the depression the ribs are slightly deflected. The angular fracture of the ribs in the final maturity stage may turn into a bend.

Measurements — Specimen C142D: L = 23 mm, S = 21.5 mm, B = 11.8 mm (B/L = 0.51, B/S = 0.55).

Distribution — The subspecies has the same distribution as the typical subspecies *L. a. angulocostatus* (late Hauterivian).

Occurrence — *L. angulocostatus angulicostatus* occurs mainly in beds W30-34; it was also found in beds A144 and C142D (Ohmi Zone, latest Hauterivian).

Lamellaptychus angulocostatus gracilicostatus subsp. nov.

Pl. 2, fig. 6.

Material — A fragment of a fairly large valve (W30D-34), which is indicated as holotype, and two additional fragments (W30, W30B-31).

Derivation of name — With graciously bent ribs.

Type locality — From section W, 250 m west of Casa de Alguacil, along the Río Argos west of Caravaca.

Type horizon — Not in situ, but derived from one of the beds between beds W30D and W34 (Ohmi Zone, latest Hauterivian).

Description — Vaulted valve with keel and apparently without depression. Below the keel slightly angularly bent ribs are preserved, which in their continuation towards the outer margin are slightly folded in a concave way. In the keel area the ribs are

characteristically bent back in an angular way.

Remarks — On account of the existence of three valves with a rib curvature of this type, it is sure that the characteristic curvature is not caused by anomalous growth. This is one more new subspecies in the frame of the considerable morphological variability of *L. angulocostatus*.

Occurrence — The holotype is derived from one of the beds W30D to W34 (Ohmi Zone, latest Hauterivian). It is associated with a fragment *L. angulocostatus angulocostatus*.

Lamellaptychus ?angulocostatus bifractus Khalilov, 1978

Pl. 2, fig. 7.

1978 *Lamellaptychus ?angulocostatus bifracta* A. Khalilov subsp. nov. — Khalilov, p. 56, pl. 1, figs. 16-17.

Material — One incomplete valve (W30B-31) which lacks the frontal part.

Description — The valve shows the characteristic double-folded angular bend of the ribs in the terminal area, rather prominent in the area of the poorly expressed keel, but weaker farther away from the keel. Both bends are separated from each other by a sharp groove.

Remarks — The name given by Khalilov (1978) does not refer to the groove, which separates the two angular bends of the ribs, but to the double-angular bends itself. This becomes clear from the descriptions of the other specimens by Khalilov. The illustration of his specimen is however poor, so that the actual visual course of the ribs remains hidden and unclear.

Distribution — Khalilov (1978) assigns his subspecies to the late Hauterivian (in SE of Caucasian Mts.).

Occurrence — The specimen identified as *L. ?angulocostatus bifractus* comes from beds W30B-31 (Ohmi Zone, latest Hauterivian). It was found together with *L. angulocostatus angulocostatus*.

Lamellaptychus filicostatus filicostatus Stefanov, 1961

Pl. 2, fig. 8.

1994 *Lamellaptychus filicostatus filicostatus* Stefanov — Vašíček et al., p. 76, pl. 24, fig. 1 (cum syn.)

Material — Ten valves; the six most complete ones are derived from the beds W30B, W30B-31, A145, Q8-16, Q19-20, 387 969.

Description — The valves are small to medium-sized. They are strongly vaulted with a prominent keel, without or with only a weakly developed lateral depression. Thin and closely spaced ribs form an acute angle in the area of the angular chevrons so that in the terminal area, i.e. in the area between the last complete rib and the terminal apex, at least four incomplete ribs occur.

Remarks — Thin and closely spaced ribs, which are folded under an acute angle, and a large number of incomplete ribs in the terminal area distinguish *L. filicostatus* from the group of *L. angulocostatus*. The latter has only two or maximal three incomplete ribs in the terminal area.

Distribution — *Lamellaptychus filicostatus filicostatus* occurs in beds W30, W30A, W30B, W35, A145 (Ohmi Zone), Q8-16, Q19-20 (Sayni Zone). This species is considered to characterize the late Hauterivian.

Lamellaptychus cf. *filicostatus* Stefanov, 1961
Pl. 2, fig. 9.

Material — One incomplete valve which lacks the frontal part (Q8-16).

Description — Strongly vaulted valve with an anomalous development of thin and closely spaced ribs. The first three preserved ribs make an acute angle, the following two ribs are broadly curved, the next is acute again, whereas the remaining ribs, up to the terminal periphery, are curved.

Remarks — The course of the ribs is probably exceptional and anomalous.

Occurrence — The valve is derived from one of the beds Q8-16 (Sayni Zone), where it occurs together with a juvenile valve of *L. filicostatus filicostatus* (late Hauterivian).

Stratigraphic remarks

In the studied material two genera of aptychi predominate and from a stratigraphic point of view these genera constitute two successive associations of valves. The first association comprises the valves belonging to the genus *Punctaptychus*, the second one the valves of the genus *Lamellaptychus*, of which most specimens belong to the group of *L. angulocostatus*.

The first group of valves primarily pertains to the wide range of morphological variability of the species *Punctaptychus punctatus* (which is divided into a number of subspecies) and several closely allied species. The stratigraphic assessment of this group has been obtained from the latest results from Kurovice section in Outer Carpathians in Czech territory, and has been deduced primarily on the basis of calpionellid biostratigraphy (Vašíček & Reháková 1994, Eliáš et al., in press). In the Kurovice section the genus *Punctaptychus* practically disappears at the end of the early Berriasian. The only specimen of *Punctaptychus* from younger deposits (late Valanginian), mentioned in the paper of Michalík et al. (1990), could be redeposited, although the preservation of this specimen does not indicate that.

The latest collections of one of us (Z.V.) in the Lower Cretaceous of the Eastern Alps show that the genus *Punctaptychus* persists into the late Berriasian. The same is also evident from the Río Argos succession.

According to the results obtained from the Central Carpathians (Slovak Republic), lamellaptychi with angular ribs exclusively occur in the late Hauterivian. From a stratigraphical point of view they represent the youngest lamellaptychi. Their age can be deduced primarily from their concurrence with ammonites (Vašíček et al., 1994, Vašíček & Michalík, 1995 and others). In the same way as the typically large number of different subspecies of *P. punctatus* denotes the end of the development of the genus *Punctaptychus*, also the large number of different subspecies of lamellaptychi with angular ribs denotes the end of their development. In addition to the subspecies present in the literature, we found a new subspecies of *L. angulocostatus*, with an up to this time unknown type of ribbing.

Most specimens of the group of *L. angulocostatus* (Peters) are derived from the upper Hauterivian beds of section W. In comparison to the Carpathian sections, the studied Spanish material of *L. angulocostatus* is relatively rich, especially in the number of specimens of *L. angulocostatus radiatus*.

In addition to the diverse and rich Spanish material of aptychi with angular ribs, the studied material includes many primitive valves of the genus *Lamellaptychus*, which are however incompletely preserved and therefore not identifiable. In section Y only one specimen belonging to the group of *L. mortilleti noricus* Trauth (Y122) was found, which is characteristic for the late Berriasian and the early Valanginian. In bed Y127 (= upper Berriasian) a valve with a complicated type of ribbing has been found, which is not known from literature. It represents a new subspecies from the group of *L. aplanatus* (Peters). *L. aplanatus* belongs to the group of aptychi that usually has simple ribs and a wide stratigraphic range.

From two localities (N13, QIII4) *L. didayi* (Coquand) was identified. These beds should be of late Valanginian or early Hauterivian age.

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Plate 1

Figs. 1-2. *Punctaptychus punctatus punctatus* (Voltz, 1837); 1: from bed Z207, Jacobi Subzone, early Berriasian; 2: $\times 1$, from bed M27, Subalpina Subzone, middle Berriasian.

Fig. 3. *Punctaptychus punctatus rectecostatus* Cuzzi, 1962; $\times 1.5$, from bed Z189, Grandis Subzone, early Berriasian.

Fig. 4. *Punctaptychus punctatus divergens* Trauth, 1935; from bed Z3, Jacobi Subzone, early Berriasian.

Fig. 5. *Punctaptychus* cf. *monsalvensis* Trauth, 1935; $\times 1$, from bed X180, Picteti Subzone, late Berriasian.

Fig. 6. *Punctaptychus cinctus* Trauth, 1935; $\times 3$, from bed Y27, Privasensis Subzone, middle Berriasian.

Fig. 7. *Punctaptychus* sp. indet.; loose but derived from one of the beds between bed X182 and X220, Picteti Subzone, late Berriasian.

Fig. 8. *Lamellaptychus* sp. indet.; from bed Y127, Paramimouna Subzone, late Berriasian.

Fig. 9. *Lamellaptychus angulocostatus* aff. *angulocostatus* (Peters, 1854), loose but derived from one of the beds between bed W31 and W34, Ohmi Zone, late Hauterivian.

All figures $\times 2$, unless otherwise indicated.

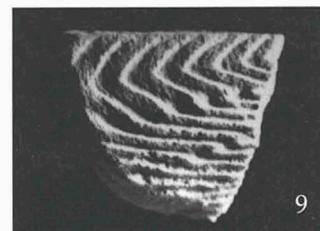
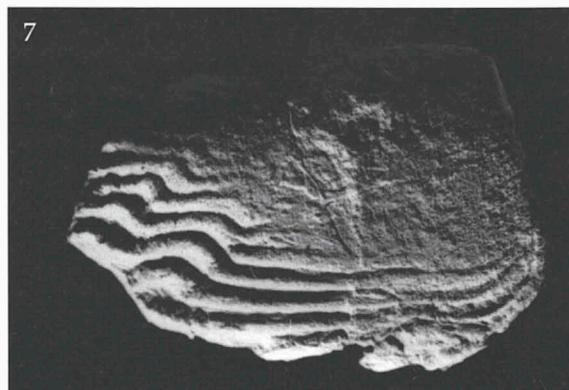
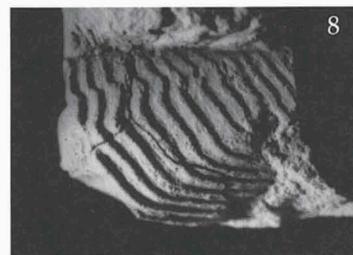
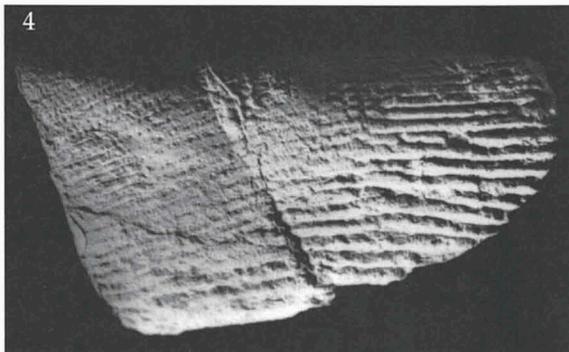
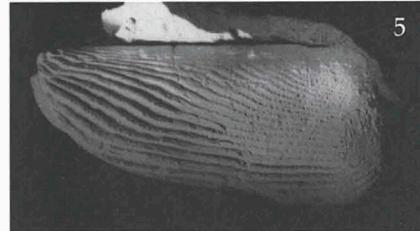
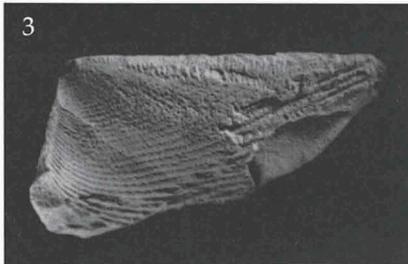
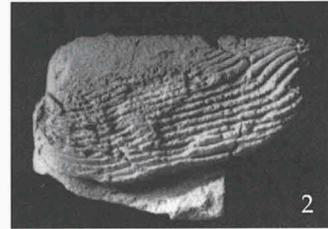
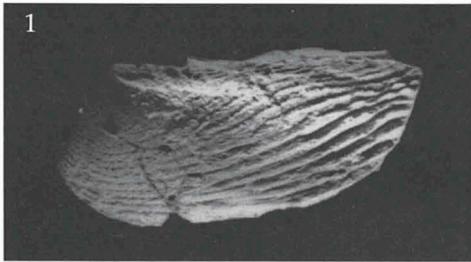


Plate 2

Fig. 1. *Lamellaptychus* ex gr. *mortilleti noricus* Trauth, 1938 from bed Y127, Paramimouna Subzone, late Berriasian.

Fig. 2. *Lamellaptychus didayi* (Coquand, 1841) from bed QIII4, Trinodosum Subzone, late Valanginian.

Fig. 3. *Lamellaptychus angulocostatus angulocostatus* (Peters, 1854) from Balearis or Ohmi zone, late Hauterivian.

Fig. 4. *Lamellaptychus angulocostatus radiatus* Trauth, 1938 from Balearis or Ohmi zone, late Hauterivian.

Fig. 5. *Lamellaptychus angulocostatus angulicostatus* (Pictet & Loriol, 1858) from bed C142D, Ohmi Zone, late Hauterivian.

Fig. 6. *Lamellaptychus angulocostatus gracilicostatus* subsp. nov., loose but derived from one of the beds between bed W30D and W34, Ohmi Zone, late Hauterivian.

Fig. 7. *Lamellaptychus ?angulocostatus bifractus* Khalilov, 1978, loose but derived from one of the beds between bed W30B and W31, Ohmi Zone, late Hauterivian.

Fig. 8. *Lamellaptychus filicostatus filicostatus* Stefanov, 1961 from the late Hauterivian.

Fig. 9. *Lamellaptychus* cf. *filicostatus* Stefanov, 1961, loose but derived from one of the beds between bed Q8 and Q16, Sayni Zone, late Hauterivian.

All figures $\times 2$, except fig. 3, which is $\times 3$.

