A NEW AMMONOID FAUNA FROM THE CARNIAN (UPPER TRIASSIC) KASIMLAR FORMATION OF THE TAURUS MOUNTAINS (ANATOLIA, TURKEY)

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Abstract: We describe a new ammonoid fauna from the Taurus Mountains of southern Turkey. The Carnian ammonoid fauna from Aşağıyayla(sub) is presented for the first time. Ammonoids were obtained from limestone to marl beds of an approximately 35-m-thick section, which presents the rare opportunity to investigate ammonoid faunas across the Lower–Upper Carnian boundary. Intense sampling near the village of Aşağıyayla led to the recognition of a new Lower Carnian (Julian 2) to Upper Carnian (Tuvalian 1) ammonoid fauna from the Kasimilar Formation. The genus Kasimilarceltites gen. nov. is reported for the first time from the Taurus Mountains, which represents the main faunal element and occurs as huge mass occurrence (n > 1 million). Kasimilarceltites kristyeni gen. et sp. nov., Klipsteinia disciformis sp. nov. and Anasirenites crassicrenulatus sp. nov. occur within the Lower Carnian Carbonate member (Units A–B) of the Kasimilar Formation from the Taurus Platform Units. Ammonoids described from the marls of the Tuvalian Marlstone member were deposited during a major, Tethyan-wide climate crisis – the so-called Carnian crisis – characterized by a demise of carbonate platforms. Based on the biostratigraphic relevance of certain ammonoid taxa described herein, the age of the analysed parts of the Kasimilar Formation is Julian 2 to Tuvalian 1. The discovery of the new ammonoid assemblages from Aşağıyayla(sub) substantiates the significance of Upper Triassic faunas within the Taurus Mountains and facilitates the correlation with faunal assemblages from other regions in the Tethyan Realm. The ammonoid fauna and facies indicate a general deepening from open-platform margins, over deeper shelf settings down to an open marine-influenced basinal environment. The tentative habitat for Kasimilarceltites gen. nov. is a shallow platform environment to upper mid-ramp.

Key words: palaeobiogeography, biostratigraphy, Julian, Tuvalian, Tethyan Realm.

UPPER Triassic sediments, especially from the Carnian stage, form a major element within the Taurus Mountains. The area around Aşağıyayla(sub) has already been investigated by Örgül and Arpat (1973), Dumont and Kerey (1975), Monod (1977), Poisson (1977), Gutnic et al. (1979), Robertson (1993, 2000), Senel (1997), Gindl (2000), Robertson et al. (2003) and Lukeneder et al. (2012).

The Carnian section at Aşağıyayla(sub) displays a lithological change from pure carbonatic to more siliciclastic sedimentation (Lukeneder et al. 2012). The facies change occurs exactly at the Lower–Upper Carnian boundary (e.g. Julian–Tuvalian boundary) and represents the beginning of the so-called Carnian pluvial episode at the section at Aşağıyayla(sub). Facies interpretations change from open-platform margin conditions, through deeper shelf margin conditions, to finally open marine-influenced basinal conditions (Lukeneder et al. 2012).

The Carnian pluvial episode (Simms and Ruffell 1989; Breda et al. 2009; Lukeneder et al. 2012) occurs at least Tethyan-wide with a huge platform and reef demise.

Due to more humid conditions, an enormous siliciclastic run-off from the Baltic craton was accumulated at the north-western branch of the Tethys (Tollmann 1976; Aigner and Bachmann 1992; Hornung and Brandner 2005). This led to a collapse of the reef ecosystems and carbonate platforms (Hornung and Brandner 2005). During this time, the sediments around Aşağıyayla(sub) were deposited within an intrashelf area on the western end of the Cimmerian System (Gindl 2000; Stampfli and Borel 2002; Lukeneder et al. 2012). Sedimentological and palaeontological investigations show a delayed carbonate factory breakdown during the Carnian pluvial episode for the carbonate platforms in Turkey (Lukeneder et al. 2012). The fact that the Carnian pluvial episode started one...
ammonoid zone (= about two my) earlier along the north-western Tethyan margin, in contrast to Aşağıiyaylabel, indicates a diachrony within the Tethys (Lukeneder et al. 2012).

The section at Aşağıiyaylabel is therefore a key section for detailed investigations of an ammonoid fauna that has been affected by this major environmental change. The worldwide distribution of pelagic ammonoids during the Triassic makes them suitable as a biostratigraphical and palaeogeographical tool (Krystyn 1973). The zonation of stages and substages assumed by Mojsisovics (1869, 1870, 1873–1902, 1879, 1882, 1893, 1896) resulted in a detailed, ammonoid-based Triassic biostratigraphy. This was accepted and is still used by the scientific ammonoid community (Diener 1906, 1917, 1921, 1923; Spath 1934; Krystyn 1973; Tozer 1981, 1984; Lucas 2010). Detailed work on comparable Upper Triassic ammonoid faunas from the Tethyan Realm has been performed by Krystyn and Schlager (1971), Tozer (1971, 1981, 1984, 1994), Krystyn (1973, 1978, 1980, 1982), Tatzeiter (1980, 1982), Balini and Jenks (2007), and Balini et al. (2007).

The Global Boundary Stratotype Section and Point for the base of the Carnian stage, and therefore for the Julian substage, has recently been defined by the lowest occurrence of Daxatina canadensis (Mietto et al. 2007a, b; Balini et al. 2010). The further ammonoid zonation of the Carnian stage is based on a major faunal change at the Julian–Tuvalian boundary. Whilst the Julian substage is dominated by the Trachyceratinae (especially Trachyceras and Austrotachyceras) and Sireniitinae (e.g. Sirenites), the base of the Tuvalian is marked by a crisis related to these groups. In the Tuvalian, Trachyceratinae are represented solely by their final descendant Trachyagenites. In contrast to the decline of the Trachyceratinae, mainly the Tropitidae (e.g. Tropites, Paratropites) and to a lesser extent the Arpaditinae underwent a radiation from the base of the Tuvalian onward and are therefore characteristic faunal elements of the Tuvalian substage (Balini et al. 2010). The Carnian ammonoid zonation of Krystyn (1978), which is mostly used by south European workers, is divided into five zones and nine additional subzones. This zonation is well correlated with the British Columbian zonation, reviewed by Tozer (1994), which yields six biozones. It is based, amongst others, on the worldwide occurrence of Tropites dilleri (Balini et al. 2010). Whilst the Tuvalian 1 is represented in both ammonoid zonations by the Tropites dilleri Zone, the Tuvalian 2 is represented by the Tethyan Tropites subbullatus Zone as well as by Tozer’s Tropites welleri Zone, which shows a slightly longer dimension (Balini et al. 2010).

Generally the sediments of the Late Triassic are dominated by diverse Tethyan ammonoid assemblages, which can simply be distinguished from the less diverse, endemic Boreal ammonoid assemblage. Sirenitinae, Ussuritidae, Acastidae and Gymnitoidei are the representatives of the Boreal ammonoids, which show an order of magnitude poorer record than the Tethyan assemblage (Dagys 1988; Balini et al. 2010).

More detailed investigations of the ammonoid fauna from Aşağıiyaylabel will help to decipher the biostratigraphical background around the Julian–Tuvalian boundary within the Taurus Mountains of southern Turkey. Lower Carnian faunal elements, exclusively detected at Aşağıiyaylabel and characterized by Kasimlarcelites krystyni gen. et sp. nov., Klipsteinia diciformis sp. nov. and Anasirenites crassicrenulatus sp. nov., show a type of isolated but still connective palaeoceanographic position of the intrashelf area on the western end of the Cimmerian System. The main aim of the present work is, besides describing new faunal elements, a review of the Late Triassic ammonoid fauna. This is accompanied by a global stratigraphic and palaeogeographic comparison.

**GEOLOGICAL SETTING**

The outcrop at Aşağıiyaylabel is situated at steep limestone walls (50 degrees towards NE) within the Taurus Mountains of southern Turkey (Anatolia), about 90 km north–north-east from Antalya, between the lakes Egedir and Beyshehir (Fig. 1). The section crops out near the little village Aşağıiyaylabel (WGS84 coordinates 37°33′05″N, 31°18′14″E), at approximately 1050–1100 m above sea level. Tectonically, the area around the locality is part of the Taurus Platform Units (Dumont and Kerey 1975; Dumont 1976; Lukeneder et al. 2012). Within the latter units, the outcrop is located on the Anamas Dag or Anamas Autochthon (Dumont 1976; Gallet et al. 2007; Luke- neder et al. 2012). The deposits of this section belong to two formations, the stratigraphically older Kartoz Formation (lowermost Carnian) and the younger Kasimlar Formation (Carbonate, Marlstone and Shale members; Lukeneder et al. 2012), which reaches from Lower to Upper Carnian age (Julian 2–Tuvalian 1). The fossil fauna reported within this work derives from the Kasimlar Formation with Lower Carnian to Upper Carnian sediments (Julian 2–Tuvalian 1; Fig. 2).

**MATERIALS AND METHODS**

All specimens described within this study were extensively collected from the Kasimlar Formation at the section Aşağıiyaylabel (Taurus Mountains, Turkey). The material was collected (1995–2012) by the authors, by Mathias
Harzhauser and Franz Topka (Natural History Museum Vienna), and on earlier field excursions (1980–1997) by Leopold Krystyn, Andreas Gindl and Philip Strauss (excursions organized by the University of Vienna). Two sections are compiled on to one log as AS, and material from the earlier field excursions by Leopold Krystyn was correlated with the new log. Therefore, new numbers are combined with old ones, for example, AS 47 + 2.5 m = AS 16 (Fig. 2). Unfortunately, the exact bed location of some ammonoid examples could not be identified. Such examples are indicated as dashed vertical lines on Figure 2 (e.g. between beds AS 19 and AS 46).

The ammonoids are well preserved, mostly with secondary calcite shells. Only few specimens of the genera Kasimlarceltites gen. nov., Klipsteinia, Anasirenites and Megaphyllites show suture lines. A total of 479 ammonoid specimens, two nautiloid specimens and four coleoid specimens have been collected and, whenever possible, determined to species level. The ammonoid assemblages consist of 12 ammonoid genera (Kasimlarceltites gen. nov., Spirognoceras, Sandlingites, Klipsteinia, Neoprotrachyceras, Sirenites, Anasirenites, Paratropites, Trachysagenites, Proarcestes, Megaphyllites and Simonyceras) containing 13 species and a single coleoid genus Atracites. The nautiloid specimen could not be determined at generic level. Conch parameters from specimens presented herein and compared taxa from literature, given in the remarks below, are shown in Tables 1–3 as well as in Lukeneder and Lukeneder (2013). Measurements were taken by using a vernier micrometer. For measuring smaller specimens or details (e.g. suture lines), SEM pictures were used and details measured with a digital scale. Thin sections were made to investigate different ammonoid growth stages, septa and body chamber length. Suture lines were also investigated using SEM (JEOL JSM-6400). Photographed specimens were coated with ammonium chloride. Additional facies investigations were conducted under a dissecting microscope (Zeiss Discovery V20) with attached digital camera (AxioCam MRc5). Sectioning and photographing were performed at the Natural History Museum in Vienna.

The collected material is stored within the systematic type collection of the Geological-Palaeontological Department of the Natural History Museum, Vienna (NHMW), and the compared type material at the collection of the Geological Survey of Austria, Vienna (GBA).

**Statistical methods.** In addition to conventional methods, we conducted principal component analyses (PCAs), bivariate plots and coefficients of determination with...
FIG. 2. Log of the section at Aşağıyaylabel with indicated occurrences of the ammonoid fauna. Biostratigraphic zonation (left); corresponding abbreviations: EC1–4, Early Carnian; LC1–2, Late Carnian (after Lukeneder et al. 2012). Note that the scale changes at 4 m. Ammonoid occurrences and ranges are marked by solid black circles (bed-by-bed sampling). Bold horizontal line indicates substage and zonal boundary, dashed vertical lines indicate ammonoid sampling from sequences or from reworked rock samples.
With respect to the conch parameters. This visualizes the diagnosis of the conch parameters of *Kasimlarceltites* gen. nov. It also tests for similarities or differences between *Kasimlarceltites* gen. nov. and related genera, as well as between *K. disciformis* sp. nov. and related species. The measured conch parameters D, H, W, U and ah (Fig. 3)

| Type/Inv. Nr. | Figure | D (mm) | H (mm) | W (mm) | U (mm) | ah (mm) | H/W | H/D | H/U | U/D | W/D | WER |
|---------------|--------|--------|--------|--------|--------|---------|-----|-----|-----|-----|-----|-----|
| **Kasimlarceltites krystyni** gen. et sp. nov. | HT (NHMW-2012z0133/0014), data source: sm | 33.0 | 9.0 | 6.8 | 16.5 | 7.5 | 1.32 | 0.27 | 0.55 | 0.50 | 0.21 | 1.675 (m) |
| | PT (NHMW-2012z0133/0266), data source: sm | 0.6 | 0.3 | – | 0.2 | 0.3 | – | 0.45 | 1.91 | 0.23 | – | 4.000 (vh) |
| | PT (NHMW-2012z0133/0269), data source: sm | 2.5 | 0.9 | – | 1.0 | 0.7 | – | 0.36 | 0.95 | 0.38 | – | 1.999 (m) |
| | PT (NHMW-2012z0133/0278), data source: sm | 2.4 | 0.8 | 1.4 | 1.0 | 0.6 | 0.53 | 0.32 | 0.80 | 0.40 | 0.60 | 1.747 (m) |
| | PT (NHMW-2012z0133/0279), data source: sm | 9.0 | 3.2 | 3.6 | 3.4 | 2.4 | 0.89 | 0.35 | 0.92 | 0.38 | 0.40 | 1.828 (m) |
| | PT (NHMW-2012z0133/0280), data source: sm | 21.7 | 8.4 | 6.7 | 6.7 | 6.5 | 1.35 | 0.39 | 1.25 | 0.31 | 0.29 | 2.046 (mh) |
| | PT (NHMW-2012z0133/0131), data source: sm | 31.4 | 8.3 | 5.9 | 13.3 | 7.8 | 1.41 | 0.26 | 0.62 | 0.42 | 0.19 | 1.770 (m) |
| | PT (NHMW-2012z0133/0001), data source: sm | 5.0 | 1.6 | 2.0 | 2.0 | 1.9 | 0.8 | 0.32 | 0.8 | 0.40 | 0.40 | 2.601 (h) |
| | PT (NHMW-2012z0133/0002), data source: sm | 7.5 | 2.3 | 3.0 | 3.4 | 2.0 | 0.77 | 0.31 | 0.68 | 0.45 | 0.40 | 1.860 (m) |
| | PT (NHMW-2012z0133/0003), data source: sm | 10.0 | 3.0 | 3.0 | 4.0 | 3.2 | 1.00 | 0.30 | 0.75 | 0.40 | 0.30 | 2.163 (mh) |
| | PT (NHMW-2012z0133/0004), data source: sm | 12.3 | 3.9 | 3.4 | 4.9 | 4.3 | 1.15 | 0.32 | 0.80 | 0.40 | 0.28 | 2.364 (mh) |
| | PT (NHMW-2012z0133/0005), data source: sm | 16.0 | 5.6 | 4.1 | 6.1 | 4.8 | 1.37 | 0.35 | 0.92 | 0.38 | 0.26 | 2.041 (mh) |

ah, aperture height; D, maximum diameter; H, whorl height; H/D, proportional height; H/U, degree of involution; H/W, whorl compression; sm, self-measured; U, umbilical width; U/D, proportional umbilical width; W, whorl breadth; W/D, proportional whorl breadth; WER, whorl expansion rate; WER standard: m, moderate 1.61–2.0; mh, moderately high 2.01–2.40; h, high 2.41–2.80; vh, very high > 2.80.

| Type/Inv. Nr. | Figure | D (mm) | H (mm) | W (mm) | U (mm) | ah (mm) | H/W | H/D | H/U | U/D | W/D | WER |
|---------------|--------|--------|--------|--------|--------|---------|-----|-----|-----|-----|-----|-----|
| **Klipsteinia disciformis** sp. nov. | HT (NHMW-2012z0133/0290), data source: sm | 20.5 | 9.0 | 5.0 | 5.0 | 6.0 | 1.80 | 0.44 | 1.80 | 0.24 | 0.24 | 1.999 (m) |
| | PT (NHMW-2012z0133/0293), data source: sm | 14.0 | 5.5 | 3.0 | 4.0 | 5.2 | 1.83 | 0.39 | 1.38 | 0.29 | 0.21 | 2.531 (h) |
| | PT (NHMW-2012z0133/0291), data source: sm | 19.0 | 8.0 | 4.8 | 5.0 | 6.7 | 1.67 | 0.42 | 1.60 | 0.26 | 0.25 | 2.386 (mh) |
| | PT (NHMW-2012z0133/0292), data source: sm | 18.1 | 8.60 | 4.4 | 4.0 | 5.90 | 1.95 | 0.48 | 2.15 | 0.22 | 0.24 | 2.201 (mh) |

ah, aperture height; D, maximum diameter; H, whorl height; H/D, proportional height; H/U, degree of involution; H/W, whorl compression; sm, self-measured; U, umbilical width; U/D, proportional umbilical width; W, whorl breadth; W/D, proportional whorl breadth; WER, whorl expansion rate; WER standard: m, moderate 1.61–2.0; mh, moderately high 2.01–2.40; h, high 2.41–2.80.
TABLE 3. Measurements of the holotype and the paratype of *Anasirenites crassicrenulatus* sp. nov. from Aşağıyaylabel (Taurus Mountains, Turkey).

| Type/Inv. Nr. | Figure | D (mm) | H (mm) | W (mm) | U (mm) | ah (mm) | H/W | H/D | H/U | U/D | W/D | WER |
|--------------|--------|--------|--------|--------|--------|---------|------|------|------|------|------|------|
| Anasirenites crassicrenulatus sp. nov. | | | | | | | | | | | | |
| HT (NHMW-2012z0133/0310), data source: sm | 10E–F | 27.0 | 11.5 | 5.5 | 5.5 | 10.0 | 2.09 | 0.43 | 2.09 | 0.20 | 0.20 | 2.522 (h) |
| PT (NHMW-2012z0133/0309), data source: sm | 10C–D | 30.7 | 11.4 | 7.3 | – | 11.7 | 1.56 | 0.37 | – | – | 0.24 | 2.611 (h) |

ah, aperture height; D, maximum diameter; H, whorl height; H/D, proportional height; H/U, degree of involution; H/W, whorl compression; sm, self-measured; U, umbilical width; U/D, proportional umbilical width; W, whorl breadth; W/D, proportional whorl breadth; WER, whorl expansion rate; WER standard: h, high 2.41–2.80.

FIG. 3. Explanation of dimensions and conch parameters used. *A*. *Kasimlarceltites krystyni* gen et sp. nov. (see also Fig. 5I–J; 2012z0133/0262). B, schematic ammonoid sketch with indicated conch parameters. Abbreviations: ah, aperture height; bc, body chamber; D, diameter; d, diameter exclusive of last whorl; H, whorl height; ph, phragmocone; U, umbilical width; W, whorl breadth. Scale bar represents 1 cm.

FIG. 4. Ontogenetic stages, morphology and suture of *Kasimlarceltites krystyni* gen. et sp. nov. A–G, early whorls, scale bars represent 100 μm. A, lateral view of the ammonitella, paratype, 2012z0133/0266. B, ventral view of the ammonitella, 2012z0133/0267. C, lateral view of the ammonitella, 2012z0133/0268. D, juvenile stage of specimen, paratype, 2012z0133/0269. E, detailed photograph of juvenile whorls, 2012z0133/0270. F, ventral view of juvenile stage, paratype, 2012z0133/0271. G, detailed photograph of inner whorls, 2012z0133/0272. H, detailed photograph of the striae, paratype, 2012z0133/0273; scale bar represents 1000 μm (1 mm). I–K, scale bars represent 100 μm. I, suture, paratype, 2012z0133/0274. J, drawing of the suture line from specimen 2012z0133/0274. K, detailed photograph of the siphuncle, 2012z0133/0275. L–P, scale bars represent 1000 μm (1 mm). L, median thin section, paratype, 2012z0133/0276. M, thin section of the body chamber, paratype, 2012z0133/0277 with emphasis (arrow) on the siphuncle. N, transversal thin section of a juvenile specimen, paratype, 2012z0133/0278, note corresponding H/W values for compression/depression. O, transversal thin section of an intermediate stage, paratype, 2012z0133/0279, with indicated H/W values. P, adult stage, paratype, 2012z0133/0280, with indicated H/W values. A–K, figured specimens and paratypes from bed AS 6. L–P, paratypes from bed AS 4. Abbreviations: a, ammonitella; bc, body chamber; ll, lateral lobe; ls, lateral saddle; s, siphuncle; ul, umbilical lobe; vl, ventral lobe; vl, ventrolateral saddle; vs, ventral saddle.
moderately high 2.01–2.40; h, high 2.41–2.80; and vh, very high > 2.80 (Korn 2000).

**SYSTEMATIC PALAEONTOLOGY**

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Order CERATITIDA Hyatt, 1884
Suborder CERATITINA Hyatt, 1884
Superfamily CERATITACEAE Mojsisovics, 1879
Family CELTITIDAE Mojsisovics, 1893

**Genus KASIMLARCELTITES gen. nov.**

_Figures 3A, 4A–P, 5A–AH_

2000 Orthoceltites n. sp. 1 Gindl, p. 36–52, pl. 1, figs 1–4.
2012 Orthoceltites Lukeneder et al., p. 280, 282, 284, 285, 289–290, fig. 5.

**LSID.** urn:lsid:zoobank.org:act:E74134E3-B84B-420C-8F15-D3E21327FB0

_Derivation of name._ After the Upper Triassic Kasimlar Formation in Anatolia, Turkey.

_Type species._ Kasimlarceltites krystyni gen. et sp. nov. from the Upper Triassic Kasimlar Formation in Aşağıiyalıbel (Anatolia, Turkey).

_Type locality._ Kasimlar Formation at Aşağıiyalıbel, Carbonate member Unit A, beds AS 4 and AS 6 (Fig. 2), 37°33′05″N, 31°18′14″E, Upper Triassic (Lower Carnian, Julian 2).

**Diagnosis.** Evolute, medium-sized (up to 33 mm, Table 1). _Kasimlarceltites_ gen. nov. occurs with four recognizable, distinct and different ontogenetic stages of shell ornamentation. The ontogeny starts with smooth ammonitellae (Fig. 4A–C), followed by widely spaced and distinctly ribbed juvenile morphologies. Strong ribs cross flanks, but weaken on venter, occasionally cross venter or disappear (Fig. 4D–F). Fine to striae ribbing evolves at the mid-aged to preadult phase (Fig. 4G–H), finally ending with strongly ribbed adult shell morphologies (Fig. 5A–C). Whorl sections strongly depressed in juveniles (Fig. 4N), becoming increasingly compressed towards adult stages (Fig. 4O–P) with narrow, rounded venter. A clear positive correlation of the conch parameters H, W, U and ah with respect to D is evident, with coefficients of determination (r²) being 0.93, 0.90, 0.94 and 0.88, respectively (Fig. 6A–D). With increasing diameters, the conch parameters H, W, U and ah as well as the ratio H/W increase gradually (quadratic, Fig. 6A, C; cubic, Fig. 6B, D–E). The increasing ratio of H/W with D (Fig. 6E–F) confirms the already described change from a more depressed (juvenile) to compressed (adult) conch morphology (Fig. 6F); the ratio H/W has been tested at different ontogenetic stages of three specimens of _Kasimlarceltites_ gen. nov. (for more details see Discussion). The goniatitic to weakly ceratitic suture, with smooth lobes and a ventral saddle, is shallow in juveniles and more prominent in adults (Fig. 4I–J).

**Composition of genus.** Monospecific.

**Remarks.** Kasimlarceltites gen. nov., incorrectly assigned to the genus Orthoceltites by Lukeneder et al. (2012), differs from other similar Upper Triassic (Carnian) ammonoids by the combination of its ontogenetic change in the ribbing and by numerous morphological conch parameters. The following discussion of the relationships between similar genera is based on the examination of data from the literature as well as of material from different Carnian type localities such as Glamoča (Bosnia and Herzegovina), St. Cassian (northern Italy), as well as from the Feuerkogel and Röthelstein (Austria). A principal component analysis (PCA, Fig. 7A) as
well as bivariate plots with respect to D (Fig. 7B–G), for testing similarities of conch parameters, was conducted for Kasimlarceltites gen. nov. and its related genera. The first two axes of the PCA explain a total of 99.20 per cent of the variance (PC1 explains 97.82 per cent; PC2 explains 1.38 per cent), which clearly separate the genus Cycloceltites, as well as most specimens of the species Dinarites avisianus and Lecanites vogdesi, from Kasimlarceltites gen. nov. (Fig. 7A). The related genus Cycloceltites Mojsisovics, 1893 appears in the Carnian and
Norian with the type species *Cycloceltites arduini* differing from *Kasimlarceltites* gen. nov. by strong, radially flared ribbing throughout the shell and by its general conch morphology (Fig. 7A). This difference is also present in the more evolute Carnian genus *Coeloceltites* Spath, 1951 with its type species *Coeloceltites rectangularis* (Hauer, 1860), which plots randomly to *Kasimlarceltites* gen. nov. (Fig. 7A).

In contrast to this, the genus *Orthoceltites* Spath, 1951, and most species of the genera *Celtites* Mojsisovics, 1882 and *Lecanites* Mojsisovics, 1882 plot close to *Kasimlarceltites* gen. nov., possessing similar conch parameters. The conch parameters of *'Goniatites' buchi* (Klipstein 1843), representing the type species of *Orthoceltites*, as well as the parameters of *O. belcheri* (Tozer 1994) and *O. klipsteinianus* (= *'Ammonites' klipsteinianus*;...
Laube 1870), are characteristic for the genus Orthoceltites. Nonetheless, Kasimlarceltites gen. nov. exhibits weaker or no ribbing throughout, compared with the genus Orthoceltites. Orthoceltites buchii and O. klijsteinianus additionally show a different suture line (pointed ventral lobes), and O. belcheri shows wrinkled lobes and saddles (Tozer 1994).

The Late Anisian genus Aplococeras, defined by Hyatt (1900) based on the type species ‘Dinaries’ avianus Mojsisovics, 1882, is morphologically closely related to Kasimlarceltites gen. nov. However, nearly all specimens of Kasimlarceltites gen. nov., except for one example which plots randomly. ‘Dinaries’ avianus differs by almost every conch parameter from Kasimlarceltites gen. nov., including a higher H (10–14 mm), W (7.5–10 mm) and ah (8.57–11.51 mm; Fig. 7B–D), but similar values of U (12.5–16.5 mm; Fig. 7E) and H/W (1.33–1.4; Fig. 7F). Aplococeras transiens Manfrin et al. 2005 (figs 5, 10–18), seems to be very close to Kasimlarceltites gen. nov. Nevertheless, Aplococeras shows an almost flat venter, and the main ribbing is stronger throughout; moreover, Aplococeras has been described so far only from Anisian beds (Assereto 1969; Manfrin et al. 2005).

Further analytical measurements were taken on numerous species of the genus Celtites, including C. confinis, C. edithae (Mojsisovics 1893), C. laevior (Diener 1917) and C. neumayri (Mojsisovics 1893) (Fig. 7A). Species such as C. confinis, C. laevior and C. edithae, which plot close to Kasimlarceltites gen. nov. (Fig. 7A), show high similarities with Kasimlarceltites gen. nov. in the conch parameters H, ah and U (Fig. 7B, D–E). Only within the conch parameter W, C. edithae plot randomly (6.0 mm) compared with Kasimlarceltites gen. nov., with W of 0.43–6.8 (mean 3.6 mm; Fig. 7C). In contrast to all other species of Celtites, Celtites neumayri plots randomly to Kasimlarceltites gen. nov. (Fig. 7A), due to the higher values of the whorl breadth (Fig. 7C). The major difference between the genus Celtites and Kasimlarceltites gen. nov. appears to be the more evolute coiling of Celtites, indicated by mean U/D values of 0.52 vs 0.40 (Table 1 and Lukeneder and Lukeneder 2013). Celtites laevior and C. confinis show a similar suture, but differ from Kasimlarceltites gen. nov. in strong, tuberculate ribbing throughout the shell.

Assereto (1969), Balini et al. (2000) and Manfrin et al. (2005) described different species of the Ladinian to Lower Carnian genus Lecanites Mojsisovics, 1882, closely related to Kasimlarceltites gen. nov. The smooth shell, with weak sigmoidal ribs (Mojsisovics 1882; Arkell et al. 1957), is quite similar. In contrast to the specimens of L. vogdesi, which generally plot separated, respectively, randomly from Kasimlarceltites gen. nov., L. glaucus and L. misanii plot close and are therefore quite similar in their conch morphology (Fig. 7A). However, both species (L. glaucus and L. misanii) show a higher ratio of H/W (2.0 and 1.69; Fig. 7F), what represents a more compressed conch than Kasimlarceltites gen. nov. (mean 1.19; Fig. 7F). The notable differences in L. vogdesi compared with Kasimlarceltites gen. nov. are due to a higher W (mean 9.34 mm vs mean 3.6 mm; Fig. 7C) and with mostly wider diameters (mean 32.84 mm vs mean 13.2 mm; Fig. 7G). The type species of Lecanites, ‘Ammonites’ (Ceratites) glaucus Münster, 1834, differs from Kasimlarceltites gen. nov. by lacking the distinct ribbing, a feature characteristic for juvenile stages in Kasimlarceltites gen. nov.

Although some genera mentioned above generally show certain similar conch parameters (Fig. 7A), most of them differ at least in one parameter from Kasimlarceltites gen. nov. (Fig. 7B–G), but also by stronger ribbing throughout ontogeny and by more evolute whorls. Based on shell morphology and suture line, we follow Arkell et al. (1957) and include Kasimlarceltites gen. nov. into the family Celtitidae Mojsisovics, 1893.

Stratigraphic distribution and age. The co-occurrence of Kasimlarceltites gen. nov., together with Klijsteinia (beds AS 4, AS 6 and AS 7) and Sirenetes (bed AS 6) suggests at least Julian age. Due to the presence of Neoprotrachyceras sp. within bed AS 2, and therefore below the occurrence of Kasimlarceltites gen. nov., the stratigraphic distribution of Kasimlarceltites gen. nov. can be defined as not older than Julian 2/lb.

Kasimlarceltites krystyni sp. nov.

Figures 3A, 4A–P, 5A–AH

2000 Orthoceltites n. sp. 1 Gindl, p. 36–52, pl. 1, figs 1–4.
2012 Orthoceltites sp. Lukeneder et al., pp. 280, 282, 284, 285, 289–290, fig. 5.

LSID. urn:lsid:zoobank.org:act:820A9EAF-9564-4A0A-877E-0418E039B317.

Derivation of name. Named after Leopold Krystyn (Vienna, Austria) in honour of his inspiring work on Triassic ammonoids.

Holotype. Natural History Museum, Vienna, NHMW-2012z0133/0014 (Fig. 5AE–AF).

Paratypes. Sixteen paratypes have been defined: NHMW-2012z0133/0266 (Fig. 4A), NHMW-2012z0133/0269 (Fig. 4D), NHMW-2012z0133/0271 (Fig. 4F), NHMW-2012z0133/0273–0274 (Fig. 4H–I), NHMW-2012z0133/0276–0277 (Fig. 4L–M), NHMW-2012z0133/278–280 (Fig. 4N–P), NHMW-2012z0133/0001 (Fig. 5A–B), NHMW-2012z0133/0002 (Fig. 5C–D), NHMW-2012z0133/0003 (Fig. 5E–F), NHMW-2012z0133/0004 (Fig. 5G–H), NHMW-2012z0133/0005 (Fig. 5K–L), NHMW-2012z0133/0013 (Fig. 5AC–AD).
Type locality and horizon. Aşağıyaylabel, Anatolia, Turkey, Kasimlar Formation, Carbonate member Unit A, bed AS 6 (holotype NHMW-2012z0133/0014) and paratypes NHMW-2012z0133/0266, 0269, 0271, 0273–0274, 0001–0005, 0013), bed AS 4 (paratypes NHMW-2012z0133/0276–0280; Fig. 2) (WGS84: 37°33′05″N, 31°18′14″E), Upper Triassic (Lower Carnian, Julian 2).

Material. About 280 specimens from the Carbonate member, Units A–B (NHMW-2012z0133/0001–0280).

Measurements. See Table I and Lukeneder and Lukeneder (2013).

Diagnosis. Evolute shell, up to 33 mm D (Fig. 7G), with mesolongidome body chamber. Four different ontogenetic stages of shell morphology are characterized by different ribbing (smooth ammonitellae at the early stage of juvenile shells, followed by strongly ribbed juvenile morphologies, evolving a fine-ribbed mid-aged to preadult phase and finally a strongly ribbed adult stage), different whorl shape (from depressed to compressed, see Fig. 6E–F) and different umbilical wall (from shallow arched to steep; Fig. 4N–P). The lack of an adventive lobe classifies the initially goniatitic suture as ceratitic (Gindl 2000). Lobe size and saddle size generally decrease in ventral direction.

Description. Kasimlarceltites krystyni gen. et sp. nov. generally shows an evolute shell with U/D = 0.23–0.50 (Table 1). The parameters H and U show a positive quadratic correlation with D ($r^2 = 0.93, 0.94$), whilst W, ah and H/W show positive cubic correlations with D ($r^2 = 0.90, 0.88, 0.70$; Fig. 6A–E). Whorl shape changes from highly depressed to compressed in ontogeny (Figs 4N–P, 6E–F). Juvenile whorl shells are depressed, with H/W 0.35–0.60 (paratype, Figs 4N, 6F), whereas preadult stages show H/W values of 0.58–0.91 (paratype, Figs 4O, 6F), and adult whorl stages are compressed (paratype, Fig. 4P), with maxima of H/W 2.15 (Fig. 6E–F). The meso- to longidome body chamber comprises almost the entire whorl (270–360 degrees; paratype, Fig. 4L). Ribbing differs in the various growth stages (Fig. 4A–H). Juveniles have a shallow, arched umbilical wall, whereas adults have a steep umbilical wall (paratype, Fig. 4N–P).

Juvenile, smooth shells (e.g. ammonitellae) have a maximum D of 0.6 mm (paratype, Fig. 4A; see also Fig. 4B–C). Whorl shape is globular to depressed; tube-like whorl sections with H/W 0.75 are present (Fig. 6F). At a D of 0.7 mm, the H is 0.3 mm and W 0.4 mm (Fig. 4A). A smooth embryonic protocochn at the juvenile stage (ammonitella until first whorl) is followed by strong ribbing. One whorl bears 16 prominent, very well and widely spaced strong ribs (paratype, Fig. 4D; see also Fig. 4E). Ribbing appears sharp, distinct and prominent on flanks. Single ribs start at upper umbilical edge and cross the flanks. Ribs are weaker (hardly visible) on venter (paratype, Fig. 4F). Strongly ribbed stage ends at a D of approximately 2–4 mm. The juvenile phase with strong ribbing is replaced by two to four whorls exhibiting fine, slightly sigmoidal ribbing (crossing the venter in a proverse adoral bow; paratype, Fig. 4H) to almost smooth whorls at the end of the juvenile stage up to the mid-aged (preadult) stage (holotype, Fig. 5AE–AF; also see Figs 4G, 5S–W). Ribbing, somewhat variable in strength, ranges from very fine ribs over striae (narrow-spaced striae; paratypes, Figs 4H, 5K–L) to stronger ribs (holotype Fig. 5AE–AF). A final strong ribbing near the aperture is visible only in large adult specimens (paratype, Fig. 5AC–AD; see also Fig. 5W–Z). This rib type starts at the mid-flank, crossing the venter in a proverse adoral bow (paratype, Fig. 5AC–AD).

Width and depth of lobes and saddles generally decrease in ventral direction (Fig. 4I–J). The umbilical lobe is five times wider than the ventral lobe. A wide and deep umbilical lobe and a subsequent smooth and rounded lateral saddle are followed by a deep and narrow lateral lobe and again by a wide smooth and rounded ventrolateral saddle. The ventrolateral saddle is again followed by a shallow and narrow ventral lobe, ending in a smooth and rounded, but flattened ventral saddle (paratype, Fig. 4J–L). The lack of an adventive lobe classifies the initially pseudo-goniatitic suture as a primitive, ceratitic suture (Gindl 2000).

Siphuncle structures of K. krystyni gen. et sp. nov. (Fig. 4L–M) are preserved in numerous ($n = 6$) thin sections from AS 4c (Fig. 4L). Siphuncle walls appear as black rings within the transparent, secondary calcite filling of the phragmcone. The shell is also replaced by secondary calcite crystals (Fig. 4L–P). The siphuncle is described from thin section AS 4c (paratype, Fig. 4M). At an H of 4 mm, a W of 3 mm and a st of 0.01 mm, the sd is 0.21 mm. Swt in that specimen is 0.010 mm. A second specimen on the same thin section shows values of H 5 mm, W 3 mm, st 0.09, sd 0.22 mm and swt 0.013 mm. Additionally, siphuncle structures on one specimen (Fig. 4K) could be measured after taking SEM photographs.

Remarks. The herein described K. krystyni gen. et sp. nov. differs from all other known members of the family Celitidae Mojsisovics, 1893 by its distinctive morphological conch parameters (Fig. 7A–G).

Stratigraphic range. Upper Triassic, Lower Carnian, Julian 2.

Regions. Aşağıyaylabel, Taurus Mountains, Turkey.

Superfamily CLYDONITACEAE Mojsisovics, 1879
Family TRACHYCERATIDAE Haug, 1894
Subfamily PROTRACHYCERATINAE Tozer, 1971
Genus SPIROGMOCERAS Silberling, 1956

1956 Spirognoceras Silberling, p. 1147.
1981 Spirognoceras Tozer, p. 95.
2002 Spirognoceras Sepkoski, p. 131.
2012 Spirognoceras Lukeneder et al., p. 284.
Type species. *Trachyceras* (*Protrachyceras*) *shastense* Smith, 1904, from the *Tropites subbullatus* Zone of Shasta County, California, Brock Mountain, on the trail from Squaw Creek to Pitt River, 6 miles north-east of the Bully Hill Mine (Smith 1904).

Remarks. Silberling (1956) established the genus *Spirogmoceras* for the type species *Protrachyceras shastense* (Smith, 1904). He defined *Spirogmoceras* as differing from *Protrachyceras* Mojsisovics, 1893 by: (1) more involute and more compressed shells bearing, in contrast to *Protrachyceras*, more numerous tubercles; (2) distinct longitudinal ridges forming the major ornamentation; and (3) a poorly developed ventral furrow, with less prominent spiral tubercles, bordering the ventral furrow, and more complex ammonitic septa (Silberling 1956).
Stratigraphic range. Upper Triassic, Upper Carnian, *Tropites dilleri* Zone (Tuvalian 1).

*Spirogmoceras cf. shastense* (Smith, 1904)  
Figure 8A

cf. *1904 Trachyceras (Protrachyceras) shastense* Smith, p. 391, pl. 46, figs 9–9a, pl. 48, figs 3–4.  
2012 *Spirogmoceras* Lukeneder et al., p. 284.

Material from Asağıyaylabel. Eight specimens from the Marlstone member, from sequence AS 16–AS 16 + 10 m (Fig. 2): NHMW-2012z0133/0467–0474.

Measurements. See Lukeneder and Lukeneder (2013).

Description. The pictured specimen (Fig. 8A) of *Spirogmoceras cf. shastense*, which is only partly preserved, bears dichotomous falcoid ribs. The shell shows a fine sculpture comprising 8–10, spirally arranged, well-defined rows of longitudinal ridges (Fig. 8A), which form the dominant ornamentation. *Spirogmoceras* additionally shows complex septa (Smith 1927), a feature not observable in the material from Asağıyaylabel.

Discussion. Poorly preserved fragments of the flanks, without any remains of the venter or the umbilicus, have been collected. No suture line could be observed. Never-theless, the specimens show characteristic spiral sculptures as described for *Sp. shastense*, but due to taxonomic uncertainties of this species, we decided to assign the material in open nomenclature. It closely resembles *Sp. shastense* from the Lower Carnian of north-western Nevada figured by Silberling (1961). Further similarities are evident with specimens described and figured by Tozer (1967, 1994) from the Upper Carnian of Canada. As noted by Silberling (1956, 1961), numerous forms such as *Trachyceras (Protrachyceras) lecontei* Hyatt and Smith, 1905, *Trachyceras (Protrachyceras) beckeri* Smith, 1927, *Trachyceras (Protrachyceras) californicum* Smith, 1927, *Trachyceras (Protrachyceras) lindgreni* Smith, 1927, and *Trachyceras (Protrachyceras) madisonense* Smith, 1927 should be placed in one species designated as *Sp. shastense* (Smith, 1904). This opinion was shared by Tozer (1994) and is followed herein.

Stratigraphic range. Upper Triassic, Upper Carnian, *Tropites dilleri* Zone (Tuvalian 1).

Regions. British Columbia (Tozer 1994); Shasta County, California (Smith 1904, 1927; Silberling 1956); Sonora, Mexico (Lucas and Estep 1999); north-west Nevada (Silberling 1961); Asağıyaylabel, Taurus Mountains, Turkey.

Family SANDLINGITIDAE Tozer, 1971

Genus SANDLINGITES Mojsisovics, 1893

1893 *Sandlingites* Mojsisovics, p. 706.
1981 *Sandlingites* Tozer, p. 97.
2002 *Sandlingites* Sepkoski, p. 131.

Type species. *Ammonites oribasus* Dittmar, 1866 (p. 384, pl. 18, figs 8–10), from the ‘Vorderer Sandling’ near Goisern, Austria.

Remarks. Mojsisovics (1893) described three different ontogenetic stages: Whilst the inner whorls show a typical *Tiroliites*-like smooth venter, an abrupt change to a *Protrachyceras*-like stage takes place. The body chamber shows the final sculpture stage, on which no further spines or tubercles are present. The increasing H shows smooth falcoid, branching ribs. The initially narrow median furrow vanishes, and lateral ribs cross the venter. *Sandlingites* shows a goniatitic to ceratitic suture. Entirely rounded saddles and entirely, or at most, slightly lobulate lobes are present (Mojsisovics 1893).

Stratigraphic range. Upper Triassic, Upper Carnian – Norian stage. According to Krystyn (1973) and Tatzreiter (1980), the genus *Sandlingites* is characteristic for the Upper Carnian.

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**FIG. 8.** Fauna of Asağıyaylabel, Kasımlar Fm. A–D, Marlstone member, *Tropites dilleri* Zone (Tuvalian 1). E–L, Carbonate member Unit A, M–Z, Carbonate member Unit C, *Austrotrachyceras austricum* Zone (Julian 2). A, *Spirogmoceras cf. shastense*, 2012z0133/0467, from bed AS 16 + 5.5 m. B–D, *Sandlingites cf. pilari*, B, lateral view, 2012z0133/0335, from bed AS 47 + 2.5 m. C, lateral view, with enlarged ventrolateral part, 2012z0133/0336, from bed AS 47 + 2.5 m. D, lateral view, 2012z0133/0475, from sequence AS 16 – AS 16 + 12.8 m. E–L, *Klipsteinia disciformis* sp. nov, from bed AS 6. E, lateral view, paratype, 2012z0133/0291, with detailed picture of ribbing and arrow to corresponding suture. F, ventral view, paratype, 2012z0133/0291. G, lateral view, paratype, 2012z0133/0292. H, ventral view, paratype, 2012z0133/0292. I, lateral view, holotype, 2012z0133/0290. J, ventral view, holotype, 2012z0133/0290. K, lateral view, paratype, 2012z0133/0293. L, ventral view, paratype, 2012z0133/0299. M–N, *Neoprotrachyceras attila*, 2012z0133/0331, from sequence AS 32 – AS 46. O, lateral view, 2012z0133/0314. P, ventral view, 2012z0133/0314. Q, lateral view, 2012z0133/0316. R, ventral view, 2012z0133/0316. S, lateral view, 2012z0133/0315. T, ventral view, 2012z0133/0315. U, lateral view, 2012z0133/0319. V, ventral view, 2012z0133/0319. W, lateral view, 2012z0133/0317. X, ventral view, 2012z0133/0317. Y, lateral view, 2012z0133/0320. Z, ventral view, 2012z0133/0320. Scale bar represents 1 cm. Abbreviations: ll, lateral lobe; ls, lateral saddle; ul, umbilical lobe; vls, ventrolateral saddle.
**Genus KLIPSTEINIA Mojsisovics, 1882**

_type species._ Ammonites (Ceratites) achelous Münster, 1834, from marly beds at the Stuores Wiesen near St. Cassian. Whilst the genus _Klipsteinia_ was defined by Mojsisovics (1882), its type species ‘Ammonites achelous’ was subsequently selected by Diener (1915).

 Remarks. ‘Ammonites’ achelous resembles _Dinarites eduardi_, but at about 12 mm D, the initially flat furrow at the venter becomes deeper. At approximately 20–24 mm, ribs become more prominent and end in nodes, which border the ventral furrow (Mojsisovics 1882). Similar to _Dinarites_ and _Tirolites_, _Klipsteinia_ shows a primitive suture line with only one lateral lobe. As shown by the relationship of _D. eduardi_ with ‘A.’ _achelous_, _Klipsteinia_ evolves a deepening of the median furrow on venter, bordered by accompanying spines and nodes or sometimes by granulated keels (e.g. _Klippingtina nataliae_ Mojsisovics, 1882). The lateral tubercles can be present or absent (Arkell et al. 1957).

 **Stratigraphic range.** Upper Triassic, Lower Carnian (Krystyn 1978, Tozer 1981, Urlichs 1994).

**Klipsteinia disciformis** sp. nov.

Figure 8E–L

**LSID.** urn:lsid:zoobank.org:act:96310FF2-1D3C-4DE2-B202-FE8FE0974A0E.

**Derivation of name.** From the Latin term _discus_ and _disciformis_ for discus shaped.

**Holotype.** NHMW-2012z0133/0290 (Fig. 8I–J).

**Paratypes.** Three paratypes have been defined: NHMW-2012z0133/0293 (Fig. 8E–F) and NHMW-2012z0133/0292 (Fig. 8G–H).
Type locality and horizon. Aşağıyaylabel (WGS84: 37°33′05″N, 31°18′14″E), Anatolia, Turkey, from the Carbonate member Unit A, bed AS 6, of the Kasimal Formation, Upper Triassic (Lower Carnian, Julian 2) (Fig. 2).

Material. Nineteen specimens (NHMW-2012z0133/0290–0308).

Measurements. See Table 2.

Diagnosis. Involute, discoidal shape; whorls bearing slightly rounded flanks with a very weak and smooth ventral furrow and a steep umbilical wall. Straight flanks bend at the upper third towards the venter. Shallow, but dense, sigmoidsly curved ribbing occurs throughout ontogeny. The suture is characterized by smooth lobes and saddles.

Description. The description is based on the holotype (Fig. 8J). Shell exhibits discoidal whorls, slightly rounded flanks, a steep umbilical wall and an involute coiling, opening in adults. The rounded venter bears a distinct, sharp, but smooth furrow. The ventrilo more rounded in juveniles, with almost straight mid-part in adults (Fig. 8E–L). Flanks are straight, but bend at the upper third with subrounded shape to venter. At a D of around 10 mm, a sculpture element with sigmoidal incisions, accompanied by the ‘overlapping’ segments in between the latter, occurs. This ‘segmented’ part appears step-like in lateral view (Fig. 8E). The generally smooth shell, upon more detailed examination, bears a weak, dense, sigmoidaly curved ribbing. Ribs start at a steep umbilical wall, pass the flanks sigmoidaly and cross the venter (hardly visible), from a D of 20 mm, in a proverse bow towards the aperture. Ribs can end at the distinct ventral furrow. Rib interspace at the umbilicus is about 0.7 mm, and rib interspace increases at the venter to 2.2 mm. At a D of about 12 mm, ribs are distinctly developed and then become weaker and broader with increasing D. The ventral furrow is most prominent at a D of 12 mm. No swellings of ribs at the shoulder. The suture is characterized by smooth lobes and saddles. A wide and rounded ventrolateral saddle is followed by a narrow and deep lateral lobe and again by a wide and rounded lateral saddle and a smooth deep and rounded umbilical lobe (Fig. 8E).

Discussion. Klipsteinia disciformis sp. nov. and related species of Klipsteinia were compared by performing a PCA and different bivariate plots on conch parameters (Fig. 9A–G). The respective data sources from specimens are indicated in Table 2 and Lukeneder and Lukeneder (2013). The first two axes of the PCA explain a total of 96.16 per cent of the variance (PC1 85.87 per cent; PC2 10.29 per cent). They clearly separate Klipsteinia boetus (Münster, 1834), Klipsteinia irregularis (Münster, 1841) and Kl. naturaliae Mojsisovics, 1882 from Kl. disciformis sp. nov. (Fig. 9A). The species Klipsteinia achelous (Münster, 1834) and Klipsteinia hirschi (Laube, 1870) plot closer to Kl. disciformis sp. nov., resembling Kl. disciformis sp. nov. in H, U and ah, but having higher W (4.88 and 5.0 vs mean 4.5 mm) and therefore a lower ratio of H/W (1.16 and 1.12 vs mean 1.77; Fig. 9B–F). Hence, these species show a more depressed whorl section (lower H/W values; Fig. 9F). Klipsteinia karreri Mojsisovics, 1882 plots similar to Kl. disciformis sp. nov. within the PCA due to its similar parameters H, U and ah (Fig. 9B, D–E). However, Kl. karreri clearly differs from Kl. disciformis sp. nov. in a higher W with 6.5 vs mean 4.5 (Fig. 9C), and therefore, like the other species of Klipsteinia, in a lower ratio of H/W (1.23 vs 1.77; Fig. 9F), due to a more depressed conch morphology. Kl. disciformis sp. nov., therefore, has a more compressed whorl section (Fig. 9F) than the measured species of Klipsteinia, for example the type material from Münster (1834, 1841; Lukeneder and Lukeneder 2013). The generally narrow and discoidal (more compressed) character of Kl. disciformis sp. nov. slightly resembles Kl. naturaliae (Fig. 9F; Lukeneder and Lukeneder 2013), but differs in a much weaker and smoother ventral furrow. Kl. naturaliae furthermore exhibits stronger ribbing and granulated external ridges, which run parallel to the deep, ventral furrow. Specimens of Kl. disciformis with D < 20 mm closely resemble Kl. achelous (Münster, 1834). Finally, Kl. achelous has a more rectangular whorl section.

In contrast to all other species, in which lateral lobes are serrate (trifid), the lobes and saddles in Kl. disciformis sp. nov. are smooth (Fig. 8E). Kl. disciformis sp. nov. additionally differs from Kl. achelous, Kl. boetus, Kl. hirschi and Kl. karreri in lacking nodular swellings or external nodes. Kl. irregularis further differs from Kl. disciformis sp. nov. in a smooth venter (no furrow) at the inner whorls, as well as in bearing a furrow on the last whorl, bordered by a keel on each side. WER in Kl. disciformis sp. nov. measures 2–2.5 (mh–h) and is smaller than the very high values in Kl. achelous (3.1) and Kl. hirschi (2.9; Fig. 9G; Table 2; Lukeneder and Lukeneder 2013; see Discussion).

Stratigraphic range. Upper Triassic, Lower Carnian, Austrotrachyceras austricium Zone (Julian 2).

Regions. Aşağıyaylabel, Taurus Mountains, Turkey.

Suborder TRACHYCERATINA Krystyn, 1978
Superfamily TRACHYCERATACEAE Haug, 1894
Family TRACHYCERATITIDAE Haug, 1894
Subfamily TRACHYCERATINAE Haug, 1894
Genus NEOPROTRACHYCERAS Krystyn, 1978

1978 Neoprotrachyceras Krystyn, p. 69.
1981 Neoprotrachyceras Tozer, p. 95.
2002 Neoprotrachyceras Sepkoski, p. 130.
2012 Neoprotrachyceras Lukeneder et al., p. 282, 284.
Type species. *Trachyceras attila* Mojsisovics, 1870, from Veszprém, Bakony Mountains, Hungary.

Remarks. The genus *Neoprotrachyceras* is characterized by a *Trachyceras*-like form (involute to moderately evolute coiling) bearing nodular ribs. The venter is externally interrupted by a furrow. In contrast to *Trachyceras*, lateral nodes might be absent in *Neoprotrachyceras*. Whilst in *Neoprotrachyceras* the ventral furrow is bordered on each side by a row of single nodes (with a trend to reduplication at the adult stage), *Trachyceras* shows a row of dou-
ble-pointed nodes on both sides of the venter (Krystyn 1978).

Stratigraphic range. Upper Triassic, Lower Carnian – Upper Carnian, Julian 2–Tuvalian 1.

**Neoprotrachyceras attila** (Mojsisovics, 1893)

*1870 Trachyceras Attila Mojsisovics, p. 105–106, pl. 5, figs 2–4.
1893 Trachyceras (Protrachyceras) attila E. v. Mojsisovics; Mojsisovics, p. 633–634, pl. 169, figs 6–9, pl. 170, figs 1–2.

Material from Aşağıyaylabel. One specimen from the Carbonate member Unit C, from sequence AS 32–46 (Fig. 2): NHMW-2012z0133/0331.

Measurements. See Lukeneder and Lukeneder (2013).

Description. Whorls are generally involute, with a narrow umbilicus. The venter bears a broad and deep furrow, which is bordered by two coarse, spirally arranged external tubercle rows. Ribs are slightly curved on flanks, but appear with a sharp apical bow (proverse towards aperture) at the upper third of the flanks (Fig. 8M). Up to a D of approximately 15–19 mm, ribs are coarse and strong. Branching is irregular, and bifurcations occur at the umbilical shoulder, on tubercles or from lateral tubercles at mid-flank, occurring mainly at the fourth tubercle row from umbilicus. Ribs start to become more distinct and finer and seem to be more crowded from a D of 19 mm. The specimen in Figure 8M exhibits a different arrangement of the spiral tubercle lines on both flanks. The furrow on one shell side is bordered by three external tubercle lines (lateral view Fig. 8M and right side on Fig. 8N), whereas at the corresponding opposite side, the external flank is bordered by only a single external tubercle line (Fig. 8N). All other spiral tubercle lines, towards the umbilicus (from the marginal, mid-flank), are equally arranged. Overall, 12 spiral tubercle lines are visible on the right side, but only ten on the left side: two umbilical-lateral tubercle lines, six lateral tubercle lines, one marginal tubercle line and one external line (left), respectively, three lines (right).

Discussion. The specimens from Aşağıyaylabel resemble mostly the type material from the Bakony Mountains from Hungary described by Mojsisovics (1870) as Neoprotrachyceras attila. A comparable specimen was also figured by Diener (1925) as Trachyceras (Protrachyceras) attila (Mojsisovics, 1870) from the Carnian of Feuerkogel (Styria). Neoprotrachyceras attila from Aşağıyaylabel differs from Neoprotrachyceras thou (Dittmar, 1866) in having more distinct spiral tubercle rows, numbering 12 versus 3–4 in *N. thou* of Dittmars’ material (Röthelstein, Styria). This difference, marked by an almost tuberculate ribbing style in *N. thou*, is also visible on specimens from Mojsisovics’ (1893, pl. 168, figs 2–11) material from the Röthelstein, near Bad Aussee (Styria).

Neoprotrachyceras attila from Aşağıyaylabel (Fig. 8M–N) furthermore resembles Neoprotrachyceras baconicum (Mojsisovics, 1870), with the contrast that the latter has only 8–9 rows of tubercle spirals and differs in a broader umbilicus (Mojsisovics 1893). The external furrow is less prominent in *N. attila*. Differences in whorl proportions from our specimen (Fig. 8M–N) were measured and compared with material from *N. attila* (Mojsisovics, 1893) and *N. baconicum* (Mojsisovics, 1870; see measurements and remarks for *N. baconicum*). The respective data sources from specimens are indicated in Lukeneder and Lukeneder (2013). *N. attila* from Aşağıyaylabel (Fig. 8M–N) shows nearly similar whorl proportions to *N. baconicum*, but with the difference that *N. attila* shows lower values of U/D (≤0.2) compared with *N. baconicum* with U/D values ≥0.2, what reflects the more narrow umbilicus of *N. attila* (see Lukeneder and Lukeneder 2013).

Stratigraphic range. Upper Triassic, Lower Carnian (Julian 2).

Regions. Bakony Mountains, Hungary (Mojsisovics 1870; Diener 1925); Feuerkogel, NCA, Austria (Mojsisovics 1873–1902; Krystyn 1978; Kittl 1903; Geyer 1915); Aşağıyaylabel, Taurus Mountains, Turkey.

**Neoprotrachyceras baconicum** (Mojsisovics, 1870)

*1869 Ammonites (Trachyceras) sp.; Mojsisovics, p. 93.
*1870 Trachyceras Bacoicum Mojsisovics, p. 106, pl. 5, fig. 5.
2000 Neoprotrachyceras cf. thou (DITTMAR), 1866; Gindl, p. 54–56, pl. 2, fig. 1a–c.

Material from Aşağıyaylabel. Eleven specimens from the Carbonate member Unit C, from sequence AS 32–AS 46; (Fig. 2): NHMW-2012z0133/0314–0317, NHMW-2012z0133/0319–0325.

Measurements. See Lukeneder and Lukeneder (2013).

Description. Medium-sized (up to D 38.5 mm), moderately involute shells with open umbilicus, steep umbilical wall and strong ornamentation. Sculpture consists of strong, straight ribs in juveniles to weakly sigmoidal curved ribs in adults. Juvenile specimens (Fig. 8O–P, S–T, W–X) bear a rounded venter with a shallow median furrow. The almost smooth median area at the venter is bordered by the typical Neoprotrachyceras-like single and distinct external tubercle rows. In juveniles, that is,
smaller specimens up to 15 mm (Fig. 8O–P, W–X), whorls are more compressed with H/W values of 0.86 and 0.96. In the figured 20-mm specimen (Fig. 8S–T), the H is more depressed, with an H/W value of 1.38. In adult specimens (Fig. 8U–V, Y–Z), whorl shape is, at diameters of approximately 40 mm, more depressed, with H/W values of 1.52–1.68 (see Lukeneder and Lukeneder 2013). Juvenile specimens (Fig. 8O–P, S–T and W–X) exhibit strong, bifurcate ribbing. Ribs start at a strong umbilical tubercle. Umbilical wall smooth. Ribs are almost radial, up to the round mid-flank, where they bifurcate at a big lateral tubercle, in slightly proverse direction. Ribs end at pointed tubercles on each side of the smooth ventral area. On the single main ribs, between the umbilical and the larger lateral tubercles (Fig. 8O–P, S–T), two to three weaker spiral tubercle lines are visible. The prominent lateral spiral tubercle line is again followed by two closely running marginal spiral lines, followed by the external tubercles. Ribs can also bifurcate on umbilical tubercles, and one branches a second time at the lateral shoulder (Fig. 8S–T). The same specimen already has eight spiral tubercle lines. Ribbing is broader in adults than in juveniles, up to 2–3 mm thick. The maximum thickness of the ribs occurs on a proverse spatulate end, between external and last lateral ridge-like tubercles. Eight rows of tubercles run up to the end of the body chamber, becoming more longitudinal, ridge-like, on adult forms (Fig. 8U–V, Y–Z). Umbilical tubercles and external tubercles are spine-like. The external furrow is deep and prominently edged. In most cases, spines are present as tubercles because they have been broken during preparation. Fine striae, or growth lines, occur on body chambers of adult specimens (Fig. 8U–V, Y–Z). The finer lines run subparallel to the ribbing, but cross the venter in an adapical bow. Lines are visible only on the outer surface of shell, not on internal moulds (Fig. 8Y–Z).

Discussion. Neoprotrachyceras baconicum closely resembles N. attila. Both species are furthermore quite similar to Neoprotrachyceras archelaus (Laube, 1868), with the difference that they show a much denser ribbing as well as finer ribs and nodes in contrast to N. archelaus (Mojsisovics 1870). Alongside the broader umbilicus of N. baconicum, and the different number of tubercle spirals, already mentioned, the external furrow is more prominent in N. baconicum observed from Aşağıiyaylabel (Fig. 8R, Z) compared with N. attila (Mojsisovics 1870, 1893). The finer and denser ribbing, compared with N. archelaus, as well as the broader umbilicus and the more prominent furrow, and the fewer count of tubercle lines compared with N. attila, clearly identifies most specimens from Aşağıiyaylabel as N. baconicum.

Stratigraphic range. Upper Triassic, Carnian – Upper Carnian (Julian 2–Tuvalian 1).

Regions. NCA, Austria (Mojsisovics 1873–1902; Kittl 1903; Geyer 1915; Krystyn 1978); Bakony Mountains, Hungary (Mojsisovics 1870); Aşağıiyaylabel, Taurus Mountains, Turkey.

Subfamily SIRENITINAE Tozer, 1971

Genus SIRENITES Mojsisovics, 1893

1893 Sirenetes Mojsisovics, p. 725.
1981 Sirenetes Tozer, p. 96.
2002 Sirenetes Sepkoski, p. 131.
2012 Sirenetes Lukeneder et al., p. 284.

Type species. Ammonites senticosus Dittmar, 1866, p. 375, pl. 17, figs 8–9, from red limestones of the Feuerkogel, Röthelstein, near Bad Aussee, Styria, Austria. Subsequent designation by Hyatt and Smith (1905, p. 198).

Remarks. Mojsisovics (1893) introduced the name Sirenetes for Trachyceras-like species bearing sigmoidal external ribs, closely prelocating the external nodes. Whereas both genera (Sirenetes and Trachyceras) show a tendency to reduplicate their external tubercles, the ribs of Trachy- ceras still branch longitudinally, whilst the ribs of Sirenetes exhibit a radial bifurcation (Mojsisovics 1893). Sirenetes represents a compressed form with a distinct furrow on venter and flattened convex whorl flanks, bearing two rows of lateral tubercles (Arkell et al. 1957). Its sigmoidal, sharply adorally projecting ribs bifurcate on a tubercle near the ventrolateral edge. Two rows of tubercles on flanks and tubercles on the umbilical edge are arranged in spiral lines (Arkell et al. 1957). Sirenetes is described with ceraticic (Diener 1925) as well as with ammonitic suture (Arkell et al. 1957).

Stratigraphic range. Upper Triassic, Carnian.

Sirenetes senticosus (Dittmar, 1866)

Figures 5AI, 10A–B

1866 Ammonites senticosus Dittmar, p. 375, pl. 17, figs 8–9.
1893 Sirenetes senticosus (A. v. Dittmar): Mojsisovics, p. 727–728, pl. 161, figs 8–12, 14–15.
1893 Sirenetes cf. ind. ex aff. S. senticosi; Mojsisovics, p. 731, pl. 161, fig. 17.
1905 Ammonites senticosus Dittmar; Hyatt and Smith, p. 198.
1923 Sirenetes senticosi Mojs.; Dierer, p. 246, 248, 250.
1925 Sirenetes senticosus Dittm.; Dierer, p. 95, pl. 18, figs 6a–b.
1927 Ammonites senticosus Dittmar; Smith, p. 81.
1957 S. (S.) senticosus (Dittmar); Arkell et al., p. L158, fig. 190, 9a–b (refigured type specimen of Mojsisovics 1893, pl. 161, fig. 8).
1976 Sirenetes senticosus (Dittmar); Hahn, p. 155–169.
1978 Sirenetes senticosus (Dittmar, 1866); Krystyn, p. 70, pl. 4, fig. 3.
1982 Sirenetes (Sirenetes) senticosus (v. Dittmar); Hahn, p. 1049.
1982 *Sirenites senticosus* (Dittmar, 1866); Tatzreiter, p. 139.
1994 *Sirenites senticosus* (Dittmar); Tozer, p. 170.
2000 *Sirenites n. sp. 1*; Gindl, p. 53–54, pl. 1, figs 7a–8b.
2000 *Sirenites multicosatus* Mojsisovics, 1893; Gindl, p. 56–57, pl. 2, fig. 2a–c.
2009 *Sirenites senticosus* (Dittmar); Breda et al., p. 82.
2012 *Sirenites sp.*; Lukeneder et al., p. 284.

Holotype. Ammonites senticosus Dittmar, 1866 (p. 375, pl. 8–9; GBA-1893/001/0646) from the *Trachyceras austriacum* beds at the Feuerkogel at Röthelstein, near Bad Aussee, Styria, Austria.

Material from Aşağıiyaylabel. One specimen from the Carbonate member Unit A, bed AS 6: NHMW-2012z0133/0281, and four specimens from Unit C, from sequence AS 32–AS 46 (Fig. 2): NHMW-2012z0133/0282, NHMW-2012z0133/0284–0285 and NHMW-2012z0133/0289.

Measurements. See Lukeneder and Lukeneder (2013).

Description. Both figured specimens (Figs 5AI–AJ, 10A–B) show a medium-sized, strongly ornamented shell and a half involute, compressed whorl section with H/W values of 1.57 (Fig. 10A–B; Lukeneder and Lukeneder 2013) and 1.85 (Fig. 5AI–AJ; Lukeneder and Lukeneder 2013). The wide umbilicus bears a steep umbilical wall. H increases rapidly, with a high WER between 2.65 (NHMWz0133/0285; Lukeneder and Lukeneder 2013) and 2.70 (Figs 5AI–AJ; 10A–B; Lukeneder and Lukeneder 2013). All specimens show typical *Sirenites*-like single ribs as well as bifurcating ribs. Ribs are broad (2–3 mm; Fig. 10A–B) and bifurcate on the umbilical edge or laterally. Ribs show tuberculation with four tubercle rows, including umbilical and external flank tubercles. Single ribs cross the steep umbilical wall; they start from strong umbilical tubercles and sigmoidally cross the straight flanks, ending at tubercles on the external flank. These tubercles give rise to falconv, pointed, adapically directed (80–90 degrees) short ribs. The latter ribs end at a distinct and prominent tubercle row, which consists mainly of spines, string-like arranged. Two of these ‘spine rows’ border a deep, sharp and smooth ventral furrow. Outer shell may bear fine striae on the body chamber, running parallel to the sigmoidal ribs. No suture line visible.

Discussion. Specimens resemble the type ‘Ammonites’ senticosus’ Dittmar, 1866. Whilst specimens from Aşağıiyaylabel show similar values of H/W (1.57–1.85), they show a slightly higher WER (mean 2.683) than the holotype of Dittmar (1866; 2.535; Lukeneder and Lukeneder 2013). Specimens figured as *S. senticosus* by Mojsisovics (1893) seem almost identical in sculpture and shape. The typical shape is shown by Diener (1925), when he refigured the specimen of Mojsisovics (1893). Both authors figured the type specimen, even though they show prominent differences, probably due to the illustration of the opposite side of the type specimen by Mojsisovics (1893), Diener (1925) and Arkell et al. (1957).

Stratigraphic range. Upper Triassic, Lower Carnian, *Trachyceras aonoides* Zone (Julian 1) – *Austrotachyceras austriacum* Zone (Julian 2).

Regions. NCA, Austria (Dittmar 1866; Mojsisovics 1893; Krysyn 1978; Tatzreiter 1982); Cortina Area, SA (Breda et al. 2009); Mersin Melange and Aşağıiyaylabel, Taurus Mountains, Turkey (Kozur et al. 2009; Moix et al. 2011); California (Smith 1896); Guanling Area, south-west China (Xiaofeng et al. 2008); northern Thailand (Hahn 1976, 1982); Bihati, Timor (Diener 1923).

Genus ANASIRENITES Mojsisovics, 1893

1893 *Anasirenites* Mojsisovics, p. 773.
1981 *Anasirenites* Tozer, p. 96.
2002 *Anasirenites* Sepkoski, p. 128.
2012 *Anasirenites* Lukeneder et al., p. 284.

Type species. *Sirenis* (Anasirenites) ekkehardi Mojsisovics, 1893 (p. 773, pl. 159, fig. 5), from the Carnian stage of the ‘Vorderer Sandling’ near Goisern, Austria. Subsequent designation by Diener (1915).

Remarks. The ventral furrow with the pair of continuous keels at the external side, which developed from the external nodes of the protractorceratid ancestors, is the main characteristic of the genus *Anasirenites*. Mojsisovics (1893) defined *Anasirenites* as a subgenus of the genus *Sirenites*, characterized by its smooth external keel (Mojsisovics 1893). Arkell et al. (1957) followed the idea of a subgenus *Sirenites* (Anasirenites). Tozer (1971, 1981) increased the hierarchical level of the former subgenera to the level of genus in his general reviews of Triassic ammonoids (Tozer 1971, 1981).

Stratigraphic range. Upper Triassic, Carnian to Norian.

*Anasirenites crassicrenulatus* sp. nov.

Figure 10C–F

2000 *Anasirenites* sp. Gindl, p. 57–58, pl. 2, fig. 3a–c.
2000 *Anasirenites cf. tripunctatus* (Mojsisovics, 1893); Gindl, p. 58–59.
2012 *Anasirenites* Lukeneder et al., p. 284.

LSID. urn:lsid:zoobank.org:act:2F53CAE1-4D81-4E9B-A28E-0B10AD39E58FB.

Derivation of name. From the Latin terms ‘crassi’, which means ‘dense’, and ‘crena’, which means ‘serration’; characterized by the presence of two densely granulated external keels.
Holotype. NHMW-2012z0133/0310 (Fig. 10E–F). Steinkern with partial shell preservation.

Paratype. One paratype: NHMW-2012z0133/0309 (Fig. 10C–D).

Type locality and horizon. Aşağıyaylabel (WGS 84: 37°33′05″N/31°18′14″E), Anatolia, Turkey, from the Carbonate member Unit C, from sequence AS 32–AS 46 (Fig. 2), which belongs to the Upper Carnian Austrotrachyceras austriacum Zone (Julian 2).

Material from Aşağıyaylabel. Four specimens from the Carbonate member Unit C (from sequence AS 32–AS 46): NHMW-2012z0133/0309–0312.

Measurements. See Table 3.

Diagnosis. Involute, small-sized and depressed shell, bearing a steep and narrow, but smooth and rounded umbilical edge. Anasirenites crassicrenulatus sp. nov. is characterized by strong and multituberculate (3–4 tubercles) ribbing at the inner whorls. *A. crassicrenulatus* sp. nov. bears a weak ribbing on adult whorls and on body chamber, a more pointed ventrolateral tubercle line as well as granulated keels, which become more and more smooth until the end of the last whorl.

Description. Small- to medium-sized (up to 30.7 mm), involute forms with narrow umbilicus. Whorls are depressed with high whorls having H/W values of 1.56 (paratype, Fig. 10C–D) to 2.1 (holotype, Fig. 10E–F). Whorl expansion rate is high with a WER of 2.5 in the holotype (Fig. 10E–F; Table 3) and a WER of 2.6 in the paratype (Fig. 10C–D). The following description is of the holotype (Fig. 10E–F). Umbilicus is narrow, and the umbilical edge is smooth, steep, but rounded. Flanks are straight, rounded only on their upper half to venter. Ribbing starts on the umbilical edge. Ribbing on inner whorls, up to a D of 10 mm, is strong and radially directed with single ribs or sometimes with bifurcating ribs from umbilicus. The latter ribs are tuberculate with four tubercles per rib. Strong ribbing and prominent tuberculation disappear after that phase. From H = 4 mm, ribs tend to start progressively and bifurcate on mid-flank. The branches end at small, pointed tubercles on the ventrolateral edge, resembling a ‘pearl necklace’. This spiral line of tubercles is followed by a smooth, furrow-like area, edged on the venter by one of the external granulated keels. The granulation of the keels appears to be due to the fading of most ventral ribbing, rising from the lower ventrolateral tubercle line. A ventral median deep smooth furrow is bordered by those granulated external keels. At the phragmocone, keels seem to be smooth on steinkerns, but clearly strongly granulated in the case of shell preservation (Fig. 10E–F). Keels become smooth until the end of the last whorl. From H 8 mm onward, ribs become weaker and falcoid, branching on mid-flank and ending at tiny, but elongated proversly directed crests. Two to three very shallow, but present, tubercle rows are spirally arranged throughout the shell, accompanied by fine, striate spiral lines. The suture line appears ceratitic (trifid). The body chamber has a length of three-quarters of the last whorl (mesocone).

Discussion. *Anasirenites crassicrenulatus* sp. nov. and the above-described *Sirenites senticosus* (Dittmar, 1866) show similarities in juvenile ribbing, in tuberculation and in the arrangement of external tubercles and furrows. Mojsisovics (1893) already noted the close relation of the subgenus *Anasirenites* Mojsisovics, 1893 and certain species of *Sirenites* Mojsisovics, 1893, now confirmed by the comparison of faunal elements from Aşağıyaylabel. The species *Anasirenites* (Mojsisovics 1893) is clearly characterized by smooth external keels. These typical keels are also detected in *A. crassicrenulatus* sp. nov. and are therefore the reasons for attributing this species to *Anasirenites*. Anyhow, the keels of *A. crassicrenulatus* sp. nov. are not generally constantly smooth, but, and this is the important fact, become smooth at the end of the last whorl. This is similar to Mojsisovic’s description of *Anasirenites marthae* as well as of *Anasirenites tripunctatus*. Both forms bear tiny nodes at their keels and show the typical smoothness of the characteristic keels not before the end of the last whorl. Although *A. crassicrenulatus* sp. nov. resembles *A. tripunctatus* Mojsisovics, 1893, *A. briseis* Mojsisovics, 1893, *Anasirenites friederici* Mojsisovics, 1893 and *A. marthae* Mojsisovics, 1893 from Carnian faunas (*Austrotrachyceras austriacum* Zone) from the Feuerkogel (Styria, Austria; Mojsisovics 1893), they differ in sculpture.

**FIG. 10.** Fauna of Aşağıyaylabel, Kasımlar Fm., A–F, and O, Carbonate member Unit C, *Austrotrachyceras austriacum* Zone (Julian 2), G–N, Marlstone member, *Tropites dilleri* Zone (Tuvalian 1). A–B, *Sirenites senticosus*, from sequence AS 32–AS 46 (2012z0133/0289). A, lateral view. B, ventral view. C–F, *Anasirenites crassicrenulatus* sp. nov., from sequence AS 32–AS 46. C, lateral view, paratype, 2012z0133/0309. D, ventral view, paratype, 2012z0133/0309. E, lateral view, holotype, 2012z0133/0310, with arrow to corresponding suture line. F, ventral view, holotype, 2012z0133/0310. G–H, *Paratropites cf. hoetzendorfi*, G, adult, lateral view, 2012z0133/0352, from bed AS 16 + 5 m. H, juvenile, ventral view, 2012z0133/0368, with enlarged ventral part, from bed AS 16 + 13 m. I–J, *Trachysagnites cf. beckei*, 2012z0133/0350, from sequence AS 16 + 11.5 m – AS 16 + 13 m. I, lateral view. J, ventral view. K–N, *Proarcestes* sp. K, lateral view, 2012z0133/0443, from bed AS 16 + 5 m. L, lateral view, 2012z0133/0444, from bed AS 32. M–N, 2012z0133/0445, from bed AS 16 + 13 m. M, lateral view. N, ventral view. O, lateral view of *Megaphyllites jarbas*, 2012z0133/0479, from sequence AS 19–AS 46, white star marks the position of last septum. All scale bars represent 1 cm. Abbreviations: ll, lateral lobe; ls, lateral saddle; us, umbilical saddle; vll, ventrolateral lobe; vls, ventrolateral saddle.
A. crassicrenulatus sp. nov. exhibits very strong and multi-tuberculated (3–4 tubercles) ribbing in inner whorls, but in contrast much weaker ribbing on adult whorls and on the body chamber than in all other species within Anasire-nites. The weaker ribbing, the more pointed ventrolateral tubercle line and the more granulated keels, except for the end of the last whorl, are the motivation for establishing the new species A. crassicrenulatus sp. nov.

Stratigraphic range. Upper Carnian, Austrotachyceras austriacum Zone (Julian 2).

Regions. Aşağıiaylabel, Taurus Mountains, Turkey.

Superfamily TROPITACEAE Mojsisovics, 1875
Family TROPITIDAE Mojsisovics, 1875

Genus PARATROPITES Mojsisovics, 1893
1893 Paratropites Mojsisovics, p. 234.
1927 Paratropites Smith, p. 43.
1981 Paratropites Tozer, p. 98.
1994 Paratropites Tozer, p. 215.
2002 Paratropites Sepkoski, p. 131.
2012 Pleurotropites Lukeneder et al., p. 284, 292.

Type species. Ammonites saturnus Dittmar, 1866 (p. 367, pl. 16, figs 1–8) from the yellowish-grey limestones, together with Tropites subbullatus, of the ‘Vorderer Sandling’ near Goisern, Austria. Subsequent designation by Diener (1915).

Remarks. Slowly growing, quite involute and discoid shells, which enclose a narrow umbilicus. The distinct umbilical margin is adorned with umbilical tubercles, what excludes the genus Pleurotropites, which lacks in umbilical tubercles (Tozer 1994). Ribs project beyond the umbilical margin and end as angular, forward-facing nodes within the external furrows. The narrow furrows border a thick external keel (Dittmar 1866; Mojsisovics 1893), in contrast to the genus Discotropites (Hyatt and Smith, 1905), which lacks these furrows, bordering the keel (Arkell et al. 1957). Additionally, the ribs do not show that conspicuous sigmoidal character observed in Discotropites (Diener 1917) and its spiral ornamentation, which might be represented only by weak striae (Krystyn 1982). Tubercles give rise to rounded, distinct, sinuous ribs, separated by narrow intercostal ‘furrows’. Ribs are simple or branched; intercalary ribs may occur on flanks. Whilst juvenile stages mostly show dichotomous ribbing, adult stages dominantly bear tripartite ribbing. At the body chamber, additional quadripartite ribs are developed. Mojsisovics (1893) reported a ratio of 1:3 of umbilical nodes versus external ribs.

Stratigraphic range. Upper Triassic, Upper Carnian, Tropites dil-leri Zone (Tuvalian 1) – Tropites subbullatus Zone (Tuvalian 2).

Regions. NCA, Austria (Mojsisovics 1893; Tozer 1971; Krystyn 1973); north-east British Columbia (Tozer 1994); Aşağıiaylabel, Taurus Mountains, Turkey.

Paratropites cf. hoetzendorfii Diener, 1917
Figure 10G–H

cf. *1917 Paratropites Hoetzendorfii Diener, p. 369, pl. 1, figs 1–4.
2012 Pleurotropites Lukeneder et al., p. 284, 292.

Material from Aşağıiaylabel. Sixty-five specimens from sequence AS 16–AS 16 + 13 m of the Marlstone Member (Fig. 2): NHMW-2012z0133/0351–0368, NHMW-2012z0133/0371–0393, NHMW-2012z0133/0396–0399, NHMW-2012z0133/0402–0403, NHMW-2012z0133/0405, NHMW-2012z0133/0407–0408, NHMW-2012z0133/0410–0417, NHMW-2012z0133/0420–0424, NHMW-2012z0133/0426–0427.

Measurements. See Lukeneder and Lukeneder (2013).

Description. The existing material, especially the juvenile examples, are poorly preserved and are laterally compacted. The whorl shape can be studied only in few, undeformed specimens. In specimen NHMW-2012z0133/0352 (Fig. 10G), whorl thickness decreases from the umbilical edge towards the venter. The juvenile specimen (Fig. 10H) shows a more evolute shell morphology, in contrast to the involute whorls in adults (Fig. 10G; Lukeneder and Lukeneder 2013). Ribbing in juveniles appears from the umbilical edge as thick main ribs, bifurcating at the mid-flank (Fig. 10H). The latter specimen shows badly preserved suture lines, resembling those in specimens shown by Diener (1917) for his type material from Bosnia and Herzegovina. The strong and smooth external keel is bordered by two furrows (Fig. 10H), at which the dense, flat, but rounded ribs are interrupted. From a D of approximately 20 mm onward, typical Paratropites ribbing occurs. Ribs, distinct on inner whorls, bifurcate at the umbilicus and/or on mid-flank. Bifurcation is irregular, and the point of bifurcation is shifted towards the umbilicus in adult stages. Ribs are generally slightly proverse and straight, bending adapically, near the ventrolateral shoulder, with a slightly sigmoidal character. Umbilical tubercles are present, whilst spiral lines are absent, as characteristic for Paratropites.

Discussion. Diener (1917) described similarities between medium-sized forms of P. hoetzendorfii Diener, 1917 and Pleurotropites anakreontis Mojsisovics, 1893. Note that the
specimen shown by Mojsisovics (1893) as *P. anakreontis* from the Upper Carnian (Tuvalian) from the Raschberg (Upper Austria) bears a prominent ventral keel, but lacks ventral furrows. Therefore, the presence of the typical furrows, which border the keel, the bifurcate ribbing, as well as the absence of spiral lines within material from Asağıyaylabel, proves the close relationship with *P. hoetzendorfi*. Due to the strong deformation of our material, we operate with an open nomenclature in *Paratropites cf. hoetzendorfi*. Morphological details such as the strong keel bordered by two furrows and the characteristic bifurcation of ribbing are detected. Umbilical tubercles are present, but there is no evidence for spiral lines. Adult specimens from Asağıyaylabel are similar to those described by Diener (1917) from Bosnia and Herzegovina. Specimens show the typical characteristics of *P. hoetzendorfi* with dense, straight ribbing on flanks, exhibiting a strong adapical bow on outer flanks. In particular, the maximum thickness of the shell at the umbilical margin described by Diener (1917) for his type material can be observed in the material from Asağıyaylabel.

**Stratigraphic range.** Upper Triassic, Upper Carnian, *Tropites dilleri* Zone (Tuvalian 1) – *Tropites subbullatus* Zone (Tuvalian 2).

**Regions.** Glamoça, Bosnia and Herzegovina (Diener 1917, Ćorić 1999); Asağıyaylabel, Taurus Mountains, Turkey.

**Family HALORITIDAE Mojsisovics, 1893**

**Subfamily SAGENITINAE Spath, 1951**

**Genus TRACHYSAGENITES Mojsisovics, 1893**

1893 *Trachysagenites* Mojsisovics, p. 156.
1981 *Trachysagenites* Tozer, p. 96.
2002 *Trachysagenites* Sepkoski, p. 132.

**Type species.** *Ammonites erinaceus* Dittmar, 1866 (p. 380, pl. 17, figs 15–17), from the yellowish-grey limestone of the ‘Vorderer Sandling’, Carnian, Upper Triassic. Subsequent designation by Hyatt and Smith (1905).

**Remarks.** Strongly involute, subglobose whorls, broader than high, bearing a long body chamber (Mojsisovics 1893; Hyatt and Smith 1905). Flanks and venter are rounded. The narrow umbilicus shows a rounded but steep umbilical margin (Mojsisovics 1893; Hyatt and Smith 1905). Radial dichotomous ribs, almost straight on flanks, cross the venter. Ribs bear rows of regularly arranged blunt spines. Based on those spines, Mojsisovics (1893, p. 179) defined the subgenus *Trachysagenites* for the group *Sagenites spinosi*.

**Stratigraphic range.** Upper Triassic, Upper Carnian, *Tropites dilleri* Zone (Tuvalian 1) – *Tropites welleri* (equals *Tropites subbullatus* Zone, Tuvalian 2).

**Regions.** NCA, Austria (Mojsisovics 1893); Glamoça, Bosnia and Herzegovina (Diener 1917); Shasta County, California (Hyatt and Smith 1905; Smith 1927; Spath 1951); Canada (Tozer 1994); Toebœ Lopo, Timor (Spath 1951); Himalaya, India and Nepal (Diener 1908; Krystyn 1982); Asağıyaylabel, Taurus Mountains, Turkey.

**Trachysagenites cf. beckei** Diener, 1921

*Figure 101-J*

cf.*1921 *Trachysagenites Beckei* Diener, p. 501 (37), pl. 5, fig. 1a–b.

**Material from Asağıyaylabel.** One specimen from the Marlstone member, from sequence AS 16 + 11.5 m – AS 16 + 13 m (Fig. 2), NWMW-2012z0133/0350.

**Measurements.** See Lukeneder and Lukeneder (2013).

**Description.** The observed specimen (Fig. 101–J) shows a large D, up to 100 mm (see Lukeneder and Lukeneder 2013)). Regular arrangement of blunt spines in rows (or broken base) on subglobose inner whorls with rounded venter. No ventral furrow. Adult stage and body chamber are deformed. The ribbing is more distinct on body chamber, with 8–10 tubercles or spine rows. Rib spacing and strength vary on body chamber, up to 10 mm apart. Stronger ribs are intercalated by finer ribs, also bearing tubercles. The first tubercle row occurs on umbilical edge. The steep umbilical whorl is crossed by fine ribs that end in the latter umbilical tubercles.

**Discussion.** Diener’s (1917) figured *Trachysagenites gla-
moensis* Diener, 1917 (NWMW-1998z0056/0025 and 0027, syntypes) from Carnian beds of Bosnia and Herzegovina also shows similarities in juvenile to mid-aged whorls. The involute coiling of the specimen *T. cf. beckei* additionally resembles *Trachysagenites herbichi* Mojsisovics, 1893 and figured Carnian specimens of ‘*Sagenites* herbichi’ Mojsisovics, 1893 by Hyatt and Smith (1905) from Shasta County (California, North America). Similarities are also observable with figured specimens of *Sag. (Trachysagenites) herbichi* Mojsisovics, 1893 by Smith (1904), from the same locality (Tuvalian 2, Upper Carnian). Due to the poor preservation, we choose an open taxonomy with *T. cf. beckei* Diener, 1921.

The figured *Trachysagenites cf. beckei* (Fig. 101–J) from the Kasımlar Fm. of Asağıyaylabel is similar, especially the adult size and sculpture, to the Upper Carnian (Tuvalian) *T. beckei* Diener, 1921 from the Feuerkogel (Styria, Austria). The holotype (NWMW-1926/0002/0688) of Diener (1921) exhibits a fine, spiral striation. Only few
spines are preserved on the opposite flank of the holotype shown in Diener (1921). Due to preparation, most of the spines were broken, yielding the typical verrucose sculpture. Rows of tubercles are crowned at the shoulder and on the venter, with up to 10 rows in 30 mm width. The same can be observed in the specimen from Aşağıyaylabel (Fig. 10F–J), with 10 rows within 20 mm width. Number of ventrolateral tubercle rows is apparently constant in ontogeny. The holotype shows a typical weakening of sculpture at the steinkerns, where shell is removed. The venter seems to be less rounded and straighter in the adult stage of the holotype.

Stratigraphic range. Upper Triassic, Upper Carnian, T. dilleri Zone (Tuvalian 1) – Tropites subbullatus Zone (Tuvalian 2).

Regions. NCA, Austria (Diener 1921); Glamoča, Bosnia and Herzegovina (Diener 1917); Aşağıyaylabel, Taurus Mountains, Turkey.

Superfamily ARCESTACEAE Mojsisovics, 1875
Family ARCESTIDAE Mojsisovics, 1875

Genus PROARCESTES Mojsisovics, 1893
1893 Proarcestes Mojsisovics, p. 785.
1981 Proarcestes Tozer, p. 95.
2002 Proarcestes Sepkoski, p. 131.

Type species. Arcestes bramantei Mojsisovics, 1869 (p. 18), from limestone beds of Hallstatt, near Bad Aussee, Austria. Subsequent designation by Mojsisovics (1893).

Remarks. Ribs and constrictions on phragmocone appear similar to that on body chamber (Arkell et al. 1957). Mojsisovics (1893) defined the genus Proarcestes for a group of Arcestidae in which the body chamber shows structural elements similar to those in the phragmocone.

Stratigraphic range. Middle Triassic – Upper Triassic, Anisian–Carnian (Arkell et al. 1957).

Proarcestes sp. Figure 10K–N

Material from Aşağıyaylabel. One specimen from the Carbonate member Unit C, bed AS 32: NHMW-2012z0133/0444, as well as 23 specimens from the Marlstone member, from beds AS 16 – AS 16 + 13.5 m (Fig. 2): NHMW-2012z0133/0443, 0445–0466.

Measurements. See Lukeneder and Lukeneder (2013).

Description. The preservation of the specimens from Aşağıyaylabel (Fig. 10K–N) is generally too bad (deformed and crushed) for a classification at species level. Specimens are smooth and subglobular, with very involute shells. Constrictions occur on the body chamber (Fig. 10K–M), and in one specimen (Fig. 10K), the adult aperture shows an aberrant form. We therefore use open nomenclature for this material.

Stratigraphic range. Middle Triassic – Upper Triassic (Anisian–Carnian; Arkell et al. 1957). At Aşağıyaylabel, Proarcestes sp. was found at the Carbonate member Unit C, Lower Carnian (Julian 2), as well as at the Marlstone member, which belongs to the Upper Carnian Tropites dilleri Zone (Tuvalian 1).

Superfamily MEGAPHYLLITACEAE Mojsisovics, 1882
Family MEGAPHYLLITIDAE Mojsisovics, 1879

Genus MEGAPHYLLITES Mojsisovics, 1879
1879 Megaphyllites Mojsisovics, p. 135.
1981 Megaphyllites Tozer, p. 92.
1994 Megaphyllites Tozer, p. 91.
2002 Megaphyllites Sepkoski, p. 130.

Type species. Ceratites jarbas Münster, 1841 (p. 135, pl. 15, fig. 25), from the beds of St. Cassian, South Tyrol.

Remarks. Small-sized, discoidal, compressed, involute and smooth shell. Generally without any sculpture, except for weak sigmoidal growth lines and regular constrictions on body chamber (Münster 1841; Hauer 1846; Arkell et al. 1957; Tozer 1994). The genus Megaphyllites shows a specific ceratitic suture. Lobes are rather similar to that of Monophyllites, but do not show that phylloid tops of the main lateral branches, as well as do not have an alternating occurrence of bigger versus smaller lateral branches and of serrated lobes (Fig. 10O). Saddles are nearly circular. Lobes are separated into three to four sharp and acute beaks. The external lobus is divided by a median depression, as known from Palaeozoic forms. Lateral lobes of Triassic forms are divided into two ‘lobes’ (Mojsisovics 1882).

Stratigraphic range. Middle Triassic – Upper Triassic, Anisian–Rhaetian stage (Diener 1916), Ladinian–Carnian (Arkell et al. 1957).

Megaphyllites jarbas (Münster, 1841) Figure 100

*1841 Ceratites jarbas Münster, p.135, pl. 15, fig. 25a–c.
1843 Ammonites umbilicatus; Klipstein, p. 117, pl. 6, fig. 5.
Ammonites Jarbas Münster; Hauer, p. 26, pl. 1, fig. 15.

Ammonites Jarbas sp. Münster; Hauer, p. 15.

Ammonites Jarbas Münster.; Hauer, p. 16, 26.

Ammonites Jarbas Münster.; Quenstedt, p. 240, pl. 18, fig. 12.

Ammonites Jarbas sp. Münster.; Hauer, p. 26.

Ammonites Jarbas Münster sp.; Laube, p. 412.

Phylloceras Jarbas Münster sp.; Laube, p. 85, pl. 41, fig. 12.

Pinacoceras cf. jarbas Münster; Mojsisovics, p. 47, pl. 19, figs 9, 10, 16.

Megaphyllites Jarbas v. Mstr. sp.; Branco, p. 62, pl. 10, fig. 5.

Megaphyllites Jarbas Münster.; Bittner, p. 318.

Megaphyllites Jarbas (Graf Münster); Mojsisovics, p. 193, pl. 53, figs 7a–b, 8.

Megaphyllites Jarbas; Mojsisovics, p. 94.

Megaphyllites Jarbas Münster sp.; Arthaber, pl. 44, fig. 3a–c.

Megaphyllites Jarbas, Münster.; Diener, p. 39, pl. 5, fig. 1.

Megaphyllites Jarbas Münster.; Frech, p. 19, pl. 4, fig. 1a–d.

Megaphyllites Jarbas Mnstr.; Renz, p. 79.

Megaphyllites jarbas Münster.; Diener, p. 39, pl. 5, fig. 1.

Megaphyllites jarbas Mstr.; Kittl, p. 53.

Megaphyllites jarbas Münster; Renz, p. 263, 265, 270, 272, pl. 10, fig. 2.

Megaphyllites jarbas Münster; Renz, p. 521, 523, pl. 22, fig. 5.

Megaphyllites jarbas Münster; Renz, p. 3, 5, 15, 66–67, 95.

Megaphyllites Jarbas Mstr. sp.; Arthaber, p. 163.

Megaphyllites Jarbas Gt. Muenster; Arthaber, p. 199.

Megaphyllites Jarbas Münster.; Diener, p. 465.

Megaphyllites Jarbas Mstr.; Diener, p. 75, pl. 17, fig. 2.

Megaphyllites Jarbas Muenstr; Arthaber, p. 113.

Megaphyllites Jarbas Muenst.; Kutassy, p. 137, pl. 2, fig. 11.

Megaphyllites jarbas Muenstr. 1841; Kutassy, p. 587.

Megaphyllites jarbas Münster; Masutomi and Hamada, p. 82, pl. 41, fig. 2a–b.

Megaphyllites jarbas (Münster); Arkell et al., p. L179, fig. 210, 4a–c (refigured holotype).

Megaphyllites jarbas; Kollárová-Andrusovová and Kochanová, p. 102.

Megaphyllites jarbas Münster; Yurttaş-Özdemir, p. 64–65, 79–80, pl. 5, figs 3–6.

Ammonites jarbas Münster; Tozer, p. 91.

Megaphyllites jarbas (Münster); Urlichs, p. 36.

Megaphyllites jarbas (Münster); Urlichs, p. 1, 18, 20–21, 24, 29, fig. 9.

Megaphyllites jarbas; Hornung et al., p. 271, 279, fig. 6e.

Megaphyllites jarbas (Münster 1841); Kožur et al., p. 26.

Megaphyllites jarbas (Münster); Moix et al., p. 70.

Type material. Holotype from Münster (1841), from Carnian beds of St. Cassian, South Tyrol, northern Italy.

Material from Asağıayalabel. One specimen from the Carbonate member Unit C, from sequence AS 19–AS 46 (Fig. 2); NHMW-2012z0133/0479 (Fig. 100).

Measurements. See Lukeneder and Lukeneder (2013).

Description. The specimen from Asağıayalabel (Fig. 100) is small (D 33 mm; Lukeneder and Lukeneder 2013), discoidal, with slightly flattened flanks and a rounded venter. Whorls are compressed and very involute, bearing a narrow and deep umbilicus with rounded umbilical walls. The shell is smooth, bearing growth striae only where shell is preserved. Where shell is removed, parts of the clearly phylloceratid, nearly circular ventrolateral and lateral saddles are visible, as typical for that form (see Arkell et al. 1957). The last suture line is visible and reveals that the body chamber embraces the last half whorl. Furthermore, one very shallow, poorly visible constriction occurs on the body chamber.

Discussion. Generally, specimens of this species lack strong sculpture, except for weak sigmoidal growth lines and regular constrictions on the body chamber (Münster 1841; Hauer 1846; Diener 1925; Arkell et al. 1957; Tozer 1994). The discoid and completely involute shell, the narrow, deep umbilicus as well as details of the ventrolateral suture (Arkell et al. 1957) are most similar to those forms shown in the articles provided in the synonymy list. The described specimen resembles specimens shown by Mojsisovics (1893) from the Carnian beds of the Röthelstein (Styria, Austria) and the Raschberg (Upper Austria, Austria). Very similar examples of M. jarbas (Münster, 1841) are given and figured in the early literature from Carnian faunas of Epidaurus (Greece) by Frech (1907), from Carnian beds of St. Cassian (South Tyrol, northern Italy) by Diener (1925) and Urlichs (2004) and from Carnian beds of Tepeköy (north-west Turkey) by Yurttaş-Özdemir (1973).

Stratigraphic range. Middle Triassic – Upper Triassic, Ladinian–Carnian (up to Tropites subbullatus Zone, Tuvalian 2).

Regions. NCA, Austria (Hauer 1847; Mojsisovics 1873, 1882; Bittner 1882; Wöhrmann 1893; Arthaber 1906; Frech 1907); southern Germany (Wöhrmann 1893; Hornung et al. 2007); Bosnia and Herzegovina (Bittner 1880; Mojsisovics 1882; Hoer-
Genus SIMONYCERAS Wiedmann, 1970

1970 Simonyceras Wiedmann, p. 970.
1981 Simonyceras Tozer, p. 99.
2002 Simonyceras Sepkoski, p. 132.

Type species. Ammonites simonyi Hauer, 1847 (p. 14, pl. 9, figs 4–6), from the red limestones of Bad Aussee, Austria.

Remarks. Medium- to large-sized, evolute shells with subrounded whorl section. Simonyceras exhibits a distinct biconcave striation, passing the round venter without interruption. Wiedmann (1970) established the new genus Simonyceras based on the coexistence of sculptural characteristics of the real Monophyllites and the suture characteristics of Eopsiloceras (Spath, 1930). Arkell et al. (1957) included the genus Monophyllites into the family USSURITIDAE Hyatt, 1900, which is a synonym of the family Monophyllitidae Smith, 1913. See Wiedmann (1970) and Rakús (1993) for a more detailed discussion on the genus Simonyceras Wiedmann, 1970.

Stratigraphic range. Upper Triassic, Lower Carnian.

Simonyceras simonyi (Hauer, 1847)

Figure 11A

1970 Simonyceras simonyi (Hauer); Wiedmann, p. 970, pl. 2, figs 1, 2, pl. 3, text-fig. 4b, 30B (cum syn.).

Material from Aşağıyaylabel. One specimen from a reworked rock sample of the Carbonate member Unit B (Fig. 2): NHMW-20120133/0477.

Measurements. See Lukeneder and Lukeneder (2013).

Description. Only a large part of the body chamber (length 165 mm; Lukeneder and Lukeneder 2013) was found at Aşağıyaylabel (Fig. 11A). Although only partly preserved, the sculpture is unique and characterizes Simonyceras simonyi (Hauer, 1847) unequivocally. The specimen bears the typical, distinct sigmoidal biconcave ribbing of Si. simonyi (Wiedmann 1970). A strong, adapical bow of ribbing is present on the rounded venter. Rib thickness and rib interspace are equal.

Discussion. The typical, distinctly sigmoidal biconcave sculpture of the specimen from Aşağıyaylabel (Fig. 11A) is unique and closely resembles the specimens figured by Rakús (1993) as Si. simonyi (Hauer, 1847). Rakús reinvestigated the figured material of Mojsisovics (1873). The specimens figured by Rakús (1993) are the originals of Mojsisovics (1873, GBA 1873/5/48) along with one additional specimen (GBA 1993/3/1) from the same locality from the Lower Carnian of the Feuerkogel (Styria, Austria). The specimen from Aşağıyaylabel is similar in ribbing to Si. simonyi figured by Wiedmann (1970).

Stratigraphic range. Upper Triassic, Lower Carnian.

Regions. NCA, Austria (Hauer 1847; Dittmar 1866; Mojsisovics 1873–1902; Neumayr 1879; Währer 1882–1898; Arthaber 1906; Kutassy 1932; Spath 1934); St. Cassian, SA (Quenstedt 1846–1849); Western Carpathians (Kollárová-Andrusovová and Kocianová 1973); Romania (Shevyrev 1990); Greece (Renz 1909, 1910, 1911; Kutassy 1932); Lombardy (Allasinaz 1968); Aşağıyaylabel, Taurus Mountains, Turkey; Himalaya and Timor (Diener 1908, 1909; Welter 1915; Arthaber 1927; Wiedmann 1970; Kutassy 1932).

BIOSтратigraphy

The Kasimlar Formation of Aşağıyaylabel (Taurus Mountains, Turkey) consists of two ammonoid assemblages, representing the Lower Carnian Austrotrachyceras austriacum Zone (Carbonate member Unit A; Julian 2) and the Upper Carnian Tropites dilleri Zone (Marlstone member; Figs 2, 12).

Carbonate member Unit A. It should be noted that the specimen of Neoprotrachyceras sp., wrongly assigned pre-
vously to bed AS 1 (top) at the top of the Kartoz Formation (Lukeneder et al. 2012), actually derived from the bottom of bed AS 2, and therefore from the bottom of the Carbonate member of the Kasimlar Formation (Fig. 2). Nevertheless, the Carbonate member Unit A of the Kasimlar Formation has therefore to be dated, due to this occurrence of *Neoprotrachyceras* sp., as Julian 2 (*Austrotrachyceras austriacum* Zone; Fig. 12), but not older than Julian 2/Ib. The occurrence of *K. krystyni* sp. nov. together with *Kl. disciformis* sp. nov. and *Sirenites senticosus* within the layers of the Carbonate member Unit A strengthens the biostratigraphical assignment of Julian age (Fig. 12).

**Carbonate member Unit B.** The species found within the reworked material from the Carbonate member Unit B (*K. krystyni* gen. et sp. nov., *Kl. disciformis* sp. nov., *Simonyceras simonyi*) all together represent Julian age (Fig. 12). Due to the deposition above the Carbonate member Unit A, which indicates at least Julian 2/Ib, the sediments of the Carbonate member Unit B can be dated as not older than Julian 2/Ib (Figs 2, 12).

**Carbonate member Unit C.** Significant ammonoids found within Carbonate member Unit C are *N. attila*, *N. baconicum*, *S. senticosus*, *A. crassicrenulatus* sp. nov., *Proarcestes* sp. and *M. jarbas* (Fig. 2). Whilst *M. jarbas* and *Proarcestes* sp. are known within a long time interval, *S. senticosus* in contrast is limited to Julian age (Fig. 12). The occurrence of *N. attila* and *N. baconicum* would reflect at least Julian 2/Ib. The co-occurrence of *S. senticosus* and *Neoprotrachyceras* therefore dates Unit C as Julian 2. Moreover, *A. crassicrenulatus* sp. nov. at the top of the Carbonate member (Unit C) allows a more detailed classification of Unit C to Julian 2/II (Figs 2, 12). This classification (latest Early Carnian) has already been investigated from conodonts (*Gladigondolella tethydis* and *Metapolygnathus* sp.) and stratigraphically important ammonoids (*Neoprotrachyceras* sp. and *Anasirenites* sp.) by Lukeneder et al. (2012).
Marlstone member. The second and stratigraphically younger assemblage from the Kasimlar Formation of Aşağıyaylabel was detected within the Marlstone member (Fig. 2). All ammonoid species found within the Marlstone member suggests a late Carnian age (Tuvalian). Whilst *Sa. pilari*, *P. hoetzendorfii* and *Trachysagenites beckei* are characteristic elements for Tuvalian 1–2, *Sp. shastense* would indicate Tuvalian 1 (Fig. 12). Due to the fact

**FIG. 12.** Chronostratigraphic scale with indicated range and general geographic occurrences of recognized species (black arrows) and genera (grey bars) found at Aşağıyaylabel. Localities that bear species with open nomenclature are indicated with cf. in brackets. Numerical code: 1, Kasimlarceltites krystyni gen. et sp. nov. 2, Spirogmoceras shastense and *Spirogmoceras* sp. 3, Sandlingites pilari and *Sandlingites* sp. 4, Klipsteinia disformis sp. nov. and *Klipsteinia* sp. 5, Neoprotrachyceras attilia and *Neoprotrachyceras* sp. 6, *Neoprotrachyceras balconicum* and *Neoprotrachyceras* sp. 7, *Sirenetes senticosus* and *Sirenetes* sp. 8, *Anasirenites cassicrenulatus* sp. nov. and *Anasirenites* sp. 9, Paratropites hoetzendorfii and *Paratropites* sp. 10, *Trachysagenites beckei* and *Trachysagenites* sp. 11, *Proarcestes* sp. at AS and *Proarcestes* sp. 12, *Megaphyllites jarbas* and *Megaphyllites* sp. 13, *Simonyceras simonyi* and *Simonyceras* sp. Abbreviations: AS, Aşağıyaylabel; Fr. rego., Frankites regoledanus; Guem. jand., Guembelites jandianus; NCA, Northern Calcareous Alps; Pr. lon., *Protrachyceras longobardicum*; Pr. neu., *Protrachyceras neumayri*; SA, Southern Alps; WC, Western Carpathians.
that Sp. cf. shastense was found within the same beds as the species characteristic for Tuvalian 1–2 (Fig. 2), the sediment can be placed as Tuvalian 1. The stratigraphic age of the Marlstone member is therefore dated as Tuvalian 1, Tropites dilleri Zone (Fig. 2). Previously, Lukeneder et al. (2012) dated the Marlstone member, based on the occurrence of the ammonoid genera Pleurotropites sp. and Spirenomoceras sp. as earliest Late Carnian (Tuvalian). It has to be noted that Lukeneder et al. (2012) misinterpreted P. cf. hoetzendorfii as Pleurotropites sp.

Although there are still biostratigraphical inconsistencies (i.e. condensation, possible hiatus) at the top of the Kartoz Formation, the Lower Carnian – Upper Carnian (Julian–Tuvalian) boundary can be identified precisely at Aşağıyaylabel, between the Carbonate and the Marlstone members (Figs 2, 12).

**TAPHONOMY OF THE AMMONOID FAUNA**

The ammonoid fauna of Aşağıyaylabel is variable in the quantity of taxonomic groups, and the quality of preservation through the section. Kasimlarcellites krystyni gen. et sp. nov. forms a mass occurrence (>1 million specimens; Fig. 2) within the Carbonate member Unit A, as well as being present within reworked 'Cipit-like' boulders of Unit B (i.e. bed 18). The quantity of K. krystyni gen. et sp. nov. has been extrapolated from an $150 \times 45 \times 140$ mm block of bed AS 6 and calculated from the known distribution of the mass occurrence at Aşağıyaylabel within a 112-m$^3$ bed. 2D and 3D reconstructions were made from this reference block, which yielded more than 3000 ammonoids.

Even within Unit A, different beds show different kinds of preservation of K. krystyni gen. et sp. nov. Layers with 'normal' sedimentation, in which K. krystyni gen. et sp. nov. occurs on and off, alternate with 'event beds' (e.g. AS 6) in which K. krystyni gen. et sp. nov. occurs in masses and seems to be transported and orientated by currents (turbidity or water currents). The genesis of this mass occurrence as well as a detailed description and interpretation is beyond the field of this article, but is the topic of future publications in preparation.

In most beds within Unit A, K. krystyni gen. et sp. nov. occurs together with rare Kl. disciformis sp. nov. (AS 4, AS 6 and AS 7) and Sirenetes senticosus (AS 6). All ammonoids show shell preservation, in which shell is secondary replaced by calcite.

Within the reworked material of Carbonate member Unit B, K. krystyni gen. et sp. nov. and Kl. disciformis sp. nov. occur within reworked blocks (i.e. 'Cipit' blocks). The ammonoid material (Kl. disciformis sp. nov., S. senticosus) seems to be redeposited from shallower areas down to deeper environments on the ramp, along with shallow-water organisms (e.g. gastropods, sponges). Due to the erosive process and weathering over thousands of years at the surface, ammonoids can be easily removed from the mother rock. Nevertheless, the ammonoids are generally well preserved (e.g. body chamber, siphuncle structure) with shell preservation, not compacted, not fragmented, without borings, but replaced by secondary calcite. A large specimen of Si. simonyi, found in Unit B, is preserved only as fragment of the body chamber.

Ammonoids from the Carbonate member Unit C (Kl. disciformis sp. nov., N. attila, N. baconicum, S. senticosus and A. crassicrenulatus sp. nov.) stem from bedded limestones and are well preserved, mostly with shell preservation, but replaced by secondary calcite and without any compaction.

Ammonoid specimens from the Marlstone member (Sp. cf. shastense, Sa. cf. pilari, P. cf. hoetzendorfii, Trachysagenites cf. becketi and Proarcestes sp.) are generally compacted, sometimes with shell preservation (i.e. secondary calcite). Due to compaction, specimens are often fragmented.

**DISCUSSION**

Fossil composition, stratigraphy and facies change within the section at Aşağıyaylabel

The section at Aşağıyaylabel, located within the Taurus Mountains (southern Turkey), consists of the older Kartoz Formation (lowermost Carnian) and the younger Kasimlar Formation (Lower Carnian, Julian 2 – Upper Carnian, Tuvalian 1), Lukeneder et al. (2012, figs 1–3). New data led to a revised log concerning the different thicknesses of the members (Fig. 2), redefined after Lukeneder et al. (2012).

**Kartoz Formation.** The lowermost 1.7 m of the log contains only rare ammonoids ($n = 1$). Only one specimen of Neoprotrachyceras sp. was wrongly assigned to bed AS 1 (at the top of the Kartoz Formation) by Lukeneder et al. (2012), but actually belongs to bed AS 2 (at the bottom of the Kasimlar Formation; Fig. 2). The rare ammonoid occurrence in the Kartoz Formation is due to the shallow palaeowater depth, indicated by in situ reefs, megalodont bivalves, gastropods and sponges (Lukeneder et al. 2012).

**Kasimlar Formation.** The lower 28 m bears two ammonoid assemblages. The stratigraphically older one belongs to the Austrotrachyceras austriacum Zone (Julian 2; Fig. 2), whereas the younger is characteristic for the
Tropites dilleri Zone (Tuvalian 1). The Kasimal Formation (1.7 m up to about 35 m) has been subdivided by Lukeneder et al. (2012) into the Carbonate member comprising Units A, B and C (1.7–15.35 m), into the Marlstone member (15.4–31.7 m) and into the Shale member (31.8 m up to about 35 m; Fig. 2). The Lower–Upper Carnian boundary (i.e. Julian–Tuvalian boundary) is marked by a lithological change between the Carbonate member (Unit C) and the Marlstone member (Lukeneder et al. 2012).

The lowermost part of the Carbonate member (1.7–3.6 m; Fig. 2) is characterized by well-bedded dark limestones. They bear a microfacies of bioclastic pelagic wackestones, deposited within a deep shelf margin or mid-ramp position (Lukeneder et al. 2012). The ammonoid assemblage of the lowermost Unit A (Fig. 2) is extremely monotonous. The ceratitid ammonoid K. krystyni gen. et sp. nov. occurs as mass occurrence within Unit A, bed AS 4–7, and therefore dominates (>99 per cent) the cephalopod assemblage (Carbonate member Unit A). Rare specimens of K. disciformis sp. nov., Sirenes senticosus and Sirenes sp. co-occur. The abundance of the genus Kasmilarceltites gen. nov. reflects its accumulations in mass occurrences within single layers (beds AS 4–AS 7; Fig. 2). These event beds alternate between ‘normal’ sedimentation, bearing sporadically deposited ammonoids, and almost monospecific layers crowded with Kasmilarceltites gen. nov. The entire sequence reflects a tectonic deepening, hence a manifestation of deeper water sedimentation, leading to the deposition of ammonoid beds over shallow-water reefal limestone, which clearly lack cephalopods.

Carbonate member Unit B (3.6–11.6 m; Fig. 2) consists of mass flow deposits – ‘Cipit’-like blocks (Lukeneder et al. 2012) – which contain almost the same ammonoid fauna as described in Unit A with K. krystyni gen. et sp. nov., Kl. disciformis sp. nov. and one, most probably drifted, specimen of Si. simonyi (Fig. 11A). Due to the faunal similarities between Carbonate member Units A and B, the transported blocks of Unit B are interpreted as being derived from an isochronously deposited site as proximal mid-ramp, comprising corals, sponges and gastropods (Lukeneder et al. 2012). The Turkish specimen of Si. simonyi described herein is most probably drifted based on its fragmentation and rareness (n = 1), hence interpreted as an allochthonous element.

Carbonate member Unit C (11.7–15.2 m; Fig. 2) appears again with dark grey, well-bedded limestone layers. Ammonoids here include Kl. disciformis sp. nov., N. attila, N. baconicum, Neoprotarchyceras sp., S. senticosus, Sirenes sp., Austrotrachyceras crassicrenulatus sp. nov., and Megaphyllites jarbus, accompanied by a single nautiloid cephalopod (Fig. 11B–D). The occurrence of Neoprotarchyceras and S. senticosus dates the whole Carbonate member to the Austrotrachyceras austriacum Zone (Julian 2; Krystyn 1978; Lukeneder et al. 2012). The occurrence of A. crassicrenulatus sp. nov. within Unit C allows a more detailed classification into the upper part of the A. austriacum Zone (Julian 2/II; Krystyn 1978; Lukeneder et al. 2012). Unit C bears the first occurrence of Proarcestes at Aşağıyaylabel. It inhabited greater depths between 180 and 450 m, as assumed by Hewitt (1996) and Westermann (1996), calculated on shell strength data (e.g. septa and shell).

The composition of the whole Carbonate member (Units A–C) is dominated to 88 per cent by the newly established K. krystyni gen. et sp. nov. (Fig. 13). This is followed by Kl. disciformis sp. nov. (6 per cent), N. baconicum (3 per cent), Sirenes senticosus (2 per cent) and A. crassicrenulatus sp. nov. (1 per cent). The residual species (N. attila, M. jarbas, and Si. simonyi) show a maximum of 1 per cent, each occurring with only one specimen (Fig. 13).

The Marlstone member (15.3–31.7 m; Fig. 2) of the Kasimal Formation at Aşağıyaylabel consists of calcareous marls and marlstones (Lukeneder et al. 2012). The ammonoid fauna is dominated by P. cf. hoetzendorfii, which constitutes 58 per cent of the whole ammonoid fauna, within this assemblage (Fig. 13). Further ammonoids, which belong to this assemblage, are Proarcestes sp. (21 per cent), Sa. cf. pilari (13 per cent), Sp. cf. shastense (7 per cent), T. cf. beckei (1 per cent) as well as coleoids represented by some specimens of Atractites sp. (Figs 11E–G, 13). The entire cephalopod assemblage and the occurrence of Sp. cf. shastense indicate a Tuvalian age (Tuvalian 1, Tropites dilleri Zone) for the Marlstone member. The Julian–Tuvalian boundary is marked by a lithological change and by the occurrence of A. crassicrenulatus sp. nov. immediately below (Carbonate member Unit C) and Sp. cf. shastense above that boundary (Marlstone member; Lukeneder et al. 2012). The deep-water inhabitant Proarcestes occurs throughout the Marlstone member and reflects the general drowning trend from the Carbonate member Unit C onward, as also shown by facies analyses (Lukeneder et al. 2012).

The ammonoid fauna from Aşağıyaylabel in the Tethyan Realm

The ammonoid fauna from Aşağıyaylabel embraces a time interval around the Lower–Upper Carnian boundary within the Upper Triassic. The locality offers one of the few opportunities to investigate ammonoid faunas across the Lower–Upper Carnian boundary. Hence, the section at Aşağıyaylabel represents a key section for a detailed investigation of an ammonoid fauna affected by an environmental turnover. It is one of the few sections in the
from an open-platform margin, to a deeper shelf margin setting, to open, marine-influenced basinal conditions (Lukeneder et al. 2012). New Carnian ammonoids detected at Aşağııyaylabel are K. krystyni gen. et. sp. nov., Kl. disciformis sp. nov., and A. crassicrenulatus sp. nov. The new taxa appear at an isolated, but generally connective palaeoceanographic position on the western end of the Cimmerian System.

The almost worldwide distribution of Triassic pelagic to hemipelagic ammonoids during that time makes these cephalopods suitable for biostratigraphic correlations within the Tethyan Realm. Ammonoids are therefore a valuable tool to test palaeoceanographic hypotheses and intercontinental biostratigraphic correlations. The zonation of stages and substages assumed by Mojsisovics (1869, 1870, 1873–1902, 1879, 1882, 1896), Diener (1906, 1917, 1921, 1923), Spath (1934) and Tozer (1967, 1971, 1981, 1984, 1994) is still in use, even though adapted to modern taxonomy (Krystyn 1973, 1978; Mietto et al. 2008; Balini et al. 2010; Lucas 2010). Detailed work on comparable Upper Triassic ammonoid faunas from the Tethyan Realm was, for example, conducted by Krystyn and Schlager (1971), Tozer (1971, 1981, 1984, 1994), Krystyn (1973, 1978, 1980, 1982), Tatzreiter (1980, 1982), Balini and Jenks (2007) and Balini et al. (2007).

Implications for the marine Upper Triassic Mediterranean–Himalayan–Andean Realm

The general Tethyan-wide drastic change within the ammonoid fauna from Lower–Upper Carnian (Julian 2 to Tuvalian 1) is clearly reflected at Aşağııyaylabel. The Julian–Tuvalian boundary, and therefore the Lower–Upper Carnian boundary, is located between the Carbonate and Marlstone members at Aşağııyaylabel (Figs 2, 12). The locality yields two distinct ammonoid assemblages, the Lower Carnian assemblage from the Austrotrachyceras austriacum Zone (Julian 2) and the Upper Carnian assemblage from the Tropites dilleri Zone (Tuvalian 1; Fig. 12). The stratigraphy and palaeogeography of each species from Aşağııyaylabel are given in Figure 12 and Table 4.

The Tethyan-wide crisis within the Trachyceratinae affected genera such as Trachyceras, Austrotrachyceras and Neoprotrachyceras. Trachysagenites gen. et. sp. nov., Tethyan-wide known only from the Lower Carnian, is the last representative at the Marlstone member (Tuvalian). During the Lower Carnian (Julian), Trachyceratinae generally flourished within the whole Tethys, as also observable at Aşağııyaylabel (Carbonate member, Julian 2). Characteristic faunal elements of the Marlstone member at Aşağııyaylabel are Sirentes senticosus sp. nov., Tropites dilleri gen. et. sp. nov., Kl. disciformis sp. nov., and A. crassicrenulatus sp. nov. The new taxa appear at an isolated, but generally connective palaeoceanographic position on the western end of the Cimmerian System.

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reflects the radiation of Tropitidae within the whole Tethyan area (Balini et al. 2010) from the Tuvalian onward.

The ammonoid fauna from Aşağıaylabel mirrors the connective palaeoceanographic position of the intrashelf area on the western end of the Cimmerian System. Spirogmoceras, Sandlingites, Klipsteinia, Neoprotrachyceras, Sirenites, Anasirenites, Paratropites, Trachysagenites, Proarcestes, Megaphyllites and Simonyceras appear with worldwide distribution or at least Tethyan-wide (Fig. 12; Table 4). These genera are characteristic cephalopods for the Carnian of Tethyan and Andean realms (Balini et al. 2010; Lucas 2010).

Typical and frequent ammonoids for the Upper Triassic Mediterranean–Himalayan–Andean Realm are Sandlingites, Klipsteinia, Neoprotrachyceras, Sirenites, Anasirenites, Paratropites, Trachysagenites and Simonyceras. The ammonoid assemblage of Aşağıaylabel resembles Lower Carnian assemblages of Austria (NCA) and Germany (e.g. Rappoltstein), based on the co-occurrence of Megaphyllites jarbas, Neoprotrachyceras, Sirenites and Anasirenites. Clear analogies, strengthening the concept of a Mediterranean–Himalayan–Andean Realm, are detected by comparison and correlation with European, Asian and American faunas. Well-known and comparable sections are in the southern Alps (near St. Cassian, Stuores Wiesen in South Tyrol, northern Italy; Münster 1841; Klipstein 1843; Laube 1870; Neumayr and Uhlig 1880–1881; Mojsisovics 1882; Wöhrmann 1893; Frech 1907; Urlichs 1994), in the Balkony Mountains (Veszprém, Hungary; Mojsisovics 1870, 1893), in the Dinarides (Glamoča, Dragolac, Bosnia and Herzegovina; Bittner 1880; Mojsisovics 1882; Hoernes 1903; Kittl 1903; Diener 1917), and in India (Himalaya) and Timor (Diener 1915, 1921).

Spirogmoceras cf. shastense appears to be a North America–Andean faunal element, typically found in Canada (British Columbia; Tozer 1994) and in the USA (Shasta County, California; Smith 1904, 1927; Hyatt and Smith 1905; Silberling 1956; Tozer 1994). Further conclusions on the palaeogeography or on migration paths, based on the ammonoid fauna from Aşağıaylabel, would be highly speculative, and more material from Triassic cephalopod faunas from the Taurus Mountains is needed.

**CONCLUSIONS**

The macrofauna of the Kasimlar Formation at the Aşağıaylabel section (Taurus Mountains, Turkey) is

| Genus /species name | Lower Carnian | Upper Carnian |
|---------------------|---------------|---------------|
| Kasimlarceltites krystyni gen. et sp. nov. | AS | |
| Klipsteinia disciformis sp. nov. | AS | |
| Neoprotrachyceras attila | NCA, AS | NCA |
| Neoprotrachyceras baconicum | NCA, AS | |
| Sirenites senticosus | NCA, California | NCA, SA, Turkey (MM), SW-China, AS |
| Anasirenites crassicrenulatus sp. nov. | AS | |
| Megaphyllites jarbas | Dobrudscha, Himalaya | NCA, Bavaria, Dobrudscha, Greece, Turkey (MM), AS Himalaya |
| Simonyceras simonyi | NCA, SA, WC, Romania, Greece | AS | |
| Spirogmoceras shastense | AS (cf.), Canada, USA, Mexico | Nevada |
| Sandlingites pilari | AS (cf.) | B & H |
| Paratropites hoetzendorfii | AS (cf.) | B & H |
| Trachysagenites beceki | AS (cf.) | NCA |

AS, Aşağıaylabel; B & H, Bosnia and Herzegovina; MM, Mersin Melange; NCA, Northern Calcareous Alps; SA, Southern Alps; WC, Western Carpathians; WPM, Western Pontian Mountains. Localities that yield species with open nomenclature are indicated with cf. in brackets.

**TABLE 4.** Compendium of stratigraphic and palaeogeographic occurrences of all species found at Aşağıaylabel.
mainly represented by ammonoids. A total of 479 ammonoid specimens, two nautiloid specimens and four coleoid specimens were collected and investigated. Material from former excavations and collection type material was correlated with the more recent material (bed-by-bed sampling). The biostratigraphic ammonoid zonation is based on the presence of single ammonoids, assemblage data and composition of the corresponding ammonoid fauna.

The locality offers one of the few opportunities to investigate ammonoid faunas across the Lower–Upper Carnian boundary. Hence, the deposits at Aşağıaylabel represent a key section for a detailed investigation of an ammonoid fauna affected by an environmental turnover. It is one of the few sections in the world that bears a record of upper Lower Carnian to lower Upper Carnian ammonoids.

The Lower Carnian (Austrotrachyceras austriacum Zone) and the Upper Carnian (Tripolites dilleri Zone) were confirmed by the ammonoid biostratigraphy. The assemblages consist of 12 ammonoid genera with Kasimoceriellites gen. nov., Spirognoceras, Sandlingites, Klipsteinia, Neoprotrachyceras, Sirentes, Anasrenites, Paratropites, Trachysagenites, Proarcestes, Megaphyllites and Simonyceras bearing 13 species, accompanied by a single coleoid genus with Atractites.

The cephalopod fauna drastically changed from the lower to Upper Carnian (Julian 2 to Tuvalian 1) at Aşağıaylabel, a change also reflected throughout the Tethyan Realm. The stratigraphically older assemblage, which is dominated by K. krystyni gen. et sp. nov. (88 per cent), belongs to the Carbonate member (Units A–C) and is dated as Lower Carnian (Julian 2; A. austriacum Zone). The occurrence of A. crassicrenulatus sp. nov. at the top of the Carbonate member (Unit C) allows a more detailed classification of Unit C to Julian 2/II.

The second and younger assemblage, which is dominated by P. cf. hoetzendorffii (58 per cent), belongs to the overlying Marlstone member. The co-occurrence of P. cf. hoetzendorffii and Sp. cf. shastense within this member is indicative of Upper Carnian (Tuvalian 1, T. dilleri Zone). The occurrence of Paratropites confirms a Tuvalian age because the family Tropitidae flourished from the Late to Upper Carnian (Julian 2 to Tuvalian 1, Lipotis formis/C21, Kasimoceriellites/a C) and Kasimoceriellites/A. austriacum bearing 13 species, accompanied by a single coleoid genus with Atractites.

Ammonoid faunas affected by a general deepening from open-platform margins, over deeper shelf settings down to an open marine-influenced basinal environment reflecting water depths between 180 and 450 m.

The main faunal differences between Aşağıaylabel and all other known Carnian ammonoid faunas are the newly described K. krystyni gen. et. sp. nov., Kl. disciformis sp. nov. and A. crassicrenulatus sp. nov. Biometric data on shell parameters and ratios (D, H, W, ah, U, H/W, W/D and WER), and comparison of PCAs, support the taxonomic conclusions on the newly established genus and species.

The ammonoid data collection is the first step in producing a detailed biostratigraphic scheme for the Aşağıaylabel key section, part of the Cimmerian System between the European, African and Asian continents. The main focus of further studies will be to define the mechanisms behind the genesis of ammonoid mass occurrences of K. krystyni gen. et sp. nov. Forthcoming analyses will include palaeomagnetic, isotope and geochemical analyses.

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Data for this study are available in the Dryad Digital Repository: http://dx.doi.org/10.5061/dryad.0rp6

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