Supplementary online material

Late Givetian ammonoids from Hassi Nebech (Tafilalt Basin, Anti-Atlas, southern Morocco)

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1. Investigated succession

Bed 10f, "Lower Marker Bed" (Bed 24 in Bensaïd et al. 1985), 80 cm light-grey, bioturbated nodular limestone, styliolinid wackestone with intraclasts, some fine quartz sand and some goniatites, especially at the top of the bed; relatively poor conodont fauna of the *cristatus ectypus* to *disparilis* Zone (*Klapperina* has not yet been found locally); macrofauna:

> *Thamnopora* sp. (2 specimens)
> *Panenka* sp. (2 specimens)
> bellerophontid gastropod (2 poorly preserved specimen)
> breviconic nautiloids (2 fragments)
> *Epitornoceras mithracoides* (MB.C.22137 a single specimen)
> *Darkaoceras meridionale* (MB.C.22140 and10 other specimens/fragments)
> *Extropharciceras librum* (MB.C.22141 and 6 other specimens/fragments)
> *Extropharciceras conex* (MB.C.22142 and 19 other specimens)
> *Extropharciceras arenicum* Group (MB.C.22144, poorly preserved)
> *Stenopharciceras protectum* (MB.C.22145 and one additional specimen)
> *Synpharciceras* sp. (MB.C.22146 ,a single mould)
> *Lunupharciceras serpentinum* (MB.C.22147, a single mould)

Bed 11a, ca. 800 cm of deeply weathered, dark grey shales with very poorly preserved, loose limonitic fauna:

> *Epitornoceras mithracoides* (1 specimen)
> *Darkaoceras velox* n. sp. (2 specimens)
> *Taouzites taouzensis*(4 specimens/fragments)
> *Pharciceras lateseptatum* (3 specimens)
> *Pharciceras fornix* n. sp. (1 specimen)
> *Extropharciceras arenicum* (6 poorly preserved specimens)
> *Lunupharciceras incisum* n. sp. (4 specimens)
> *Stenopharciceras kseirense* (1 specimen)
> *Stenopharciceras progressum* n. sp. (1 specimen)
> *Synpharciceras frequens* n. sp. (3 poorly preserved specimens)
> numerous poorly preserved, unidentified pharciceratids
> orthoconic cephalopod (1 specimens)
> crinoid stem piece
> wood remain (1 large fragment)

Beds 11b-c, two thin layers of grey nodular limestone, poor in macrofauna, separated by ca. 100 cm of dark, greenish-grey shales.

> *Pharciceras* sp. indet. (MB.C.22148, relative evolute but compressed at 55 mm dm, with uw/dm = 0.4 and ww/wh = 0.95; no sutures)

Bed 11d, ca. 90 cm of deeply weathered, dark grey shales, with a thin layer of nodular limestone at the top.

Bed 11e, ca. 640 cm of deeply weathered, dark grey shales with extremely abundant limonitized ammonoids (MAIN COLLECTING LEVEL), with a thin layer of laminated, marly limestone at the top; loose macrofauna:

> wood (rare)
> terebratulid brachiopods

pleurotomariid gastropods

phacopid trilobites

orthoconic nautiloids

Epitornoceras mithracoides (15 specimens)

Lobotornoceras bensaidi n. sp. (4 specimens)

Nebechoceras excentricum n. gen. n. sp. (50 specimens)

Phoenixites lenticulus n. sp. (30 specimens)

Darkaoceras velox n. sp. (50 specimens)

Taouzites taouzensis (300 specimens)

Pharciceras decoratum n. sp. (7 specimens)

Pharciceras aff. *tridens* (7 specimens)

Pharciceras lateseptatum (120 specimens)

Pharciceras fornix n. sp. (50 specimens)

Pharciceras subconstans n. sp. (1 specimen)

Extropharciceras applanatum (30 specimens)

Extropharciceras arenicum (90 specimens)

Extropharciceras n. sp. 2 (1 specimen)

Lunupharciceras incisum n. sp. (10 specimens)

Lunupharciceras lunulicosta (6 specimens)

Transpharciceras procedens n. gen. n. sp. (4 specimens)

Stenopharciceras sp. (1 specimen)

Stenopharciceras kseirense (120 specimens)

Stenopharciceras progressum n. sp. (11 specimens)

Pluripharciceras plurilobatum (65 specimens)

Pluripharciceras cf. *plurilobatum* (2 specimens)

Pluripharciceras orbis n. sp. (4 specimens)

Meropharciceras disciforme (7 specimens)

Synpharciceras clavilobum (50 specimens)

Synpharciceras frequens n. sp. (250 specimens)

Synpharciceras aff. *frequens* (3 specimens)

Petteroceras errans (30 specimens)

Pseudoprobeloceras pernai (250 specimens)

Pseudoprobeloceras praecox n. sp. (50 specimens)

Scaturites minutus n. gen. n. sp. (200 specimens)

loose goniatites preserved in light grey micrite, rarely in a mixture of micrite and limonite, derive from nodular levels within the upper part of Bed 11 and include:

Epitornoceras cf. *mithracoides* (MB.C.22149, single small fragment)

Pharciceras involutum n. sp. (MB.C.22113)

Taouzites taouzensis (MB.C.22150 and 4 other fragments)

Extropharciceras cf. *arenicum* (MB.C.22139.1, MB.C.22139.2)

Pseudoprobeloceras pernai (MB.C.22143and 7 additional fragments)

Bed 12, ca. 400 cm of deeply weathered dark grey shales with rare limonitized ammonoids, alternating with four thin layers of light grey nodular limestone; the 4th nodule layer forms the top of the unit.

Bed 13a, ca. 200 cm of deeply weathered, dark grey shale with limonitized ammonoids, plant remains, and a brownish, platy siderite layer near the middle:

Nebechoceras excentricum n. gen. n. sp. (3 specimens)

Taouzites taouzensis (1 specimen)

Pharciceras lateseptatum Morphotype II (1 specimen)

Pharciceras fornix n. sp. (1 specimen)

Extropharciceras applanatum (1 specimen)

Stenopharciceras kseirense (2 specimens)

       Synpharciceras frequens n. sp. (3 specimens)

       Pseudoprobeloceras pernai (3 fragmentary specimens)

       Pseudoprobeloceras praecox n. sp. (1 specimen)

       Scaturites minutus n. gen. n. sp. (2 specimens)

       gastropods (2 specimens)

       wood remains (2 fragments)

Bed 13b, ca. 20 cm of light grey nodular limestone lacking macrofauna (Bed 40 of Bensaïd et al. 1985).

Bed 14, ca. 650 cm of deeply weathered dark grey shales with limonitized ammonoids (loose collection) and a 9 cm layer of laminated, turbiditic limestone at the top, which probably correlates with Bed 43 of Bensaïd et al. (1985); macrofauna:

       Pseudoprobeloceras pernai

Bed 15a, ca. 120 cm of deeply weathered, dark grey shale with uncommon loose (?transported) limonitized ammonoids and some marly concretions (septaria)

Bed 15b, level of marly septaerians, up to 16 cm thick

Bed 16, ca. 160 cm of deeply weathered, dark grey shales with a layer of brown siderite platelets in the middle and a layer of marly septarians at the top.

Bed 17, ca. 100 cm of deeply weathered, dark grey shales with a second layer of siderite platelets and with marly septarians at the top

Bed 18, ca. 310 cm of deeply weathered, dark grey shales, followed by a level of septarians, up to 22 cm thick

Bed 19, ca. 300 cm of deeply weathered dark grey shales, followed by a level of septarians, up to 25 cm thick

Bed 20, ca. 300 cm of deeply weathered dark grey shales, with a thin, irregularly bedded, marly, laminated styliolinite at the top

Bed 21, ca. 120 cm of deeply weathered shale with some brown siderite platelets in the middle and a thin unit of red limestone nodules at the top that contain *Sandbergeroceras, Manticoceras*, and large bivalves

Bed 22, ca. 460 cm of deeply weathered shale, at the top with ca. 18 cm nodular limestone with *Sandbergeroceras* and *Naplesites*

Bed 23, ca. 260 cm of deeply weathered shale with an unfossiliferous, thin buff marl or marly limestone at the top

Bed 24, ca. 680 cm of deeply weathered shale, laterally with two layers of light grey limestone nodules, an intervening thin, dark styliolinite, and some siderite platelets below

Bed 25, 18 cm thick, light-grey nodular limestone with early mesobeloceratids and *Manticoceras*

Bed 26, ca. 200 cm of deeply weathered shale

Bed 27, ca. 14 cm of light-grey nodular limestone with more advanced mesobeloceratids, followed in the subsequent main slope to the South by nodular limestones with beloceratids and *Carinoceras*

The "Lower Marker Bed" goniatite fauna closely resembles that from Dar Kaoua (Bockwinkel et al. 2009) but is less diverse. *Synpharciceras, St. protectum, D. meridionale, Ex. librum*, and *Ex. conex* clearly place it in the *Synpharciceras clavilobum* Zone. *Mzerrebites erraticus*, the index species of the older *Mzerrebites erraticus* Zone (MD III-B), occurs below (see Aboussalam 2003). Bed 11a and the main collecting level of Bed 11e contain abundant *T. taouzensis* and *Ps. pernai*, the index species of the *Taouzites taouzensis* Zone, which is probably the age of most of the fauna. The faunal change between the successive *Synpharciceras clavilobum* and *Taouzites taouzensis* zones is distinctive; only *Ep. mithracoides*, *Ph. lateseptatum*, and *Syn. clavilobum* occur in both levels and there is evidence of morphological and evolutionary change within these three species (see discussions in taxonomic chapter). The precise position of some *Petteroceras* specimens, as indicators of the *Petteroceras errans* Zone (MD III-E), is not known but Bed 13b may correlate with the Upper Marker Bed of the northern Tafilalt, which underlies the *Petteroceras* Beds. The conodont data of Bensaïd et al. (1985) suggest that the Givetian-Frasnian boundary lies in the thick interval between Beds 13b and 14b. The thin siderite units indicate episodes of strongly starved sedimentation in a low-oxygen environment. The Early Frasnian is poorly fossiliferous and characterized by septarian levels (Beds 15-20b). The

Middle Frasnian, starting with Bed 21, includes several distinctive goniatite levels, which require further study.

2. Systematic Palaeontology

Order **Agoniatitida** Ruzhencev, 1957
Suborder **Gephuroceratina** Ruzhencev, 1957
Superfamily **Gephurocerataceae** Frech, 1897
Family **Acanthoclymeniidae** Schindewolf, 1955

Subfamily **Ponticeratinae** Korn & Klug, 2002

Included genera.
Ponticeras Matern, 1929
Pseudoprobeloceras Bensaïd, 1974
Chutoceras Becker & House 2000

Discussion. The Acanthoclymeniidae include all genera with "pharciceratoid" subdivision of the external lobe (see Clausen 1971), lacking outer umbilical lobes. This excludes *Uchtites* from the family. The Ponticeratinae and Gogoceratinae of Korn & Klug (2002) are currently kept as subfamilies but the type genus of the first requires revision.
Stratigraphic range. Late Givetian, *Taouzites taouzensis* Zone (to Late Frasnian, just below the lower Kellwasser level; see discussion in Becker & House 1993).
Geographic distribution. Canada (NW Territorries), USA (West Virginia, New York State), SW England, France/Belgium (Armorican Massif, Ardennes, Montagne Noire), Germany (Rhenish Massive, Harz Mountains), Austria/Italy (Carnic Alps), Spain (Cantabrian Mountains), Morocco (Tafilalt, Maider), Algeria (Saoura Valley, Ougarta), Poland (Holy Cross Mountains), Russia (Russian Platform/Timan, Urals, Altai Mountains, Kolyma), China (Guangxi and Guizhou), Western Australia.

Pseudoprobeloceras **Bensaïd, 1974**

Type species. Pseudoprobeloceras nebechense Bensaïd, 1974, a subjective junior synonym of *Ps. pernai*.

Diagnosis: Small to large-sized, earliest whorls depressed, intermediate to mature conchs strongly compressed, subinvolute to evolute, with rounded venter and weak ventrolateral furrows; growth lines concavo-convex, bundled to ribs in early stages. Sutures with deep I lobe, shallow, internal U lobe, rounded L lobe, dominant, rounded, slightly asymmetric flank saddle, incipient E_2 lobe, and narrow, deep E_1 lobe; suture formula: $(E_2E_1E_2)L:UI$.

Included species. Gephyroceras Pernai Wedekind, 1918
Gephyroceras Pernai var. *applanata* Wedekind, 1918
Gephyroceras Barroisi Wedekind, 1918
Ponticeras sahlgrundensis Matern, 1931
Manticoceras pontiformis Termier & Termier, 1950 (= *pernai*)
Probeloceras costulatum Petter, 1959 (= *pernai*)
Pseudoprobeloceras nebechense Bensaïd, 1974 (= *pernai*)
Pseudoprobeloceras praecox n. sp.
Probeloceras sp. 1 and sp. 2 in Bensaïd et al. (1985)

Stratigraphic range. Latest Givetian.

Geographic distribution. Germany (Wedekind 1918: Rhenish Massive), France (House et al. 1985: Montagne Noire,), ?Spain (Montesinos & Henn 1986: Cantabrian Mountains; no description or illustration of alleged *Pseudoprobeloceras* sp.), southern Morocco (Bensaïd 1974: Tafilalt, Maider), southern Algeria (Petter 1959: Saoura Valley, Ougarta), South China (Ruan 1981: Guizhou, Hou et al. 1985: Guangxi).

Pseudoprobeloceras pernai (Wedekind, 1918)

1918 *Gephyroceras Pernai* Wedekind, p. 121, 166, textfig. 28e_1-e_2, pl. 21, fig. 1.
1924 *Gephyroceras Pernai*. - Paeckelmann, p. 60.
non 1931 *Ponticeras pernai*. - Gaertner, p. 152 [probably a late Frasnian evolute gephuroceratid].
non 1933 *Gephyroceras pernai*. – Anniss, p. 437, pl. 41, fig. 3 [= *Manticoceras* sp.; see House 1963].
1931 *Ponticeras pernai pernai*. – Matern, p. 79-80, 116.
non 1943 *Ponticeras pernai*. – Heritsch, p. 305 [Gaertner specimen].
1950 *Manticoceras pontiforme* Termier & Termier, p. 52, 149, figs 3-5, pl. 150, figs 1-5.
1959 *Probeloceras pernai*. – Petter, p. 153, pl. 11, text-fig. 40c, pl. 11, figs 5, 5a [non pl. 11, figs
              6, 6a = *Ps. praecox* n. sp.].
1959 *Probeloceras costulatum* Petter, p. 156-157, fig. 40D, pl. 11, figs 7, 7a, 8, 8a.
non 1965 *Ponticeras pernai*. - Flügel & Kropftisch-Flügel, p. 10 [Gaertner specimen].
1971 *Probeloceras pernai*. - Clausen, p. 184.
1971 *Probeloceras costulatum*. - Clausen, p. 135.
1974 *Pseudoprobeloceras nebechense*. – Bensaïd, p. 90, 102-103, figs 10-11, pl. 4, figs 1, 1a, 4,
              4a, 9, 9.
1977 *Ponticeras pernai pernai*. - House & Ziegler, p. 75, 79, pl. 1, figs 18-22.
1982 *Ponticeras pernai pernai*. - Ziegler & Klapper, p. 476.
non 1985 *Pseudoprobeloceras* cf. *pernai*. - Becker, p. 24 [= "*Ponticeras*" sp.].
non 1985 *Ponticeras pernai* Group. - House et al., p. 5, figs 5G-H, pl. 1, fig. 1-2 [= "*Ponticeras*" sp.].
non 1989 *Pseudoprobeloceras* cf. *nebechense*. - Göddertz, p. 185-186, fig. 32, pl. 14, figs 1-4.
1993 *Pseudoprobeloceras pernai*. - Becker & House, p. 117.
1993 *Pseudoprobeloceras pernai*. - Becker & House, p. 117.
1993 *Pseudoprobeloceras pontiformis*. - Becker & House, p. 117.
1999 *Pseudoprobeloceras nebechense*. - Belka et al., tab. 5, ?fig. 8.
2000a *Pseudoprobeloceras* cf. *pernai*. - Becker & House, p. 32.
2002 *Pseudoprobeloceras pernai*. - Korn & Klug, p. 98.
2002 *Pseudoprobeloceras nebechense* .- Korn & Klug, p. 98, figs 93A-C.
2002 *Pseudoprobeloceras pontiforme*. - Korn & Klug, p. 98.
2003 *Pseudoprobeloceras pernai*. - Aboussalam, fig. 14.
2003 *Pseudoprobeloceras nebechense*. - Korn & Klug, p. 344.
2003 *Pseudoprobeloceras pernai*. - Korn & Klug, p. 344.
2005 *Pseudoprobeloceras pernai*. - Aboussalam & Becker, p. 5.

Description. Typical are almost identical ww/dm and uw/dm values from ca. 2 mm dm on, which first stagnate until ca. 5 mm dm, and then decline steadily towards value near 0.30. The trend to rapidly expanding whorls, with only gently rounded flanks and subangular ventrolateral shoulders (e.g., MB.C.22134.12, MB.C.22134.16), bordering a somewhat flattened venter (e.g., MB.C.22134.4, Fig. 5D, and MB.C.22134.8, Fig. 5H), begins at 4 mm dm. MB.C.22134.6 develops rather distinctive ventral edges. Other specimens (e.g., MB.C.22134.1, Fig. 5A, and MB.C.22134.7, Fig. 5G) possess a more rounded venter. Compressed whorl profiles start at 10 mm dm (Fig. 5M). Spiral furrows are very weak or only indicated by weak flattening zones. They are better developed in MB.C.22134.9 and MB.C.22134.1. Very shallow spiral depressions may lie on the outer flanks of moulds, at the base of

the strong ventrolateral projection of the growth lines (MB.C.22134.10, MB.C.22134.12, MB.C.22134.6, MB.C.22134.14, MB.C.22134.26), or on the mid-flank (MB.C.22134.11, MB.C.22134.19). Early whorls have more rounded flanks and may display clear ventrolateral furrows (MB.C.22134.24). There is some variability of the umbilical width but no deviation from the general trend towards increasingly subevolute mature conchs.

There are distinctive phases of ontogenetic ornament development (e.g., in MB.C.22134.21 and MB.C.22134.24). The ammonitella, which includes the protoconch and less than ¾ of a whorl, appears to be smooth, as in all Gephuroceratacea, as far as this has been observed. The first two post-embryonic whorls show a dense inner flank ribbing, then follows a whorl with rather strong or nodose ribbing (Fig. 6F). The ribs fade gradually during the 4th to 5th whorl (MB.C.22134.14, Fig. 6E). The mature conch is smooth (e.g., MB.C.22134.10, Fig. 6A) apart from weak concavo-convex growth lines. MB.C.22134.22 and MB.C.22134.23 have especially strong and coarse ribs.

There is some variation when the small and very short E$_2$ lobes become distinctive and pointed: at 9-10 mm dm in MB.C.22134.18 but much later (after 17 mm dm) in MB.C.22134.9 and MB.C.22134.10 (Fig. 5I). The shallow internal U lobe is best seen in MB.C.22134.11(Fig. 5K), MB.C.22134.25, the septal face of MB.C.22134.6 (Fig. 5F), and also present, even at 3.5 mm wh, in MB.C.22134.26.

Discussion. Unfortunately, the ontogeny of German type material is not yet known since no detailed cross-section has been published and since no material for sectioning was available. The two subspecies of *Ps. pernai* described by Wedekind (1918) can be recognized as seperate species (see Korn & Klug 2002). This is confirmed by the lack of intermediates or of any forms resembling *Ps. applanata* in the abundant Moroccan material. House & Ziegler (1977) re-illustrated the holotype of *Ps. applanata*, with its distinctive ventrolateral edges. Termier & Termier (1950) formalized a new species from an unpublished manuscript of E. Clariond as *Manticoceras pontiforme*. It was based on a Clariond specimen (pl. 149, figs 3-5) from Gara Mdouar (= Mdoura) and on a collection of Marcais from the Tafilalt, which probably derived from the Hassi Nebech area (pl. 150, figs 1-5); the latter collection shows early ontogenetic ribbing. Bensaïd (1974) was unsuccesful to retrieve the Mdoura specimen but it is preserved in the Musée National d´Histoire Naturelle in Paris (see re-illustration in Fig. 6C) and here selected as lectotype. Its conch parameters do not allow a distinction from mature *Ps. pernai*. Consequently the species is regarded as a subjective junior synonym. The same applies to *Probeloceras costulatum*, which Petter (1959) based on well-preserved moulds from Erg el Djemel of the Ougarta Chain in southern Algeria. The syntypes show the typical juvenile ribbing and plot on the conch dimension diagrams for the Hassi Nebech specimens, including the *Ps. pernai* lectotype. The only specimen from the Saoura Valley (her pl. XI, figs 6, 6a) identified by G. Petter as *Probeloceras pernai* is too involute for this species.

Bensaïd (1974) thought he could distinguish between his *Ps. nebechense* from Hassi Nebech and the Mdoura *Ps. pontiforme* but made no comparison with the other syntypes and failed to discuss the relationships with the German *pernai* or with Petter´s Algerian *costulatum*. Our detailed morphometry of a rich topotypic collection of *nebechense* provides no features that make it possible to distinguish forms around its holotype from either *Ps. pernai* or *Ps. costulatum*. However, it is possible that the Bensaïd collection includes some specimens assigned here to *Ps. praecox* n. sp.

Ps. sahlgrundense is more similar than evident from Matern´s (1931) drawing. The difference lies in the rather regular growth lirae, which form only few, indistinctive ribs in the inner whorls. In this respect Chinese juveniles described as *Probeloceras* sp. by Ruan (1981) are similar. *Ps. barroisi* (holotype re-illustrated in House & Ziegler 1977) has thicker and more evolute whorls than *Ps. pernai*. MB.C.22134.13 (Fig. 6D) is an interesting pathological specimen in which the whorls partially deviate from the coiling plane. Similar features have been described from Mesozoic ammonoids (e.g., Checa et al. 2002; "Morton´s Syndrome" or "Forma undaticarinata-undaticoncha" in the overview of Hengsbach 1996) and are attributed to an infestation by epizoans.

Stratigraphic range. Latest Givetian.

Geographic distribution. Germany (Wedekind 1918; Paeckelmann 1924; Matern 1931: Rhenish Massive), Morocco (Bensaïd 1974: Tafilalt), Algeria (Petter 1959: Ougarta; Göddertz 1989: Saoura Valley). A topmost Givetian specimen from the Col du Puech de la Suque (Montagne Noire) assigned by House et al. (1985) to the *Ponticeras pernai* Group is much too evolute and has a high median saddle.

Pseudoprobeloceras praecox n. sp.

1959 *Probeloceras pernai*. - Petter, p. 153-154, fig. $40c_{1-2}$, pl. 11, figs 6, 6a [only].

Description. The uw/dm and WER plots show a marked ontogenetic change after the 3nd whorl, between 3 and 4 mm dm. The whorl width and ww/wh ratios decrease less rapidly towards intermediate whorls. The change from rather rounded, depressed to compressed whorl form occurs after the 4th whorl (e.g. in MB.C.22135.3 and MB.C.22135.4, Figs 7B, C), followed by a mature whorl with the characteristic, laterally and ventrally flattened, high profile (paratype MB.C.22135.4, Figs 7C, and holotype). The largest specimens (e.g., paratype MB.C.22135.4) may have WER > 2.5. Very weak ventrolateral furrows are visible in many specimens (e.g., paratype MB.C.22135.7, Fig. 8C), including juveniles (e.g., in paratypes MB.C.22135.5 and MB.C.22135.6, Fig. 8B) and the holotype (Fig. 8A). Very slight spiral mid-flank furrows occur on paratypes MB.C.22135.4 and MB.C.22135.14. The ontogenetic change of the ornament is visible in many specimens, for example in paratypes MB.C.22135.9 and MB.C.22135.15. The smooth ammonitella, which includes the protoconch and ca. 2/3 of a subsequent whorl, is followed by three whorls with ribs/nodes on the inner flanks. Normally they disappear between 8 and 9.5 mm dm, sometimes already between 6 and 8 mm dm (e.g., in the holotype and in MB.C.22135.3). Paratype MB.C.22135.13 displays well a radial *Ritzstreifung* with ca. 10 fine grooves/mm. The course of the growth ornament, with its high ventrolateral salient, is poorly visible on paratype MB.C.22135.6.
Sutures show the typical pattern of the genus. The E_2 lobe may become subangular from 6 dm. The holotype (Figs 7E, 8A) displays a rising low saddle between E_1 and E_2 at ca. 10 mm dm and final septal crowding. A very shallow internal U lobe can be discerned in paratype MB.C.22135.13 (at 11 mm dm) but is almost non-existant in paratypes MB.C.22135.11 (at 13 mm dm) and MB.C.22135.8 (at 17.5 mm dm). It is slightly enhanced by weathering in paratypes MB.C.22135.12 and MB.C.22135.16.

Discussion. The new species is related to *Ps. pernai* and *Ps. sahlgrundense* but differs significantly by its rapidly expanding, more involute whorls from ca. 7-8 mm dm on. Ww/dm values always exceed the uw/dm ratios (Fig.7F), and high WER values are reached at 4-5 mm dm (at ca. 9 mm dm in *pernai*). The ribbing disappears earlier in ontogeny. *Ps. applanatum* has wider whorls and ventrolateral edges, *Ps. barroisi* has also wider whorls and is much more evolute.
A specimen from the Saoura Valley of Algeria, illustrated by Petter (1959) as *Probeloceras pernai*, shares the small umbilicus of *Ps. praecox* n. sp. but has a slightly higher ww/wh ratio. Allegedly it came from the lowest part of the Late Frasnian, together with *Manticoceras* (*Playfordites* Genozone, Becker et al 1993, updated chronostratigraphy in Becker & House 2009). All other well-dated *Pseudoprobeloceeas* fall still in the Late Givetian.
Stratigraphic range and geographic distribution. Type locality and horizon. The possible occurrence of *Ps. praecox* n. sp. in southern Algeria needs further documentation.

Subfamily Acanthoclymeniinae Schindewolf, 1955 (nom. transl.)

Included genera.

Probeloceras Clarke, 1899
Acanthoclymenia Hyatt, 1900
Prochorites Clausen, 1969
Scaturites n. gen.
Geographic distribution. USA (New York State, Virginia, Maryland, Pennsylvania), SW England (South Devonshire), Germany (Rhenish Massive), ?Carnic Alps, France (Montagne Noire), ?Spain (Cantabrian Mountains), southern Morocco (Tafilalt), Poland (Holy Cross Mountains), Russia (Timan, Urals, Rudnyi Altai), South China (Guangxi, Guizhou), NW Australia (Canning Basin).
Stratigraphic range. *Scaturites* n. gen. extends the range of the subfamily into the latest Givetian; youngest members are from the Late Frasnian (see discussions in Becker & House 1993 and Becker et al. 2000).

Scaturites **n. gen.**

Derivation of name: After the Latin *scaturire* = to spring and the Greek *ites* = stone; due to its basal position within the Acanthoclymeniinae.
Type species: *Scaturites minutus* n. sp.
Diagnosis. Very small sized, smooth, earliest whorls depressed, intermediate to mature conch compressed, subevolute, with rounded venter and faint ventrolateral furrows; growth lines concavo-convex with high ventrolateral projection. Sutures with deep I lobe, widely rounded L lobe, strongly asymmetric, relative narrow and subtriangular ventrolateral saddle, incipient E_2 lobe, and narrow, deep E_1 lobe; suture formula: $(E_2E_1E_2)$L:I.
Included species.
Sc. minutus n. gen. n. sp.
?*Pseudoprobeloceras* cf. *nebechense* in Göddertz (1989)
Discussion. The markedly subtriangular saddle and wide L lobe allow a clear distinction from the contemporaneous and associated *Pseudoprobeloceras*. Both with respect to morphology (flank saddle and incipient E_2 lobe) and age, the new genus is ancestral to the Frasnian *Acanthoclymenia*. Small size is kept in most *Acanthoclymenia*.
Geographic distribution and stratigraphic range. North Africa (Tafilalt, ? Southern Algeria). (Late Givetian).

Scaturites minutus **n. sp.**

Description. Because of its restricted variability and characteristic smooth conch shape, the species can be easily identified. A change to compressed cross-section and high, eventually very high WER rates occurs in the 3rd whorl (Fig. 9J). As in *Ps. pernai*, uw/dm and ww/dm values are very similar (Fig. 9H) but hardly exceed 0.40 between 1 and 4 mm dm. There is some variability of mature ww/wh values (Fig. 9I), with paratype MB.C.22136.4 (Fig. 9C) representing slightly thicker, and paratype MB.C.22136.5 (Fig. 9D) representing thinner informal morphotypes. Ventrolateral furrows are impressed on the steinkern of paratype MB.C.22136.13 but absent in the majority of specimens (e.g., paratype MB.C.22136.8, Fig. 10B, paratype MB.C.22136.9, Fig. 10C). The smooth protoconch and ammonitella are well visible in the holotype (Fig. 10A); the latter includes less than 2/3 of a whorl. The ventrolateral saddle is narrow and subtriangular in all specimens (Figs 9F, G). Only MB.C.22136.6 shows a septal face, which lacks a clear U lobe at almost 9 mm dm (Fig. 9E). Several specimens, including the holotype, show crowding of the last septa, which is interpreted as evidendce of maturity with only four whorls (at ca. 15 mm dm).

Discussion. The new species differs by its subtriangular flank saddle, and the lack of ribbing from all species of *Pseudoprobeloceras*. The ontogenetic change near 10 mm indicates the transition to a terminal, mature whorl and suggests a micromorphic species (Marchand et al. 2002, Monnet et al. 2011). A similar stagnation of uw/dm, ww/dm and ww/wh ratios occurs in *Ps. pernai* significantly later, from ca. 20 mm dm on. Some poorly preserved (crushed) specimens described by Göddertz (1989) from the Saoura Valley as *Ps*. cf. *nebechense* display the ribbing of that species but have sutures similar to *Sc. minutus* n. gen. n. sp.; they may represent an unnamed Algerian *Scaturites* n. gen.

Stratigraphic range and geographic distribution. Type locality and horizon.

Family **Taouzitidae** Korn, 2001

***Darkaoceras* Bockwinkel, Becker & Ebbighausen, 2009**

***Darkaoceras velox* n. sp.**

1974 *Pharciceras* cf. *meridionalis*. – Bensaïd, p. 113, pl. 4, fig. 2.

Description. The new species shows some variability of conch parameters, ornament, and suture ontogeny. Typical specimens have relatively thick suboxyconic conchs with shortly rounded umbilical wall and broadly rounded flanks until ca. 25 mm dm (see paratype MB.C.22105.6, Fig. 11E). MB.C.22105.12 (Fig. 12A) is a slightly more gracile specimen that becomes oxyconic at an earlier stage than all others. Paratype MB.C.22105.2 (Fig. 11A) is more involute than the other types (see plot of three ratios between 5 and 12 mm dm below the main ontogenetic uw/dm trait in Fig. 11L) but shows the typical, wide and depressed first three whorls. The protoconch is ca. 0.6 mm in diameter (e.g., Figs 11 A-D) and followed by three markedly depressed whorls. The change from depressed cross-section with rounded venter to compressed, suboxyconic conch shape occurs within the 4th whorl at ca. 10 mm dm. Mature whorls rapidly become much higher, with very high WER values (Fig. 11N). The juvenile ribbing varies strongly between individuals. It disappears at the end of the first ontogenetic stage (between 5 and 6 mm dm) in paratypes MB.C.22105.22 and MB.C.22105.19, but is stronger, until the change to compressed whorls, in MB.C.22105.13 (Fig. 12C). Few specimens (e.g., paratype MB.C.22105.9) show weak, undulose flank ribbing in intermediate stages. There are peculiar fine radial lines on the umbilical shoulder. Paratype MB.C.22105.17 displays on only one side a narrow spiral furrow on the inner flank. The ventrolateral furrows are relatively wide (holotype, Fig. 12B, paratypes MB.C.22105.21, MB.C.22105.14, and MB.C.22105.18) or subdivided by a minor spiral elevation (e.g., paratypes MB.C.22105.16, MB.C.22105.17, and MB.C.22105.15). They weaken from ca. 15 mm dm.

Sutures show some variability of lobe and saddle shape and in the timing when elements appear or when lobes are sharpened. The second outer U lobe (U_4) appears between 9 and 13 mm dm, sometimes with a small difference on the two conch sides (e.g., in paratype MB.C.22105.21). The visible septal face in paratype MB.C.22105.7 (Fig. 11F) proves that a very shallow and small internal U_3 is present before the U_4 starts to develop. All larger specimens (e.g., the holotype and paratypes MB.C.22105.16, MB.C.22105.11, see Fig. 11K, and MB.C.22105.22) show two internal U lobes that are more pronounced than the corresponding external U lobes. The L lobe becomes pointed and sometimes dorsally recurved (e.g., paratype MB.C.22105.10, Fig. 11J) at ca. 24 mm dm. The U_1 and U_2 are subsequently sharpened and remain slightly shorter than the L lobe. The arched E_2 L saddle is the dominant suture element on the flanks. The L U_2 saddle is either subsymmetric (e.g., in the holotype and paratypes MB.C.22105.12 and MB.C.22105.9) or characteristically asymmetric, with a wider and obliquely ascending inner branch (Figs 11J-K).

Discussion. The comparison of the new species with the slightly older but closely related *D. meridionale* has to consider the differences of size and preservation. The second species is known in the Tafilalt from mature specimens with preserved shell. The most obvious difference are the thicker early whorls of *D. velox* n. sp. In juvenile *D. meridionale*, ww/dm ratios do not exceed 0.60 and ww/wh ratios barely exceed 1.50 (Bockwinkel et al. 2009). There is no cadiconic stage comparable to the 2nd and 3rd whorl of *D. velox* n. sp. At 20 mm dm, and despite mould preservation,. *D. meridionale* is also slightly more involute at maturity (uw/dm < 0.20), especially its lectotype. The mould preservation of the Hassi Nebech material does not permit a comparison of ornament details, such as ventral crenulation. There are some minor differences in the sutures. *D. meridionale* has more strongly pointed lobes at equivalent sizes, the L U_2 saddle is wider, U_4 appears somewhat later in ontogeny, in accord with its more ancestral phylogenetic position, and the L lobe always has a distinctively asymmetric shape.

D. complanatum (Petter, 1959) is even more compressed than *D. meridionale*. *D. flenderi* (Wedekind, 1918) possesses distinctive outer flank ribs. *D. acutum* (Matern, 1931) is much more involute.

Stratigraphic range and geographic distribution. Type locality and horizon.

Taouzites **Korn, 2001**

Type species. *Pharciceras taouzensis* Termier & Termier, 1950.

Included species.

Pharciceras taouzensis Termier & Termier, 1950

Sandbergeroceras acutum Termier & Termier, 1950 [= *T. taouzensis*]

Eobeloceras palentinum Yatskov, 1990

Korn & Klug (2002, 2003) also included *Pharciceras acutum* Matern, 1931 but this species was transferred to the ancestral *Darkaoceras* by Bockwinkel et al. (2009).

Discussion. Becker & House (2000a, 2000b) recognized that *Ph. taouzense* represents the type species of a distinctive index genus but left it in open nomenclature. The new knowledge of septal ontogeny (see below) shows that advanced Taouzitidae follow a different path of lobe ontogeny than typical Pharciceratidae. This requires an emendation of the sutural formula.

Geographic distribution. Northern Spain and southern Morocco.

Stratigraphic range: Latest Givetian, *Taouzites taouzensis* to *Petteroceras errans* zones.

Taouzites taouzensis **(Termier & Termier, 1950)**

1950 *Pharciceras taouzensis* Termier & Termier, p. 54, pl. 150, figs 23-27 [non pl. 150, figs 21-22, and pl. 151, figs 16-18 = *Syn. plurilobatum*; non pl. 150, fig. 28].

1950 *Sandbergeroceras acutum* Termier & Termier, p. 55, pl. 151, figs 32-33.

1959 *Pharciceras taouzensis*. - Petter, p. 141, fig. 33i, 36, pl. 9, figs 7, 7a, 11, 12, 15.

1959 *Eobeloceras* cf. *multiseptatum*. - Petter, p. 141-142, pl. 10, figs 11-12.

1974 *Pharciceras taouzense*. - Bensaïd, p. 113-114, fig. 19e, pl. 4, figs 3, 3a.

1982 *Pharciceras taouzense*. - Walliser in Ziegler & Klapper, p. 475.

non 1985 *Pharciceras taouzense*. - Henn, fig. 41, pl. 2, fig. 5 [= holotype of *T. palentinus*] .

non 1985 *Timanites* aff. *keyserlingi*. - Henn, fig. 41, pl. 1, figs 1a-c [= *T. palentinus*].

non 1986 *Timanites? taouzense*. - Montesinos & Henn, p. 71-72, 74, figs 4, 5A, 6B, 6M [= *T. palentinus*].

1993 „*Pharciceras*" *taouzensis*. - Becker & House, p. 117.

1999 *Eobeloceras taouzense*. - Belka et al., tab. 5, fig. 8.

2000a "*Pharciceras*" *taouzense*. - Becker & House, p. 31.

2000b N. Gen. 2 *taouzense*. - Becker & House, p. 53.

2001 *Taouzites taouzensis*. - Korn, p. 208.

2002 *Taouzites taouzensis*. - Korn & Klug, p. 99, figs 96C-D.

2003 *Taouzites taouzense*. - Aboussalam, fig. 14.
2003 *Taouzites taouzense*. - Korn & Klug, p. 344.
2005 *Taouzites taouzensis*. - Aboussalam & Becker, p. 5 .
2010 *Taouzites taouzense*. - Klug, p. 89, fig. 5D.

Description. The slightly depressed first three whorls that follow a small protoconch (0.6 – 0.7 mm dm) have a rounded venter. The change to a fully acute venter occurs before 10 mm dm, as early as 5.5 to 7 mm in MB.C.22106.21 and MB.C.22106.13. The flanks remain very gently rounded, the umbilical wall very short and rounded. From 20 mm dm, the fast increase of WER stops (Fig. 13M) but the mature whorls remain extremely high. The biconvex growth lines with a strongly projecting, subangular ventrolateral salient are impressed on some moulds and may cause inconspicuous, undulose flank ribbing (MB.C.22106.23). The dense, juvenile ribbing of the inner flank disappears gradually from ca. 8 mm dm. There are ca. 30 ribs/whorl at 7 mm dm in MB.C.22106.18 but only ca. 20 ribs in the similarly small MB.C.22106.17. Small specimens have distinctive single ventrolateral furrows. A second, outer and weaker spiral furrow develops between 10 (MB.C.22106.22) and 13 mm dm (MB.C.22106.19). The double furrows get weaker towards maturity (MB.C.22106.20, Fig. 14A, MB.C.22106.9, Fig. 14C).

 Two intraspecific morphotypes can be distinguished that differ in their umbilical width (Fig. 13K). More evolute specimens, such as MB.C.22106.4 (Fig. 13E) and MB.C.22106.3 (Fig. 13C), have uw/dm values > 0.40 between ca. 2 and 5 mm dm, and values > 0.20 at 20 mm dm or more. The conch ontogeny of more involute specimens, with uw/dm < 0.20 at 20 mm dm, is shown in Figs 13B (MB.C.22106.2) and by MB.C.22106.10. These two forms do not correlate with forms that have variably deep (e.g., MB.C.22106.7, Figs 13I-J, MB.C.22106.4, Fig. 13F) or short E_2 lobes (MB.C.22106.5, Fig. 13G, and MB.C.22106.6, Fig. 13H). Fig. 13K illustrates the presence of intermediates between both morphotypes.

As mentioned above, the most obvious suture variability concerns the relative depth of the neighbouring E_2 and L lobes. Specimens with short E_2 lobes may falsely leave the impression that there are three external lobes, as has been claimed in the unrelated *Eobeloceras*. As in all members of the Taouzitidae, the ventrolateral E_2 L saddle is the largest and dominant outer suture element. The L lobe can be symmetric and lanceolate (MB.C.22106.7, Figs 13I-J) or asymmetric and dorsally incurved (MB.C.22106.6, Fig. 13H). The dorsolateral L U_2 saddle may be higher (MB.C.22106.7) or lower (MB.C.22106.4 and MB.C.22106.6) than the E_2 L saddle. The height of the dorsolateral saddles decreases towards the umbilicus. Fig. 13D illustrates a typical mature septal face with eight U lobes, only three of them on the dorsal side, of a specimen from Ouidane Chebbi (eastern Tafilalt). During septal ontogeny the external U_4 lobe appears between 8 and 10 mm dm, followed "irregularly" by an external U_5 lobe between 13 and 18 mm dm, the internal U_6 lobe at 17-18 mm dm, the external U_7 lobe rather variably between 20 and 30 mm dm, and, again "irregularly", by the shallow external U_8 lobe at ca. 30 mm dm (MB.C.22106.7). The sharpening of the lateral lobe occurs at 11 (MB.C.22106.5, Fig. 13G) to 15 mm dm, that of the U_2 lobe at 13 to 20 mm dm, and that of the small U_4 lobe at 20 (MB.C.22106.6, Fig. 13H) to 25 mm dm (MB.C.22106.16). The U_2 and U_4 lobes are also narrow and pointed at maturity. The E_1 lobe is often slightly displaced to one conch side. Septal crowding occurs in some individuals. The median saddles are still very low and small until 7 mm dm. Many specimens are broken at septa, which makes it possible to follow the internal suture ontogeny and to confirm that the internal U_6 lobe is formed later than the outer U_5 lobe, reversing the regular alternation known from the associated Pharciceratidae

Discussion. Montesinos & Henn (1986) gave the authorship of the species to Petter (1959), which was corrected by Korn & Klug (2002). The bulk sampling at Hassi Nebech does not allow to judge whether the two recognized morphotypes may have a different distribution within the succession. Material collected bed-by-bed from other Tafilalt localities (e.g., from Ouidane Chebbi) will be used in future to follow that question.

The cross-section and suture illustrated by Termier & Termier (1950) for a Tafilalt specimen (Clariond Collection) named as *Sandbergeroceras acutum* are clearly identical with *T. taouzensis*. The median and ventrolateral saddles are especially characteristic and the four outer U lobes are also in agreement. The calcareous facies of the Tafilalt Platform yielded some fragments that suggest that the species could reach giant size (more than 20 cm dm). Medium-sized fragments from the Saoura Valley were misidentified by Petter (1959) as *Eobeloceras* cf. *multiseptatum*. The poorly known Cantabrian *T. palentinus* is slightly thicker at late maturity (ww/wh = ca. 0.6 in the 5th whorl, < 0.5 in *T. taouzensis*) and has wider flank saddles. It seems to lack a outer U_8 lobe, even at 78 mm dm (Montesinos & Henn 1986).

Stratigraphic range. *Taouzites taouzensis* to *Petteroceras errans* zones (Aboussalam 2003).

Geographic distribution. Southern Morocco (Tafilalt, Maider) and southern Algeria (Saoura Valley).

Suborder **Pharciceratina** Korn, 1998
Superfamily **Pharcicerataceae** Hyatt, 1900
Family **Pharciceratidae** Hyatt, 1900

Subfamily Pharciceratinae Hyatt, 1900

Pharciceras **Hyatt, 1884**
Included species.
Goniatites tridens Sandberger & Sandberger, 1850
(= *Sphaeropharciceras sandbergerorum* Bogoslovsky, 1955)
Goniatites amplexus Hall, 1886
Prolecanites lateseptatus Frech, 1902
Pharciceras galeatum Wedekind, 1918
Pharciceras Kayseri Wedekind, 1918
Pharciceras bidentatum Petter, 1959
Pharciceras pargai Montesinos & Henn, 1986
Pharciceras barnetti Work et al., 2007
Pharciceras darkaouense Bockwinkel, Becker & Ebbighausen, 2009
Pharciceras evolvens Bockwinkel, Becker & Ebbighausen, 2009
Pharciceras decoratum n. sp.
Pharciceras fornix n. sp.
Pharciceras involutum n. sp.
Pharciceras subconstans n. sp.
Pharciceras aff. *P. amplexum* in Ziegler & Klapper (1982)
Pharciceras aff. *galeatum* in House et al. (1985)
Pharciceras aff. *lateseptatum* in Bockwinkel et al. (2009)
Pharciceras aff. *tridens*
Ph. applanatum Bensaïd, 1974 is here transferred to *Extropharciceras*.
Discussion. For a recent emendation and discussion of the genus see Bockwinkel et al. (2009). Strong ribbing is the main characteristic of the Triainoceratidae, which share the phylogenetic and ontogenetic proliferation of umbilical lobes with the Pharciceratidae. The recognition of distinctive ribbing in most juvenile pharciceratids requires a revision of the definition of the Triainoceratidae, which are thought to have evolved in parallel (Becker & House 1993; also exemplified by the recognition as distinctive superfamily in Korn & Klug 2002 and Monnet et al. 2011).

Pharciceras decoratum **n. sp.**

Description. The strongly cadiconic, widely evolute whorls have higher uw/dm than ww/dm ratios between 3 and 20 mm dm. There is clearly some variation in whorl width, with paratype MB.C.22107.2 (Fig. 15A) representing a narrow and paratype MB.C.22107.3 (Fig. 16C) representing a wider morphotype. The maximum relative umbilical width (> 0.60) and ww/wh ratios (> 2.00) are reached between 8 and 15 mm dm (Fig. 15E). The slightly flattened venter becomes better rounded from ca. 18 mm dm; the umbilical wall is moderately deep and rounded. The characteristic ribs appear early in post-embryonic ontogeny and fade between 11 (MB.C.22107.7, Fig. 16D) and 13 mm dm (paratype MB.C.22107.2). They are straight to convex on the short flanks and project sharply forward on the outer part of the ventrolateral shoulders. They disappear before the ventrolateral furrows that run spirally in the position of the outer half of the ventral saddles of the sutures. The presence of double furrows is evident in well-preserved specimens (e.g., paratype MB.C.22107.2). At 12.5 dm (MB.C.22107.6, MB.C.22107.2) there are ca. 55 ribs on the last whorl but there are less than 40 ribs on the whorl before 9 mm dm in MB.C.22107.7.

Fig. 15B depicts the septal face of the holotype, which only shows three U lobes. In other specimens, the subumbilical U_4 lobe appears between 11 (asymmetrically on only one side of MB.C.22107.3; Fig. 15C, therefore, shows only one outer U lobe) and 13 mm dm (MB.C.22107.6). At this stage the E_1 lobe is still deeper than the adjacent E_2 lobes. There is a stepwise shortening of lobes from the venter to the umbilicus in MB.C.22107.4 (Figs 15D, 16A).

Discussion. The new species closely resembles the slightly older *Ph. evolvens* but shows a different and peculiar ontogenetic trait. Especially distinctive is the lack of a marked biphasic trend in whorl width (ww/wh) and WER values (compare Bockwinkel et al. 2009, figs. 8E-F). Ww/dm ratios show a minimum at 7-8 mm dm, which is the interval of widest whorls in *Ph. evolvens*. Both species share uw/dm values that exceed the ww/dm ratios but this trend is reversed, with crossing plots (Fig. 15E), only in *Ph. decoratum* n. sp. The new species also has stronger ribs in the inner whorls. MB.C.22107.6 and MB.C.22107.7 plot below the main ontogenetic trait of uw/dm (Fig. 15E) but not in the field of any other named pharciceratid. Their ww/dm ratio is too low for *Ph.* aff. *tridens* (see below). They are currently included as variants in the new species but not designated as paratypes.

The early stages of *Ph. galeatum* Wedekind, 1918 are somewhat similar (evolute and ribbed, uw/dm = ca. 0.5 and ww/wh = 1.70 to 1.80 at ca. 25 mm dm; based on notes on its holotype by the late M. R. House). But this species has an U_4 lobe sitting on the umbilical seam and a very distinctive conch ontogeny with a very rapid change to high, (sub)oxyconic mature whorls. Based on its lectotype from Mdoura in the western Tafilalt (Petter, 1959: pl. 7, figs 11, 11a; wrongly identified as holotype in Bensaïd, 1974), the poorly known *Ph. bidentatum* has similar conch parameters but keeps a spike-like, very deep E_1 lobe until maturity (at least until ca. 27 mm dm). It is not a junior synonym of *Ph. tridens*, as suggested by Bensaïd (1974).

Stratigraphic range and geographic distribution. Type locality and horizon.

Pharciceras aff. *tridens* (Sandberger & Sandberger, 1850)

Description. The seven Hassi Nebech specimens show a peculiar conch ontogeny that combine characteristics of *Ph. evolvens* and *Ph. tridens*. The early to intermediate stages are cadiconic (MB.C.22108.1, Fig. 17A), widely evolute, with ww/wh values that sharply rise in the first five whorls (until ca. 8 mm dm) to ca. 2.50, then falling equally sharply until 25 mm dm down to ca. 1.50. This strongly biphasic trend in post-embryonic whorls can also be seen, more weakly, in the ww/dm, uw/dm, and WER plots. Maximum uw/dm ratios of 0.60 are reached between 8 and 10 mm dm. Between ca. 3 and 12 mm they exceed the ww/dm values but in median stages (12-15 mm dm) they drop more sharply than the latter, which peak at 0.60 between 12 and 20 mm dm. At 12.5 mm dm there are 5 ½ post-embryonic whorls in MB.C.22108.4. The slightly coiled protoconch has a maximum diameter of ca. 0.7 mm and is followed by half an embryonic whorl. Subsequently there are

distinctive ribs on the short flanks, which fade gradually between 12 and 16 mm dm (MB.C.22108.3, Fig. 18A, MB.C.22108.2). At ca. 7 mm dm there are ca. 35 ribs on the preceeding whorl (MB.C.22108.5, Fig. 18C), but subsequent whorls have denser and weaker ribing (ca. 55 ribs on the whorl prior to 12 mm dm in MB.C.22108.3). Ventrolateral double furrows are visible on MB.C.22108.5 as early as at 6 mm dm. They are also distinctive in MB.C.22108.4 (Fig. 18B). The fading ribbing of MB.C.22108.3, which is concave on the flanks, suggests strongly biconvex growth ornament.

A characteristic outer suture is illustrated in Fig. 17C. MB.C.22108.3 and MB.C.22108.2 display a septal face with the two internal U lobes, in MB.C.22108.2 with a small plurilobe (see Fig. 17B). The outer U_4 lobe appears ca. at 12 mm dm (MB.C.22108.3). Subsequently the E_1 lobe is gradually shortened and not much deeper any more than the adjacent E_2 lobes.

MB.C.2208.01 is a small specimen with typical conch shape and ribbing that displays asymmetrically on both sides between the U_2 and incipient U_4 lobes an additional small lobe that is here interpreted as an irregular plurilobe. Another fragmentary specimen (MB.C.22108.7) with ca. equal uw/dm and ww/dm ratios at ca. 21.5 mm dm shows on the umbilical wall of one side a third, very shallow lobe while there are only two internal U lobes. In this case a plurilobe in the U_3 U_4 saddle, just outside the seam, is assumed.

Discussion. This Hassi Nebech forms is intermediate between *Ph. evolvens* and *Ph. tridens* and may represent a new species or subspecies. However, since the intraspecific variability of both taxa is not yet well established, it seems premature to establish a new taxon and open nomenclature is preferred. The comparison of the cross-section of MB.C.22108.1 (Fig. 17A) with those of the two named species (Bockwinkel et al. 2009, figs 6B and 8B) or with the ontogenetic plots for both clearly illustrates the differences. In *Ph. tridens* and *Ph. barnetti*, the uw/dm remains below the ww/dm ratio throughout the ontogeny and early stages are markedly wider. Ww/wh values of 1.50 are reached at ca. 35 mm (25 mm dm in aff. *tridens*). The original description of *Ph. tridens* mentions only indistinctive, falcate, relative widely spaced growth lirae, which are shown on the original illustration of the lectotype (Sandberger & Sandberger 1850: pl. 4, figs 2a, 2d). This gives another distinction of the ribbed Hassi Nebech specimens. The holotype of *Ph. evolvens* maintains narrower whorls toward maturity and, consequently, higher uw/dm than ww/dm ratios. The latter never reach 0.60, as they do in aff. *tridens*. The sutures of the Hassi Nebech form are closer to *Ph. tridens* than to *Ph. evolvens,* which shows a strongly ascending lobe depth from the outer flank to the umbilicus.

Ph. decoratum n. sp. has more strongly ribbed and thinner inner whorls between 5 and 15 mm dm; the whorl width follows a different ontogenetic path without clear increase and decrease before and after 10 mm dm. All other known species of the genus are more involute.

Pharciceras lateseptatum Frech, 1902

1902a *Prolecanites lateseptatum* Frech, p. 65, pl. 3, figs 11a-c.
2009 *Pharciceras lateseptatum*. - Bockwinkel et al., p. 81-84, figs 9, 10A-B, J, tabs 11-12 [further synonymy].

Description. The large Hassi Nebech collection suggests that there is considerable intraspecific variability in conch ontogeny and ornamentation within *Ph. lateseptatum*. Differences of uw/dm and ww/wh ratios characterize two morphotypes (I and II), which are shown in separate figures and conch parameter plots (Figs 19F-H and 21D-F). Morphotype I (Figs 20A-C, typical cross-sections in Figs 19A-D) has rather widely evolute early whorls (uw/dm = ca. 0.50) until ca. 8 mm dm that are strongly depressed (ww/wh = 2.2-2.4). At the same size Morphotype II (Figs 20D-G, cross-section of MB.C.22109.12 in Fig. 21A) is slightly less evolute and strongly to very strongly depressed (ww/wh = > 2.50), with steeper and deeper umbilical walls. Consequently, the latter has half of a whorl less than in Morphotype I from ca. 15 mm dm on (compare cross-sections in Figs 19 and 21).

The ontogenetic development of ornament and sutures does not differ between the two morphotypes. Subsequent to a smooth ammonitella, early whorls possess weak to strong umbilical ribs that are replaced at 8 to 14 mm dm by dense (60 – 80 per whorl), falcate, sometimes bundled growth lirae (e.g., MB.C.22109.17 and MB.C.22109.6, relatively involute Morphotype I, Fig. 20B; MB.C.22109.10, Morphotype II, Fig. 20F). Before they finally disappear they turn into very low, undulose umbilical nodes (MB.C.22109.22, Morphotype II). At 6.5 mm dm, there are 18 ribs on the previous whorl in MB.C.22109.11 (Morphotype II, Fig. 20G). Ribs and lirae terminate on the venter at the inner spiral of ventrolateral double furrows (e.g., MB.C.22109.10, Fig. 20F). These rarely form a ventral edge (at 17 mm dm in MB.C.22109.5, Morphotype I) and mostly disappear gradually between 15 (MB.C.22109.20, Morphotype II; compare MB.C.22109.8, Fig. 20D) and 25 mm dm (MB.C.22109.16, Morphotype I). However they are still strong at 27 mm dm in MB.C.22109.5 (Morphotype I). MB.C.22109.21 (Morphotype I) displays healed shell fractures on opposing whorl sides.

All specimens show outer sutures. Inner lobes are visible on many septal faces, for example in the juveniles MB.C.22109.7 (Morphotype I) and MB.C.22109.9 (Morphotype II). A third U lobe develops just inside the umbilical seam at 10 (MB.C.22109.18, Morphotype II) to 14 mm dm (MB.C.22109.23, Morphotype I). MB.C.22109.12 (Morphotype II, Fig. 21C) shows that the U_3 extends to the umbilical seam at 13 mm dm. An outer U_4 appears between 15 (MB.C.22109.5, Morphotype I; see subsequent suture in Fig. 19E) and 20 mm dm (MB.C.22109.15, Morphotype I). Until ca. 6.5 mm dm, the E_2 lobe is still only a flexure within the large, diverging E_1 lobe (MB.C.22109.11, Morphotype II). There is considerable variability when the median, subparallel to slightly diverging E_1 is shortened. It is deeper than the E_2 lobe until 25 mm dm in MB.C.22109.5 (Morphotype I, Fig. 19E) but only as deep as the E_2 at 14 mm dm in MB.C.22109.23 (Morphotype I). The body chamber length may have reached a full whorl (at 13 mm dm in MB.C.22109.10, Morphotype II).

MB.C.22109.3 (Morphotype I, septal face in Fig. 19C) shows an incipient plurilobe in the subumbilical $U_2 U_4$ saddle, episodically even on both sides. It may be mistaken for an early ontogenetic additional U lobe and *Extropharciceras* affinities of the specimen. However, the plurilobe disappears towards the end of the last whorl and leaves no traces on the adoral septal face. MB.C.22109.25 (Morphotype I) displays on one side a small depression (plurilobe) on the inner flank of the $U_4 U_2$ saddle but on the other side an additional lobe at the seam. MB.C.22109.24 (Morphotype I) has a very shallow plurilobe just outside the umbilical seam, in the $U_4 U_3$ saddle. In both MB.C.22109.25 and MB.C.22109.24, the terminal septal face proves the presence of only two internal U lobes. Fig. 21B illustrates a very small plurilobe in the $U_2 U_4$ saddle only on one side of MB.C.22109.13 (Morphotype II).

Discussion. The Hassi Nebech collection considerably expands the intraspecific variability recognized within the species. Consequently, the species diagnosis that was only recently revised in Bockwinkel et al. (2009) has to be further emended. Morphotype I includes all the representatives described from Dar Kaoua but also slightly thicker forms. It is remarkable that Morphotype II has not yet been found in the *Synpharciceras clavilobum* Zone. Also, the more common co-variation within ammonoid species consists of thinner, more involute specimens on one side and on thicker, more evolute ones on the other side of a spectrum (e.g,. in the early Famennian *Paratorleyoceras globosum*, Becker 1993; part of "Buckman´s Law of Co-variation" of Westermann 1966 for Mesozoic forms). It keeps more or less identical conch volumes if the body chamber length is constant (compare the extreme case described by Dagys & Weitschat 1993).

There is not much intergradation towards *Ph. tridens* with uw/dm > 0.50 until 20 mm dm. Only MB.C.22109.10 is slightly intermediate, but with uw/dm values of 0.48 at ca. 14 mm dm, it is assigned to *Ph. lateseptatum* Morphotype II. *Ph*. aff. *lateseptatum* of Bockwinkel et al. (2009) lies outside the wide variability field of *Ph. lateseptatum* established here and, with the discovery of additional material, should be assigned to a new species. The North American *Ph. barnetti* keeps a wider umbilicus towards maturity (Work et al. 2007)

Stratigraphic range. *Synpharciceras clavilobum* to *Taouzites taouzensis* zones possibly ranging lower.
Geographic distribution. Southern France (Montagne Noire) and southern Morocco (Tafilalt).

Pharciceras fornix n. sp.

1974 *Pharciceras* cf. *applanatum*. - Bensaïd, pl. 3, figs 8, 8a,
cf. 2009 *Pharciceras pargai* Morphotype III. - Bockwinkel et al., p. 86-90, tabs 15-16, figs 10I, 14A-F.

Description. The new species is characterized by its well-rounded, pachyconic to subglobular and relatively involute, low whorls. The uw/dm values hardly exceed 0.40 and the ww/wh values drop rapidly between 10 and 20 mm dm. The inner flanks of the post-embryonic whorls bear short ribs, which gradually become falcate and dense, before they finally disappear or fade into very low, undulose umbilical nodes (paratype MB.C.22110.9, at 12.5 mm dm, and MB.C.22110.5). The ornament terminates at the inner spiral of ventrolateral double furrows that disappear gradually until 23 mm dm (holotype, Fig. 23B).
Inner lobes are visible on septal faces, e.g., in the median stages of the holotype, in paratype MB.C.22110.3 (Fig. 22C), and in paratype MB.C.22110.4 (Fig. 22D). The outer U_4 lobe appears between 16.5 (paratype MB.C.22110.10) and ca. 21 mm dm (holotype MB.C.22110.1). It is still lacking at 5.4 mm wh in paratype MB.C.22110.5 (Fig. 22E) but incipient at 6.1 wh in paratype MB.C.22110.6 (Fig. 22F). The shortening of the E_1 lobe in relation to the E_2 lobe occurs between 18 (holotype MB.C.22110.1; see subsequent suture in Fig. 22H) and 25 mm dm (paratype MB.C.22110.10). The E_2 becomes lanceolate in some specimens, slightly before the L lobe becomes pointed (before 10.5 mm in paratype MB.C.22110.4, Fig. 22G; between 23 and 27 mm dm in paratype MB.C.22110.9).

Discussion. *Ph. fornix* n. sp. is constantly more involute than the closely related *Ph. lateseptatum*. There are no intermediate specimens that are difficult to assign to either of the two taxa. *Ph. pargai* Morphotype III in Bockwinkel et al. (2009) was based on a single, morphologically somewhat isolated specimen from Dar Kaoau. Its conch parameters plot in the narrowly umbilicate part of the variability field of *Ph. fornix* n. sp. However, it keeps very strong ventrolateral double furrows until ca. 35 mm dm. Therefore, it is currently assigned with a cf. to the new species. *Ph. pargai* is more compressed (ww/wh = 1.70-1.80 at 10 mm dm, ca. = 1.30 at 20 mm dm; 2.10-2.40 and 1.50 at the respective diameters in *fornix* n. sp.) and more involute throughout ontogeny. A comparison of typical uw/dm and ww/wh values in related *Pharciceras* species, which allows easy identification, is given in Table 18. A specimen illustrated in Bensaïd (1974) as *Ph.* cf. *applanatum,* reillustrated here in Fig. 23D, is a typical *Ph. fornix* n. sp. *Ph. decoratum* n. sp., *Ph. evolvens, Ph. tridens, Ph. amplexum*, and *Ph. barnetti* are more evolute.
Stratigraphic range and geographic distribution. Type locality and horizon. A cf. specimen was previously described from the *Synpharciceras clavilobum* Zone of Dar Kaoua (Bockwinkel et al. 2009).

Pharciceras subconstans n. sp.

Description. The rather unique characteristics of the species became evident when the holotype was sectioned. Remarkable are the rather constant (almost isometric) ontogeny of whorl widths (Figs 24A, E-F), the only slight changes of the rather narrow umbilical width, and the subconstant, for *Pharciceras* relative high WER (Fig. 24G). The umbilical wall is deeply rounded and there are only

shallow ventrolateral furrows beneath the broadly rounded venter. In paratype MB.C.22111.2, the last half whorl is squashed.

There is no external U_4 lobe in the holotype at the largest preserved diameter and the wide L lobe and small saddle towards the umbilicus suggest a relatively primitive *Pharciceras* suture, in contrast with the derived conch ontogeny. In paratype MB.C.22111.2 the U_3 lobe seems to form directly at the umbilical seam (Fig. 24D).

Two specimens, MB.C.22112.1 and MB.C.22112.2, share a primitive suture (Fig. 24C) and rather narrow umbilicus at small size but appear to have lower and more whorls than the *subconstans* holotype. These are currently identified as *Ph.* cf. *subconstans*. MB.C.22112.1 has 55-60 falcate growth lirae on the inner flanks of the whorl before 10 mm dm (Fig. 25B), resembling the sculpture of *Ph. lateseptatum*. Both specimens have also well-defined ventrolateral furrows and show septal faces with the internal U_3 (for MB.C.22112.1 see Fig. 24B)

Discussion. The conch of *Ph. subconstans* has an ontogenetic trait that differs from almost all other known *Pharciceras* species. The only related species is *Ph. kayseri* with even faster whorl expansion, a constant umbilical width ratio of ca. 0.30, and with more compressed whorls. It could be argued to place both species in a different genus. *Ph. kayseri* also has wider saddles than other pharciceratids at maturity, a feature which cannot be discerned from the two submature *Ph. subconstans* n. sp.
Stratigraphic range and geographic distribution. Type locality and horizon.

Pharciceras involutum n. sp.

Description. Most characteristic are the narrow umbilicus and the tegoid cross-section (Fig. 26A) with moderately high whorls (WER ca. 1.90) and marginal edges. Strong ventrolateral furrows continue on the body chamber, which displays a peculiar, single, oblique furrow (Fig. 26A). Two sutures are preserved, one of which is illustrated in Fig. 26B. The flank saddles are rather wide for the genus and family.

Discussion. The holotype is incomplete but so distinctive that it is sufficient to form the basis for a new taxon.The compressed cross-section and narrow umbilicus differ from any other described species of the genus. The ascending depth of the outer lobes, rather wide flank saddles and ventrolateral edges are also distinctive and suggest relationships with the more evolute *Ph. kayseri*. The rather regular course of the single furrow suggests a shell varix and speaks against the interpretation as a random burrow. However, shell varices are so far unknown in other pharciceratids.
Stratigraphic range and geographic distribution. Type locality and horizon.

Extropharciceras Bockwinkel, Becker & Ebbighausen, 2009

Included species.
Goniatites Becheri v. Buch, 1832 (nom. dub.)
Pharciceras arenicum Petter, 1959
Pharciceras arenicum var. *carinata* Petter, 1959
Pharciceras applanatum Bensaïd, 1974 (here re-assigned)
Pharciceras sp. A in Montesinos & Henn (1986)
Extropharciceras conex Bockwinkel et al., 2009
Extropharciceras librum Bockwinkel et al., 2009
Extropharciceras n. sp. 1 (from Dar Kaoua = *Ex. arenicum* in Bockwinkel et al. 2009)
Extropharciceras n. sp. 2 (from Hassi Nebech)

Stratigraphic range and geographic distribution. Late Givetian of Germany (Rhenish Massive), southern France (Montagne Noire), southern Morocco (Tafilalt, Maider), and southern Algeria (Ougarta).

Extropharciceras arenicum (Petter, 1959)

*e.p. 1959 *Pharciceras arenicum* Petter: 138-139, text-fig. 33B, 34, pl. 7, figs 9, 9a, pl. 9, figs 3, 3a [non pl. 7, figs 6-8]

?   1980 *Pharciceras arenicus* Bultynck & Hollard: 24

?   1981 *Pharciceras arenicus* Bultynck & Jacobs: text-fig. 4 [= Bultynck & Hollard record]

non 1985 *Pharciceras arenicum* House et al. : 5, fig. 4A-D,

?   1999 *Pharciceras* cf. *arenicum* Belka et al.: text-fig. 8 [not illustrated or figured]

v non 2009 *Extropharciceras arenicum* Bockwinkel et al.: 101-104, text-fig. 20, tabs. 25-26, figs 18A, 18C [= *Extropharciceras* n. sp. 1]

Description. The very distinctive conch ontogeny, with constantly reduced ww/dm, uw/dm, and ww/wh values between 4 and 20 dm is illustrated in two cross-sections (Figs 27C-D). There is some variability of mature umbilical width and whorl expansion rate (Fig. 27L). A rather high mature whorl profile (e.g., MB.C.22114.1, Fig. 28B), in comparison with many other pharciceratids and extropharciceratids, is typical. The umbilical wall is gently rounded. Early stages (3rd to 5th whorl) of typical representatives display only a weak umbilical ribbing, which appears to be completely absent in MB.C.22114.13 and MB.C.22114.14. MB.C.22114.8 possesses weak biconvex lirae until ca. 14 mm dm. Ventrolateral double furrows may be prominent until 10 (MB.C.22114.15) to 14 mm dm (MB.C.22114.9) but disappear in intermediate stages, latest at 19 mm dm (MB.C.22114.6, Fig. 28A). There is considerable intraspecific variability when individual lobes become pointed. The L lobe normally becomes lanceolate slightly earlier than the E_2 lobe, between 14 and ca. 21 mm dm. The same variation applies to the U_2 lobe. The shortening of the E_1 lobe occurs between 12 and 14 mm dm (compare Fig. 27F). The outer U_4 lobe is initiated at ca. 8 mm dm (ca. 3 mm wh), the internal U_5 (visible on septal faces) at 14-15 mm dm (MB.C.22114.11) and it is fully developed before 18 mm dm in MB.C.22114.5 and MB.C.22114.9. A small outer U_6 lobe is established between ca. 15 and 18 mm dm, just slightly later than the U_5, in several specimens (e.g., MB.C.22114.8, MB.C.22114.5, see Fig. 27F). However, it is lacking in less advanced morphotypes, at least until ca. 25 mm dm, in MB.C.22114.1 (septal face in Fig. 27A, G and 28A) and MB.C.22114.3, whilst the U_5 is present. Fig. 27B illustrates the septal face of MB.C.22114.2, with a more pronounced inner U_5 than the outer U_6 at 32 mm dm. MB.C.22114.6 (Figs 27H and 28A) shows a small plurilobe in all lateral saddles of the last preserved whorl but restricted to just one side of the specimen. An asymmetric incipient plurilobe occurs in MB.C.22114.1 on one side in the U_2 U_4 saddle between 17.5 mm dm at the end of the last preserved whorl (Fig. 28B).
An even later appearance of the third inner and outer U lobes has to be postulated for MB.C.22115.1 and especially for MB.C.22115.2, which shows a septal face with a total of only four U lobes at 30.5 mm dm. Two fragmentary specimens preserved in light-grey micrite also have only two outer U lobes at ca. 33 mm dm. MB.C.22139.1 (Fig. 28D) shows three well-developed internal U lobes (Fig. 27I). The compressed and high cross-section of MB.C.22139.2 (Fig. 27E) provides conch parameters that are within the variability of mature *Ex. arenicum*. With respect to their more primitive sutures, all are identified as *Ex.* cf. *arenicum*.

Discussion. Bockwinkel et al. (2009) recognized different ontogenetic traits in several specimens from the "Lower Marker Bed" identified as *Ex. arenicum* and the relative strong conch compression in Algerian types of the species. They discussed the possibility that there are several similar taxa, which should be tested by the ontogenetic morphometry and variability of material from different strata and

localities. The Hassi Nebech material includes two clearly separate species that resemble different *arenicum* syntypes but both are distinctively different from the two older *arenicum* morphotypes of Bockwinkel et al. (2009) from Dar Kaoua. It is unfortunate that the ontogenetic morphometry of Erg el Djemel *arenicum* types is currently unknown but the lectotype shows the small umbilicus and relative high WER ratio of the more involute Hassi Nebech forms. Consequently these are assigned to *Ex. arenicum*, at least until a detailed revision of Algerian material. The latter included originally two specimens (Petter´s pl. 7, figs 7-8) with pronounced ventrolateral furrows in intermediate stages, which may represent yet another taxon. Based on the presence of *Pseudoprobeloceras* at the Erg el Djemel type locality, the recognition of *Ex. arenicum* at Hassi Nebech is supported by the identical age of both faunas. The previously supposed *arenicum* representatives from the "Lower Marker Bed" of the Tafilalt have to be re-assigned to a new species (*Extropharciceras* n. sp. 1), which formal naming is deferred to the planned description of contemporaneous additional material from other Tafilalt localities.

The peculiar conch ontogeny of (Hassi Nebech) *Ex. arenicum*, especially its nearly constant decline of umbilical width from earliest stages on, is not matched by any other known *Extropharciceras*. It does not belong to the same species group as *Ex. conex* (generotype), *Ex. librum*, and *Ex. applanatum*, which have a markedly biphasic ontogenetic trait of umbilical width. This may become important for a possible future subdivision of the genus. Small specimens of *Ex. arenicum* without third internal or external U lobes as well as the specimens identified as *Ex.* cf. *arenicum* cannot be confused with *Ph. pargai* since they are more involute and compressed than the latter and have more rapidly expanding whorls. A variable onset of the U_6 has been noted by Bockwinkel et al. (2009) in other species of *Extropharciceras*. Material from other Tafilalt localities has to settle the question of a species closely related to *Ex. arenicum* that keeps just two outer U lobes throughout its ontogeny.

Stratigraphic range. *Taouzites taouzensis* Zone.

Geographic distribution. Southern Morocco (Tafilalt) and southern Algeria (Ougarta). Bockwinkel et al. (2009) noted that supposed Montagne Noire representatives described by House et al. (1985) are not even congeneric. Montesinos & Henn (1986) negated an earlier record by Henn (1985) from the Cantabrian Mountains, which falls in *Pharciceras*.

Extropharciceras applanatum Bensaïd, 1974

1959 *Pharciceras arenicum*. - Petter. p. 138-139, text-fig. 33B, 34, pl. 7, figs 6 [only].
1974 *Pharciceras applanatum* Bensaïd, p. 111-112, fig. 19a, pl. 4, figs 7, 7a, 10.
non 1974 *Pharciceras* cf. *applanatum* Bensaïd, pl. 3, figs 8, 8a [= *Ph. lateseptatum* Morphotype III].
non 1985 *Pharciceras arenicum*. - Henn, p. 91, fig. 41, pl. 1, fig. 4 [see Montesinos & Henn 1986].
non 1986 *Pharciceras applanatum*. - Montesinos & Henn, p. 66, figs 4, 5D, 6K, 6N [?=*Ph. pargai*].
2002 *Lunupharciceras applanatum*. - Korn & Klug, p. 142.
2003 *Lunupharciceras applanatum*. - Korn & Klug, p. 346.
2007 *Pharciceras applanatum*. - Work et al., tab. 1.
non 2010 *Pharciceras applanatum*. - García-Alcalde, p. 48 [= Montesinos & Henn record].

Description. Conch ontogeny, with distinctive ontogenetic changes from serpenticonic first whorls to cadiconic medium stages and to slightly compressed, tegoid mature conches. Based on a more gradual or rapid change, two morphotypes are separated. Morphotype I includes Bensaïd´s types and the majority of specimens (Fig. 29). After a marked ontogenetic change in uw/dm, ww/wh, and WER ratios (Figs 29I-K) near 7 mm dm, the transition from depressed to compressed conch shape occurs at ca. 25 mm dm (Fig. 29J), within the 8th whorl (e.g., MB.C.22116.2, Figs 29B). The umbilical wall, flanks and venter become gently rounded. Depending on the position of the section through the ammonitella, there are six (MB.C.22116.3, Fig. 29C) or seven (MB.C.22116.4, Fig. 29D, MB.C.22116.2, Fig. 29B) whorls at 16-17 mm dm. Submature specimens show nine whorls

(MB.C.22116.2, Fig. 29E). Ventrolateral furrows are distinctive at 10 mm dm but gradually disappear, at 17-18 mm dm (MB.C.22116.5 and MB.C.22116.18). The holotype possesses subangular ventral shoulders (Fig. 30A), which are more rounded in the Bonn paratype and in new mature topotypes. The first two whorls are smooth. Whorls three to five have distinctive, slightly convex ribbing on the umbilical wall, changing into finer, falcate lirae on the sixth whorl. There are more than 50 lirae on the whorl before 10 mm dm in MB.C.22116.6 (Fig. 30C). Few specimens (MB.C.22116.20, MB.C.22116.18) display lirae of the lower flanks until 17-18 mm dm.

Morphotype II is best represented by MB.C.22116.14 (Fig. 31A). It shows a much more abrupt change from low, broadly depressed to high and rapidly expanding whorl form. The main ontogenetic turning point occurs earlier, at 5-6 mm dm (Figs 31D-F). There are no differences in ornament or furrows. The suture ontogeny of *Ex. applanatum* shows considerable variation in timing when lobes are deepened or sharpened. An internal U_3 lobe is visible at 13-14 mm dm on septal faces of MB.C.22116.17 (Morphotype I). The outer U_4 lobe appears between 10 and 14 mm dm (e.g., MB.C.22116.19, Morphotype I). An internal U_5 lobe has been observed at 25 mm dm in MB.C.22116.10 (Morphotype I) but it develops later, at ca. 32 mm dm, in MB.C.22116.5 (Morphotype I), and earlier in a cf. specimen (MB.C.22117.1, ca. 7.5 mm wh, see septal face in Fig. 31B). Fig. 29A displays the septal face of MB.C.22116.1 (Morphotype I) with five U lobes at ca. 16.1 mm wh; its suture is depicted in Fig. 29H. An incipient outer U_6 lobe is initiated variably between 30 (MB.C.22116.5, Fig. 29F) and 40 mm dm (MB.C.22116.9; both Morphotype I). It is asymmetrically developed in the last few septa on one side of the holotype (at ca. 33 mm dm) but completely absent in the Bonn paratype (at ca. 32 mm dm). For Morphotype II an incipient third outer U lobe is shown by MB.C.22116.15 at ca. 35 mm dm (14 mm wh, Fig. 31C). Two specimens of Morphotype I seem to violate the alternating mode of umbilical lobe formation in the Pharciceratidae by showing an incipient third outer U lobe between 22 (MB.C.22116.18) and 25 mm dm (MB.C.22116.16), just outside the seam, but lacking a third internal U lobe. In MB.C.22116.16 this feature occurs asymmetrically only on one side, which suggests a pathological origin, perhaps by a slight torsion of the soft body during septal secretion. There are two specimens of Morphotype I with an episodic plurilobe on one side in the $U_2 U_4$ saddle. This feature is distinctive in MB.C.22116.10 between 6 and 10 mm wh and indistinct between 5 and 6.5 mm wh in MB.C.22116.18.

Discussion. Bensaïd (1974) over-emphasized the mature flattening of the venter, especially in paratype STIPB-Bensaïd-39 (old: GPI Bo 39) that has better rounded whorls than shown in his fig. 19a$_1$. More importantly, he neglected the well-developed third internal U lobe and incipient U_6 of the holotype, which results here in a new generic assignment. Despite some similarity of mature conchs, the ontogeny of *Ph. applanatum* bears no resemblence to that in *Ex. arenicum*. The latter is always more involute, shows an earlier ontogenetic onset of lobes, and no distinctive ribbing. The two species are not regarded as closely related. There are also important differences that separate *Ex. applanatum* from the two Dar Kaoua morphotypes assigned to *Ex. arenicum* in Bockwinkel et al. (2009; here *Extropharciceras* n. sp. 1). The latter has a slightly later (9-10 mm dm) main ontogenetic turning point. The uw/dm ratio of *Ex. applanatum* does not fluctuate around 0.40, as in the Dar Kaoua "*arenicum*", but shows a strong increase until the end of the fifth whorl (uw/dm > 0.50 rather than < 0.45) and a strong decrease in intermediate stages, which weakens in the last whorls (> 30 mm dm). Its ww/dm values reach a maximum of only 0.60 (0.68 in Dar Kaoua "*arenicum*") and WER ratios are slightly lower in early stages and rise rather sharply in intermediate whorls between 7 and 30 mm dm. The general ontogenetic traits are more similar in the compressed *Ex. librum* and *Ex. conex*. MB.C.22116.5 resembles Petter´s (1959) *arenicum* of pl. 7, fig. 6 but a ventral view of this paralectotype has not been published. Early stages of *Pharciceras* species can be distinguished by their later entry of U lobes. The superficially similar *Ph. lateseptatum* Morphotype I is slightly more involute and WER does not rise quickly after 10 mm dm. Juvenile *Ph. pargai* and *Ph. darkaouense* are markedly more involute than *Ex. applanatum*.

There are several small specimens (MB.C.22117.1, MB.C.22117.2, MB.C.22117.3, MB.C.22117.4, and MB.C.22117.5, (see Appendix) that are more involute than typical *Ex. applanatum*, which is well visible in the uw/dm plot of Morphotype II (Fig. 31D, values below 0.4). Their fine ribbing and ww/wh ratios are incompatible with *Ex. arenicum*. They are provisionally identified as *Ex*. cf. *applanatum*

Stratigraphic range and geographic distribution. Type locality and horizon.

Extropharciceras n. sp. 2

Description. The single representative is poorly preserved (encrusted by goethite), moderately large (ca. 33 mm max. dm), fully septate, and has a strongly tegoid, lenticular cross-section (Fig. 32A). The flanks converge strongly from the short umbilical wall to a narrowly rounded venter. The estimated uw/dm ratio is ca. 0.25. The last septa possess a moderately high, undivided median saddle, deep E_2 and L lobes, three well-developed outer and inner U lobes, and a deep I lobe (Figs 32A-B). All outer lobes are lanceolate to subangular, separated by relatively narrow saddles.

Discussion. The conch shape resembles intermediate-sized *Pett. errans* but there is no trend to develop incipient E_3 lobes in the outer median saddle. The sutures are more advanced than in all other named *Extropharciceras* species and the rather open umbilicus rules out relationships with the Synpharciceratinae. Until better preserved specimens become available, this new species is kept in open nomenclature. It may represent a phylogenetic link between rather evolute and depressed *Extropharciceras* and *Petteroceras*.This leaves the possibility that *Clariondites* belongs to an unrelated lineage that developed earlier and independently an incipient E_3 lobe.

The poorly known *Ex. carinatum* from the Ougarta Mountains (Petter 1959) also develops suddenly a tectiform cross-section but at smaller size (< 20 mm dm) and when the umbilicus is wider (uw/dm ca. 0.30). *Ex*. cf. *carinatum* described by Göddertz (1989) from the Saoura Valley is much more involute than the Hassi Nebech and Ougarta specimens and also early suboxyconic. It also has wider flank saddles and lobes and could represent a *Stenopharciceras*.

Lunupharciceras Korn & Klug, 2002

Discussion. For a detailed discussion of the genus see Bockwinkel et al. (2009). A typical feature of the conch shape is that the ww/dm are lower than the uw/dm values. Among *Pharciceras* this is seen in several species. *Ph. evolvens, Ph. decoratum* n. sp., and especially the poorly known "*Pharciceras* n. sp. A of Matern (1931), may have been close to the phylogenetic roots of *Lunupharciceras* since they share the distinctive, constricted, narrow flank saddles. The suture formula of the genus is somewhat equivocal since it is difficult to establish a clear order of U lobe appearances around the umbilicus (see description of *Lu. incisum* n. sp.). In several specimens a U_4 lobe at the umbilical seam is divided by an ascending small saddle into outer and inner branches. Consequently the formula should read $(E_2E_1E_2)LU_2U_3U_{4e}{:}U_{4i}U_1I$. It is possible that there is a clear sequence of the third outer and second inner U lobe in other species (see different formula given in Bockwinkel et al. 2009).

Lunupharciceras incisum n. sp.

?1959 *Pharciceras lunulicosta*. – Petter, p. 132-133, pl. 7, fig. 3 [only].

Description. The cross-sections (Figs 33B-C) and some incomplete specimens illustrate that the conchs maintain a well-rounded, depressed cross-section from earliest post-embryonic stages to at least until ca. 25 mm dm. The umbilical width ratio increases slightly but constantly (Fig. 33J). There

is only a small decrease in relative whorl width and in the ww/wh ratios (Fig. 33J, K). Paratype MB.C.22119.4 shows much wider than high whorls, with ww/wh = 1.25, at ca. 6 mm wh (which translates into ca. 20 mm dm; Fig. 33D). Paratype MB.C.22119.7 (Fig. 34B) shows a ca. 0.4 mm small protoconch, followed by a smooth ammonitella whorl, which reaches ca. 1.25 mm maximum dm. The same specimen also illustrates the suture ontogeny.

The E_1 lobe is shortened early in ontogeny. It is still deeper than the E_2 at ca. 2 mm dm in paratype MB.C.22119.5 (Fig. 33E), just slightly deeper at 17 mm dm in the same specimen (Fig. 33G), and shorter in paratype MB.C.22119.4 at 6.5 mm wh (Fig. 33H). The outer U_2 lobe appears during the 3rd whorl at ca. 3.5 mm dm, followed after 3 ½ whorls, at 5-5.5 mm dm, by the U_3 lobe. In the holotype and in paratypes MB.C.22119.4 and MB.C.22119.9 a U_4 lobe situated directly on the umbilical seam is subdivided by a small saddle at ca. 12-13 mm dm. In paratype MB.C.22119.5 (Fig. 34A), the introduction of the 5th U lobe is slightly asymmetrical on both sides but it is present from 2.7 mm wh (Fig. 33F). Fig. 33A illustrates the septal face of the holotype. The available steinkerns show no traces of growth ornament.

Discussion. The rather invariable, well-rounded, depressed and evolute juvenile and intermediate whorls resemble the conch ontogeny in the much more evolute and thicker *Lu. serpentinum* (see Bockwinkel et al. 2009). The available material shows no change to compressed, higher and more involute conchs as in *Lu. lunulicosta*, which develops a flat venter and ventrolateral furrows at maturity. Comparison of these species is hampered by the fact that the late ontogenetic stages of *Lu. incisum* n. sp. are still unknown. However, a direct comparison with a German topotype of *lunulicosta* (MB.C.22121) and Hassi Nebech specimens assigned to that species underscores the differences that separate these forms between 17 and 25 mm dm. *Lu. lunulicosta* is more involute (uw/dm = 0.40 at 20 mm dm) and shows more rapidly expanding, equidimensional whorls at this size. Sutures of both species are similar. The poorly known *Lu. alcadei* from the Cantabrian Mountains possesses undulose ribs. *Lu. kiliani* from the Montagne Noire is much thinner throughout its ontogeny.

Petter (1959) illustrated among her *lunulicosta* material from the Ougarta Mountains of Algeria a medium-sized specimen with a wide and depressed whorl that could either belong to the new species or to *Lu. serpentinum*.

Stratigraphic range. *Taouzites taouzensis* Zone (late Givetian).

Geographic distribution. Southern Morocco (Tafilalt) and possibly southern Algeria (Ougarta).

Lunupharciceras lunulicosta (Sandberger & Sandberger, 1850)

1850 *Goniatites lunulicosta* Sandberger & Sandberger, p. 69-70, pl. 3, figs 14, 14a-f.
1908 *Goniatites lunulicosta*. - Schöndorf, p. 47.1930 *Prolecanites (Pharciceras) lunulicosta* Menchikoff, p. 37.
non 1950 *Pharciceras lunulicosta*. - Termier & Termier, p. 54, pl. 150, figs 43-45 [= *Synpharciceras clavilobum*].
1950 *Pharciceras lunulicosta*. - Roch, p. 146 [= Menchikoff record].
? 1952 *Pharciceras* gr. *lunulicosta*. - Choubert, p. 120.
1959 *Pharciceras lunulicosta*. - Petter, p. 132-133, text-fig. 17, pl. 7, figs 2, 2a, 4 [non. fig. 3].
cf. 1965 *Pharciceras* cf. *lunulicosta*. - Massa, p. 104.
1977 *Pharciceras lunulicosta*. - House & Ziegler, p. 88, pl. 5, fig. 15, pl. 6, figs 7-10.
? 1980 *Pharciceras lunulicosta*. - Bultynck & Hollard, p. 24 [possibly a different species of the genus].
? 1982 *Pharciceras lunulicosta*. - Ziegler & Klapper, p. 475 [= Bultynck & Hollard record].
non 1985 *Pharciceras lunulicosta*. - House et al., p. 3, 6, fig. 3A-B [strongly depressed, evolute form with sutures unlike as in typical *Lunupharciceras*].
non 1985 *Pharciceras* cf. *lunulicosta*. - House et al., p. 3, fig. 3C-D [? = *Transpharciceras* n. gen. n. sp.].
cf. 1986 *Pharciceras* sp. A Montesinos & Henn, p. 67, 69, figs 4, 5G, 6C.
1999 *Stenopharciceras lunulicosta*. - Belka et al., fig. 8.

2000 *Stenopharciceras lunulicosta*. - Becker & House 2000a, p. 32.
2002 *Lunupharciceras lunulicosta*. - Korn & Klug, p. 145, fig. 134D [non fig. 134B = *Extropharciceras* sp.].

Description. The typical conch ontogeny features a minor maximum of relative umbilical width near 9 mm dm (Fig. 35G), variable WER between 1.65 and 1.90 until 20 mm dm (Fig. 35I), an increasing flattening of the flanks (slightly falling ww/dm and ww/wh values, Figs 35G-H), and whorl compression from ca. 20 mm dm on. The cross-sections of MB.C.22120.3 (Fig. 35E) and MB.C.22120.1 (Fig. 35C) illustrate the change from broadly depressed to compressed whorl profile. There is no trace of ribs or ventrolateral furrows in early to intermediate stages from Hassi Nebech. Most characteristic are the similarly shaped, narrow flank saddles (Fig. 35F). The available material does not clarify whether the third outer or the second inner U lobe appear earlier, or simultaneously by lobe subdivision. Two dorsal U lobes are present at 15 mm dm in MB.C.22120.1 (septal face of Fig. 35B) and at 17 mm dm in MB.C.22120.3. The shortening of the E_1 lobe occurs before 15 mm dm.

Discussion. Following a first North African record from the Ougarta region in Menchikoff (1930), the presence of close relatives of *Lu. lunulicosta* in the Tafilalt was first correctly reported by Choubert (1952). A specimen illustrated earlier in Termier & Termier (1950) as *Ph. lunulicosta* is a *Synpharciceras*. Limestone material that closely resembles the medium-sized to mature German types occurs at several levels in a number of Tafilalt localities. The small Hassi Nebech representatives are nearly identical to the inner whorls of limestone specimens. In general, they agree well with the sectioned Oberscheld topotype (Fig. 35A), especially in their relatively early and constant change to less depressed, higher, subevolute and more rapidly expanding whorls relative to *Lu. incisum* n. sp. The latter has an uw/dm ratio of 0.50 at 20 mm dm (ca. 0.40 in *lunulicosta*). The revised diagnosis includes the mature features of the german syntype series, which is shared by additional specimens from the iron limestones of the Lahn-Dill area, which are housed in the Berlin collection.
Stratigraphic range. Late Givetian, from the *Synpharciceras clavilobum* to *Petteroceras errans* zones (MD III-E).
Geographic distribution. Germany (Rhenish Massive), ?Spain (Cantabrian Mountains), southern Morocco (Tafilalt), and southern Algeria (Ougarta). None of the specimens from the Montagne Noire assigned by House et al. (1985) to *Lu. lunulicosta* or cf. *lunulicosta* belongs to the species.

Transpharciceras n. gen.

Included species.
Transpharciceras procedens n. sp.
?Pharciceras taouzensis in Termier & Termier (1950: only pl. 150, fig. 28)
?*Synpharciceras* sp. in Ruan (1981: fig. 18, pl. 9, fig. 18; possibly with even more lobes than in *Transpharciceras* n. gen.)
?*Pharciceras* cf. *lunulicosta* in House et al. (1985: figs 3C-D; uncertain number of outer U lobes)
?*Transpharciceras* n. sp. (from Seheb-el-Rhassal)
Discussion. The new genus shares the serpenticonic conch shape of early to intermediate stages with the partly older *Lunupharciceras*, but differs by the contrary ontogenetic development of uw/dm and ww/dm values and the introduction of additional U lobes. Its relationships with *Lunupharciceras* are similar to those in the pair *Pharciceras-Extropharciceras*. However, the sequence of U lobes after U_3 is not yet clear. Apparently there are two parallel lineages within the Pharciceratinae, based on differing suture ontogenies. The main lineage from *Pharciceras* to *Extropharciceras* and descendents is characterized by regularly alternating internal and external U lobes and cadiconic early whorls. The *Lunupharciceras-Transpharciceras* branch shows a more irregular ontogenetic appearance of U lobes, very narrow, similarly-shaped, medially constricted flank saddles and serpenticonic early whorls.*?Lunupharciceras nejjakhense* Bockwinkel et al., 2009, *Pharciceras* aff. *kiliani* in House et al.

(1985: figs 7C-D, F-G, pl. 2, figs 3-4), and ?*Pharciceras* sp. in House et al. (1985: fig. 7E, pl. 1, figs 4-5) also possess additional U lobes but have very compressed mature conchs with uw/dm > ww/dm. They either form a distinctive species group within *Transpharciceras* n. gen or added U lobes independently, in a lineage derived from *Lunupharciceras lunulicosta/kiliani*.

Stratigraphic range and geographic distribution. Late Givetian of southern Morocco, possibly the Montagne Noire, and South China.

Transpharciceras procedens n. sp.

Description.. The crossing of the uw/dm and ww/dm plots at ca. 10 mm dm is striking. The ww/wh ratios fall sharply in this interval while the whorl expansion rate also increases rapidly. It can be predicted that mature whorls will be slightly compressed and subinvolute. Paratype MB.C.22122.4 (Fig. 38A) shows the smooth inner whorls and the protoconch with ca. 0.6 max. dm. None of the four types possess ventrolateral furrows (see ventral view of paratype MB.C.22122.3, Fig. 38C). Paratype MB.C.22122.3 suggests that a third outer U lobe forms between 8 and 10 mm dm (Fig. 37E). The holotype displays the third inner U lobe at 16 mm dm (septal face of Fig. 37A). Its outer suture is depicted in Fig. 37F. Paratype MB.C.22122.4 has the typical conch shape but the suture ontogeny appears to be slower; there is no third outer U lobe at 12 mm dm (Fig. 37D).

Discussion. Conch ontogeny, conch shape, and sutures readily distinguish this form from any named pharciceratid.

Stratigraphic range and geographic distribution. Type locality and horizon.

Subfamily **Synpharciceratinae** Schindewolf, 1940

Discussion. The subfamily has been emended by Bockwinkel et al. (2009). The discovery of direct intermediates between *Stenopharciceras kseirense* and *Synpharciceras plurilobatum* require the placing of the latter in a new genus, *Pluripharciceras* , that added U lobes in parallel with *Synpharciceras*. A comparison of the ontogeny and shape of the external lobe in *Meropharciceras* with that in the other genera of the subfamily confirms its placement in the Synpharciceratinae (see below and discussion in Bockwinkel et al. 2009). Based on different conch shape, especially of whorl expansion rates, two lineages are recognized that are probably rooted in different species of *Stenopharciceras*: *St. kseirense – St. progressum* n. sp. –*Pluripharciceras* –*Meropharciceras* and *Stenopharciceras* n. sp. (or still unknown relatives) – *Synpharciceras – Neopharciceras*. The ancestry of the Synpharciceratinae within the Pharciceratinae is not yet resolved.

Stratigraphic range. Late Givetian (*Synpharciceras clavilobum* Zone, MD III-C) to basal Frasnian (*Neopharciceras kurbatovi* Zone, UD I-A).

Geographic distribution. Germany (Rhenish Massive, Harz Mountains), cf. Austria (Graz Palaeozoicum), France (Montagne Noire), Spain (Pyrenees, Cantabrian Mountains), southern Morocco, southern Algeria, Kazakhstan (Karaganda Basin), Russia (Rudnyi Altai), South China (Yunnan, Guangxi).

Stenopharciceras Montesinos & Henn, 1986

Discussion. For a detailed discussion of the genus see Bockwinkel et al. (2009). After its revision, the cross-section illustrated by Korn & Klug (2001) for *Stenopharciceras* falls outside the genus and closely resembles that of *Ph. pargai*. The new knowledge of suture ontogenies in Hassi Nebech

specimens, which include a new species (*St. progressum* n. sp.), require an emendation of the mature suture formula. These are now: $(E_2E_1E_2)LU_2U_4U_6{:}U_7U_5U_3U_1I$ to $(E_2E_1E_2)LU_2U_4U_6U_8{:}U_9U_7U_5U_3U_1I$.

Stenopharciceras kseirense (Termier & Termier, 1950)

1950 *Pharciceras tridens* var. *kseirense* [Clariond] Termier & Termier, p. 54, pl. 150, figs 38-42.
cf. 1959 *Pharciceras kseirense*. - Petter, p. 140, figs 33D, 35, pl. 9, figs 1, 2, 2a, 4, 4a, 5, 6, 6a.
1974 *Pharciceras kseirense*. - Bensaïd, p. 90.
1974 *Pharciceras* n. sp. Bensaïd, p. 112-113, text-figs 20a-c, pl. 5, figs 3, 3a (only).
cf. ? 1980 *Pharciceras* cf. *P. kseirense*. - Bultynck & Hollard, p. 24.
cf. ? 1981 *Pharciceras* cf. P. *kseirense*. - Bultynck & Jacobs, fig. 4 [= Bultynck & Hollard record].
? 1982 *Pharciceras* sp. cf. *P. kseirensis*. - Walliser in Ziegler & Klapper, p. 475.
1986 *Stenopharciceras kseirense*. - Montesinos & Henn, p. 65.
cf. 1986 *Stenopharciceras* cf. *kseirense*. - Montesinos & Henn, p. 65-66, figs 4, 5L, 6L.
non 1989 *Pharciceras* cf. *kseirense*. - Göddertz, p. 183-184, fig. 30, pl. 13, fig. 6 [= *St.* n. sp.].
non 2000a *Stenopharciceras kseirense*. - Becker & House, p. 31 [= *St. protectum*].
2002 *Stenopharciceras kseirense*. - Korn & Klug, p. 145 [non figs 134G and 135B = *St. progressum* n. sp.].
2003 *Stenopharciceras kseirense*. - Aboussalam, fig. 14.
non 2003 *Stenopharciceras kseirense*. - Korn & Klug, p. 346 [Göddertz specimen].
cf. 2010 *Stenopharciceras* cf. *kseirense*. - García-Alcalde, p. 48[Montesinos & Henn specimen].

Description. The topotypes allow for the first time to document the distinctive conch ontogeny (Figs 39A-D, K-M). Characteristic are the four moderately depressed early whorls with only a very weak increase in relative whorl width and the sudden change to high and compressed whorls (see Figs 40A-C). There are shallow ventrolateral depressions that may cause a cingulate, subtrapezoidal cross-section at small size (e.g., MB.C.22124.20, MB.C.22124.12, Fig. 40D, MB.C.22124.19). The spiral furrows disappear in intermediate stages. The whorl expansion of early whorls remains higher than in most other pharciceratids with WER > 2.30 at maturity (from 20 mm dm, Fig. 39M) at a higher level than in other Pharciceratidae. Another important feature of the moulds is the overlap of the umbilical wall over the umbilical opening of preceding whorls, from 14-15 mm dm on, resulting in an absolute reduction of uw values (Figs 39A, 40A-C). The decrease of uw/dm ratios begins earlier, with the major shift at ca. 7 mm dm. The mould preservation does not allow recognition of shell flares that might have sealed the umbilicus. Even small specimens show no ribbing; growth lines are not visible. But in MB.C.22124.18 the shell of inner whorls has been limonitized and, therefore, fine, dense growth striae of the inner flanks are visible. MB.C.22124.13 partially displays lateral *Ritzstreifung* (see House 1971 for a review). Very small, rounded pits (< 0.1 mm in diameter) are arranged in projecting and prorsiradiate lines.
Already at 2.5 mm wh, two outer U lobes are developed (compare Fig. 39F). Three inner U lobes are visible at 5.6 mm wh in MB.C.22124.6. A third outer U lobe forms as an incipient depression of the saddle just outside the seam variably between ca. 5.5 (MB.C.22124.17) and ca. 6.5 mm wh (MB.C.22124.1), shortly followed by the fourth inner U lobe (at 7.2 mm wh and 14.5 mm dm in MB.C.22124.6 and at 7.8 mm wh and ca. 17 mm dm in MB.C.22124.7). At this size, the outer U_6 lobe is clearly recognizable (MB.C.22124.7, Fig. 39H). The septal face of STIPB-Bensaïd-43, one of the originals to *Pharciceras* n. sp. in Bensaïd (1974), displays all seven U lobes (Fig. 39E) below 9 mm wh. MB.C.22124.8 (Fig. 39I) represents a variant with very short outer U lobes. Even the largest specimens (18.5 mm w, MB.C.22124.9) show no evidence of additional lobes but the median saddle rises and becomes as high as the ventrolateral saddle (Fig. 39J). The same individual develops a very shallow plurilobe in the $U_4 U_6$ saddle.

Discussion. Montesinos & Henn (1986) incorrectly denied that the short description and illustration of the species in Termier & Termier (1950) validated E. Clariond´s manuscript taxon. The species is

characterized by overlap of mould whorls over the umbilical space whilst closure is reached in *St. protectum* by shell flares. The lectotype possesses three outer U lobes, in accord with many topotypes. The presence of four inner U lobes was noted by Petter (1959). However, in her Algerian material, which formed the base of her fig. 35, U lobes appear later in the ontogeny than at the type locality: the internal U_5 at 20 mm dm (< 13 mm dm at Hassi Nebech), the outer U_6 at 25 mm dm (incipient at 13-16 mm dm at Hassi Nebech), the internal U_7 at 30 mm dm (incipient at 15 mm dm and more fully developed at 18-20 mm dm at Hassi Nebech). The question, whether these differences warrant taxonomic separation cannot be determined without further knowledge of the morphometry and variability of the Erg el Djemel population.

The poorly preserved *St.* cf. *kseirense* from the Cantabrian Mountains described by Montesinos & Henn (1986) shows strong similarity with the Tafilalt types. Cf.-specimens reported from other Anti-Atlas localities (Bultynck & Jacobs 1981, Ziegler & Klapper 1982) have not been described or illustrated. Currently they cannot be evaluated. The photographed specimen identified by Bensaïd (1974: pl. 5) as *Pharciceras* n. sp. clearly falls in *St. kseirense* and has a much simpler suture than given for a different specimen in his text-fig. 20d. The latter is not conspecific but as it is not stored in Bonn with Bensaïd`s types, it cannot be revised.

Stratigraphic range. *Taouzites taouzensis* Zone. (Late Givetian)

Geographic distribution. ?Spain (Montesinos & Henn 1986: cf. Cantabrian Mountains), southern Morocco (Termier & Termier 1950: Tafilalt, Bultynck & Jacobs 1981: cf. Maider), southern Algeria (Petter 1959: cf. Ougarta,). A cf. specimen described by Göddertz (1989) from the Saoura Valley of southern Algeria belongs to a different pharciceratid species characterized by a sudden change from depressed to compressed whorls with suboxyconic intermediate stages.

***Stenopharciceras progressum* n. sp.**

2002 *Stenopharciceras kseirense*. - Korn & Klug, p. 145, figs 134G, 135B [only].

Description. The conchs show the characteristic tegoid form seen in *St. kseirense*, with a rapid change from moderately depressed early stages to compressed and rapidly expanding intermediate to mature whorls. The flanks converge gently to a narrowly rounded venter. WER rises rapidly after 7 mm dm to mature values > 2.20. The overlap of adult mould whorls over the previous umbilical opening is developed (Figs 41B, 42C, E). MB.C.22125.9 displays the fine biconvex growth ornament, with a low subumbilical salient and a moderately high ventrolateral salient. In the juvenile MB.C.22125.4 there are weak, fine ribs and shallow ventrolateral depressions that produce a ventral cingulum (Fig. 42D). The suture ontogeny is accelerated in comparison to *St. kseirense*,. The third outer U lobe appears at 3.8 mm wh (MB.C.22125.5). At ca. 5 mm dm, a fourth inner U lobe is present in MB.C.22125.4 and MB.C.22125.8, but not yet in MB.C.22125.9. It is situated at the seam (Figs 41D, E). A fourth outer U lobe develops at 10.5 to 11 mm wh. Fig. 41F shows it clearly in the holotype MB.C.22125.1 at 26.5 mm dm (14.5 mm wh). A small fifth inner U lobe is formed at 14-14.5 mm wh and ca. 25 mm dm. This is visible both in paratype MB.C.22125.6 and in the holotype (see septal face in Fig. 41C). MB.C.22125.3 also has five inner U lobes but the number of outer lobes is not clear. MB.C.22125.10 displays five inner U lobes but outer sutures are asymmetric, with three U lobes on one side and four on the other (Fig. 42A).

Discussion. The new species has a similar conch shape to *St. kseirense* but develops two additional U lobes in intermediate stages (ca. 19 mm dm) and shows an earlier onset of other U lobes during ontogeny. There are no specimens that are difficult to assign to one of the two species. Therefore, *St. progressum* n. sp. is regarded as a descendent of *St. kseirense*. Its sutures are intermediate between *St. kseirense* and *Plu. plurilobatum*. The latter species, not counting plurilobes, has five outer U lobes

from 18-19 mm dm on, whereas the fourth has not yet appeared in *St. progressum* n. sp. at a similar diameter. It is also slightly thinner than *St. progressum* n. sp.
Stratigraphic range and geographic distribution. Type locality and horizon.

Pluripharciceras n.gen.

Included species.
Synpharciceras plurilobatum Petter, 1959
Pluripharciceras orbis n. gen. n. sp.
?*Pharciceras arenicum* in House et al. (1985)
Discussion. *Pluripharciceras* n. gen. shares the number of U lobes with *Synpharciceras* but has a different conch ontogeny, with more rapidly expanding whorls and very high WER at maturity. Its ontogeny is very similar to the type species of *Stenopharciceras* and its suture complexity and morphology is linked with *St. kseirense* via *St. progressum* n. sp. This morphological path most likely mirrors the phylogeny and an independent origin of *plurilobatum* within *Stenopharciceras* (*St. progressum* n. sp.). *Syn. clavilobum*, the type species of *Synpharciceras*, is morphologically and phylogenetically close to *St. protectum*, which is supported by slower whorl expansion rate and, especially, by the peculiar umbilical shell flares of both species. Typical *Synpharciceras* species differ from *Pluripharciceras* in their increasingly depressed, subglobular adolescent whorls, with a marked peak of ww/dm and ww/wh values.
Specimens erroneously assigned by House et al. (1985) to *Ex. arenicum* are involute, have a mature WER in the scale of 2.50, and four or five outer U lobes. Either they belong to *Pluripharciceras* n. gen. or they are related to *St. progressum* n. sp.
Stratigraphic range and geographic distribution. Late Givetian of the Tafilalt, possibly also the Montagne Noire.

Pluripharciceras plurilobatum (Petter, 1959)

*e.p.   1950 Pharciceras taouzensis Termier & Termier: pl. 150, figs 21-22, pl. 151, figs 16-18 [only]
*v   1959 Synpharciceras plurilobatum Petter: 149, text-fig. 39, pl. 8, figs 1, 4, 4a, 5, 5a
           1965 *Synpharciceras plurilobatum* Massa: 101
           1987 *Synpharciceras plurilobatum* Göddertz: fig. 31, pl. 13, figs 7a-b
?   1999 *Synpharciceras plurilobatum* Belka et al.: tab. 5, cf. fig. 8
v non   2000a *Synpharciceras plurilobatum* Becker & House: 31 [= *Syn. clavilobum*, see comment in Bockwinkel et al. 2009]
           2002 *Synpharciceras plurilobatum* Korn & Klug: 145
           2003 *Synpharciceras plurilobatum* Korn & Klug: 346

Description. The rapidly expanding, very involute and flat conchs are highly disctinctive. The two ontogenetic turning points after the 2nd and during the 5th whorl can be seen in the conch parameter plots of Figs 43J-L. The change at ca. 7 mm dm is more distinctive, especially for umbilical and whorl width ratios. The overlap of mould whorls over the umbilicus (absolute reduction of the umbilicus) begins at ca. 18 mm dm (MB.C.22126.5) and creates an angular umbilical seam (Figs 43C, 44A, B, D). This suggests the presence of shell flares that completely sealed the umbilicus. A few specimens (MB.C.22126.12, MB.C.22126.13, MB.C.22126.14) display the strongly biconvex growth lines with broadly convex dorsolateral salient and narrow, projecting ventrolateral salient. The juvenile MB.C.22126.10 displays weak ventrolateral furrows until ca. 3.5 mm wh (Fig. 44E). They disappear soon in median stages (MB.C.22126.9, Fig. 44C).

The suture ontogeny can be reconstructed from ca. 3.5 mm wh on (MB.C.22126.15) when there are already three outer U lobes. The E_1 lobe is already shortened. The outer U_8 originates on the umbilical wall between 6.5 (MB.C.22126.18) and 7.5 mm wh (MB.C.22126.4). At this stage there are four internal U lobes (MB.C.22126.16). A fifth inner U lobe is visible on the septal face of MB.C.22126.5 at 9 mm wh. The outer U_{10} appears at 10.5 to 11.5 mm wh (MB.C.22126.3, MB.C.22126.17), followed at 13.5 mm dm (25 mm dm) by the internal U_{11}. Sutures with four (MB.C.22126.5, at 9.3 mm wh) and five outer U lobes (MB.C.22126.6, at 15.5 mm wh) are shown in Figs 43F, H. The lectotype maintains eleven U lobes until the last, fully preserved septum at 21 mm wh. Plurilobes appear to be more common than in other pharciceratids, which justified the species name. They occur between outer and inner U lobes, often on both sides of specimens (MB.C.22126.14) or in more than one saddle. MB.C.22126.11 has two plurilobes in the U_6 U_8 and U_8 U_{10} saddles, the lectotype in the U_4 U_6 and U_6 U_8 saddles. MB.C.22126.4 (septal face shown in Fig. 43E) possesses six outer and six inner U lobes and an internal plurilobe in the U_5 U_7 saddle. MB.C.22126.7 (Fig. 44B) and MB.C.22126.8 (Fig. 44D) lack outer plurilobes at intermediate to larger stages.

Discussion. Early to median stages can be confused with *St. kseirense* and *St. progressum* n. sp. if sutures are not considered. The Algerian specimen described by Göddertz (1987) unusually shows two plurilobes in the U_2 U_4 and U_4 U_6 saddles. The outer U_{10} lobe is very shallow at 13 mm wh and the conch is not really tegoid. Despite these differences the specimen is included as a variant of the species.
Two specimens share the overall conch shape (Fig. 43A) but have slightly more advanced sutures. In MB.C.22127.1 a fifth outer U lobe is present at 9 mm wh and an outer U_{12} forms at 13.5 mm wh. The septal face of MB.C.22127.2 also shows a shallow sixth outer U lobe (Fig. 43G) and an internal U_{13} lobe at 15.5 mm wh (27 mm dm). Also, there is a small plurilobe in the U_8 U_{10} saddle. The addition of two umbilical lobes could justify separation at the species level, as in the pair *St. kseirense* and *St. progressum* n. sp. Until more is known about *plurilobatum* sutures at full maturity, we include the two individuals in cf. *plurilobatum*.
Stratigraphic range. Probably *Taouzites taouzensis* Zone (MD III-D). Supposed older specimens from the "Lower Marker Bed" of the Tafilalt have been re-identified by Bockwinkel et al. (2009) as plurilobate morphotypes of *Syn. clavilobum*.
Geographic distribution. Southern Morocco (Tafilalt), southern Algeria (Saoura Valley).

Pluripharciceras orbis n. sp.

Description. The three specimens have a distinctive discoconic conch shape and a moderate whorl expansion. The holotype suggests that the umbilicus of internal moulds is gradually closed by overlap of subsequent whorls since the previous whorl is already completely covered at the end of the preserved phragmocone (Fig. 46A). There are no ribs, growth line impressions or spiral furrows. The holotype displays four outer U lobes at 4 mm wh and a fifth appears between 5.5 and 6 mm wh (ca. 14 mm dm). At ca. 8.5 mm wh (17 mm dm) a septal face proves the presence of five inner U lobes (MB.C.22128.1 Fig. 45A). In paratype MB.C.22128.2, the origination of the outer U_{10} is somewhat delayed (until after 7 mm wh) but it is present at 6.5 mm wh in paratype MB.C.22128.3 (Fig. 45C). It is likely that larger representatives posses additional U lobes.

Discussion. The new species is only known from relatively small specimens, which prevents a conclusive generic assignment. The moderately high WER between 5 and 10 mm dm and the overall similarity of the conch ontogeny suggest relationships with *Plu. plurilobatum*, not with *Synpharciceras*. *Plu. plurilobatum* has thicker median stages and the U lobes appear later during ontogeny. Juveniles of *Mero. disciforme* are somewhat thicker and more depressed but the septal complexity is similar. It is probable that mature representatives of *Plu. orbis* have at least 13 U lobes,

as in *Plu.* cf. *plurilobatum*. The new species may represent a phylogenetic link between *Pluripharciceras* n. gen. and *Meropharciceras*.
Stratigraphic range and geographic distribution. Type locality and horizon.

Meropharciceras Becker & House, 1993

Discussion. Bockwinkel et al. (2009) raised the possibility that the incipient third E lobe of *Meropharciceras* originated independently from the Petteroceratidae and that the genus does not belong to that family. The Hassi Nebech specimens and the knowledge of their conch ontogeny, with their high adult WER, corroborate this interpretation. *Meropharciceras* is here placed in the Synpharciceratinae. The shape of the median lobes of *Meropharciceras* does not differ fundamentally from other synpharciceratines. A funnel-shaped E_1 lobe with distinctive shoulders occurs in mature *St. kseirense* (Fig. 39J), *St. protectum* (Bockwinkel et al. 2009, fig. 24J), *St. progressum* n. sp. (Fig. 41G), *Plu. plurilobatum* (Fig. 43I), *Syn. clavilobum* (Fig. 51H), and *Syn. frequens* n. sp. (Fig. 53I). This feature is only slightly more advanced in the holotype of *Mero. disciforme* (see Bensaïd 1974, pl. 5, fig. 13b). It appears to be characteristic for the Synpharciceratinae. The third E lobe of the Petteroceratidae originates in a very different way within the lateral slope of the median saddle.

Meropharciceras disciforme (Bensaïd, 1974)

*v	1974	*Beloceras ? disciforme* Bensaïd: 117, fig. 23D, pl. 5, figs 13-13b.
v	1993	*Meropharciceras disciforme* Becker & House: 115, pl. 2, figs 10-12
	1999	*Meropharciceras disciforme* Belka et al.: tab. 5, fig. 8
v	2002	*Meropharciceras disciforme* Korn & Klug: 143, fig. 136B
	2003	*Meropharciceras disciforme* Korn & Klug: 346

Description. The new topotypes allow a complete description of the conch ontogeny (Figs 47A-C, I-K). Early stages are moderately depressed, subglobular, and moderately involute, with broadly rounded flanks and venter (MB.C.22129.6, Fig. 48B). There are no distinct ventrolateral furrows and no ribs. MB.C.22129.6 displays at 6.5 mm dm the biconvex growth lines, with low dorsolateral salient, gently rounded lateral sinus, slightly higher ventrolateral salient, and a deep and parallel-sided ventral sinus. Subsequently the umbilicus opens only slowly (MB.C.22129.4, Fig. 48C) while the whorls become slightly higher, with a more narrowly rounded venter. The change to compressed and rapidly expanding whorls is preserved in MB.C.22129.2 (Fig. 47B), which also shows the absolute reduction of umbilical width. There is no sharp ontogenetic turning point but a gradual and constant decrease of the somewhat variable whorl width, which is evident in the ontogenetic trends of ww/dm and ww/wh ratios. The holotype illustrates that mature conchs are strongly compressed, with a trend towards high whorl expansion (WER > 2.20).
The combination of topotypes allows to reconstruct somewhat variable stages of the suture ontogeny. At 2 mm wh (MB.C.22129.6) there are two outer U lobes, at 3 mm wh three (MB.C.22129.6) or four (MB.C.22129.4), at 6 mm wh four (MB.C.22129.1), five (MB.C.22129.3) or six (MB.C.22129.4, septal face in Fig. 47D), and five (MB.C.22129.6) or six (MB.C.22129.4) inner U lobes. A suture with five outer U lobes at 7.8 mm is taken from MB.C.22129.1 (Fig. 47E), one with six outer U lobes at 8 mm wh from MB.C.22129.3 (Fig. 47F). At 12 mm wh there are seven outer U lobes (MB.C.22129.2, Fig. 47G), which continues until 22.5 mm wh (MB.C.22129.5, Fig. 47H). The holotype displays eight outer U lobes at 32 mm wh (Bensaïd et al. 1974: fig. 23d). The shortened, diverging E_1 changes into a funnel-shape lobe from 6 mm wh on (MB.C.22129.1). Increased flexuring forms incipient E_3 lobes at ca. 12 mm wh (Figs 47G, H) and there are short horizontal side plateaus in the larger holotype (Bensaïd 1974: pl. 5, fig. 13b. There is no evidence that a full E_3 develop at maturity.

Discussion. At maturity, *Mero. disciforme* develops four more U lobes than in the most advanced *Synpharciceras* or *Pluripharciceras* n. gen. The internal mould preservation at Hassi Nebech cannot clarify whether shell flares are developed. The lack of a clear maximum in the ontogenetic trait of whorl width (ww/dm) resembles *Syn. spirale*, *Plu. plurilobatum* and *Plu. orbis* n. sp.

Stratigraphic range. The loose Hassi Nebech material gives no clues whether the species comes from the *Synpharciceras clavilobum* or *Petteroceras errans* Zone (MD III-D or III-E). However, the specimen recorded by Belka et al. (1999) from the latest Givetian of Ouidane Chebbi suggests that this rare form is restricted to the *Petteroceras* Beds.This is in accordance with its very advanced suture complication.

Geographic distribution. Southern Morocco (Tafilalt).

Synpharciceras **Schindewolf, 1940**

Included species.
Goniatites clavilobus Sandberger & Sandberger, 1850
Pharciceras tafilense Termier & Termier, 1950 nom. nud. (= *Syn. frequens* n. sp.)
Synpharciceras spirale Bockwinkel et al., 2009
Synpharciceras frequens n. sp.
Synpharciceras n. sp. aff. *clavilobus* in Schindewolf 1940 (= *Syn. clavilobum*)
Synpharciceras sp.
Synpharciceras aff. *frequens* n. sp.

Discussion. Following the exclusion of the *plurilobatum* Group, *Synpharciceras* is restricted to species with low to moderate whorl expansion in intermediate stages (WER 1.6 to 1.8) and moderate to high (but not very high) WER at maturity (1.9 to 2.2). The presence of umbilical shell flares, which are regarded as an important feature of the genus, cannot be proven in the Hassi Nebech steinkern material, due to the lack of any shell.

Synpharciceras **sp.**

Description. MB.C.22123 is well-preserved (Fig. 50), completely septate and has a depressed, subinvolute, pachyconic conch shape with broadly rounded venter, low WER and a slight overlap of the last preserved whorl (its short, rounded umbilical wall) over the previous umbilical opening (absolute reduction of uw). There is no ribbing, and ventrolateral furrows are lacking. There are three internal and three dorsolateral U lobes (Fig. 49), an E_1 lobe that is shortened at 8-9 mm dm, and lateral saddles that become gradually smaller and lower towards the umbilicus.

Discussion. The available juvenile does not resemble any known pharciceratid and certainly belongs to a new species. It remains in open nomenclature until larger individuals become known. Due to its low whorl expansion rate, it is regarded as an initial *Synpharciceras*. Juveniles of *Syn. frequens* n. sp. (see below) have an additional pair of U lobes at the same size and close their umbilicus later, resulting in a higher uw/dm ratio. Both species share the absolute reduction of the umbilical width by whorl overlap. *Syn. clavilobum* also possesses more advanced sutures. *Syn. spirale* shows the same number of U lobes, at least until ca. 20 mm dm (Bockwinkel et al. 2009), but closes its umbilicus by extensive umbilical shell flares, not by whorl overlap.

Stratigraphic range and geographic distribution. *Taouzites taouzensis* Zone of Hassi Nebech.

Synpharciceras clavilobum **(Sandberger & Sandberger, 1850)**

1850 *Goniatites clavilobus* Sandberger & Sandberger, p. 67, pl. 8, figs 3, 3a-b.

1852 *Ammonites clavilobus*. - Giebel, p. 455.

1873 *Goniatites clavilobus*. - Kayser, p. 667-668, at least first two sutures on p. 667 [not the 3rd and 4th].

1885 *Goniatites clavilobus*. - Waldschmidt, p. 911, 920-921.

1895 *Prolecanites clavilobus* Holzapfel, p. 115-116.

1900 *Prolecanites*. - Denckmann, p. 113 [species identification in 1902a].

1900 *Prolecanites clavilobus*. - Beushausen, p. 132.

1902a *Prolecanites clavilobus*. - Denckmann, p. 16 [specimen from Denckmann 1900].

1902b *Prolecanites clavilobus*. - Denckmann, p. 17.

1903 *Prolecanites clavilobus*. - Denckmann, p. 396, 398.

1908 *Goniatites clavilobus*. - Schöndorf, p. 46.

1918 *Pharciceras clavilobum*. - Wedekind, p. 127, fig. 37d, pl. 20, figs 4-5.

1922 *Pharciceras clavilobum*. - Henke & Schmidt, p. 30.

1931 *Pharciceras clavilobum*. - Matern, p. 88, tab. II.

? 1930 *Pharciceras clavilobum*. - Menchikoff, p. 37.

non 1933 cf. *Pharciceras clavilobus*. - Anniss, p. 437 [= *Beloceras*, see House 1963].

1940 *Synpharciceras* n. sp. aff. *clavilobus* Schindewolf: pl. 1, figs 14-15.

? 1950 *Pharciceras clavilobum*. - Roch, p. 146, 150.

? 1952 *Pharciceras clavilobus*. - Choubert, p. 130.

1959 *Sympharciceras clavilobum*. - Petter, p. 147-148, figs 33C, 38, pl. 7, fig. 15, pl. 8, figs 2, 2a, 3, 3a, 6, 6a, 7 [non pl. 8, fig. 8 = *Syn. frequens* n. sp.].

1959 *Pharciceras clavilobum*. - Krebs, p. 370, pl. 2, figs 19-20.

cf. 1965 *Sympharciceras clavilobum*. - Massa, p. 101.

1970 *Synpharciceras clavilobum*. - Kullmann & Ziegler, p. 79, figs 2D, 3D, pl. 1, figs 6-7.

1974 *Synpharciceras clavilobum*. - Bensaïd, p. 115, pl. 4, fig. 11, pl. 5, fig. 2 [non fig. 19d = *Syn.* aff. *frequens* n. sp., non. pl. 5, fig. 5 = *Syn. frequens* n. sp.].

1977 *Synpharciceras clavilobum*. - House & Ziegler, pl. 5, figs 18-19 [re-illustration of holotype]

2002 *Synpharciceras clavilobum*. - Korn & Klug, p. 145, figs 134I-J [non figs 134C and 135C = *Syn. frequens* n. sp.].

2009 *Synpharciceras clavilobum*. - Bockwinkel et al., p. 113-119, figs 26A-G, 27A-M, 28D-E [further synonymy].

Description. The Hassi Nebech specimens shows a biphasic post-embryonic conch ontogeny with an ontogenetic turning point in the conch parameter plots at 8-9 mm dm (Figs 51I-K). In addition, there is a clear change from rising to falling uw/dm and falling to static WER ratios after the 2nd whorl (between 2 and 3 mm dm). Small specimens are subglobular (Figs 51D-E, 52C-D), larger ones thinly discoidal with very narrow umbilicus (Figs 51A, 52A). The moulds from Hassi Nebech do not preserve the sealing umbilical plug, which is known from medium-sized to mature Tafilalt material with preserved shell. On moulds, there is no absolute reduction of uw by overlap of later whorls over the umbilical opening (Figs 51A, 52B). The relative decrease of uw/dm ratios, from a maximum of ca. 0.3 at 3 mm dm, proceeds gradually. The parameter plots show the restricted conch variability (Figs. 51I, J.). There are markedly subglobose (e.g., MB.C.22130.4, Fig. 51D, MB.C.22130.14, MB.C.22130.11, Fig. 52D) and less inflated specimens (e.g., MB.C.22130.13). The change from slightly depressed to weakly compressed cross-section occurs at ca. 20 mm dm. None of the larger individuals has a WER > 2.00.

Weakly biconvex, somewhat bundled growth lines are impressed only on MB.C.22130.15 and show a deep ventral sinus. MB.C.22130.16 possesses ca. 22 growth lirae per whorl, which run straight to slightly concave over the flanks, up to the position of the top of the ventral saddle. Ventrolateral furrows are lacking in all of the material.

The collection provides distinctive details of the suture ontogeny. The E_1 lobe is shortened very early in ontogeny (MB.C.22130.15). At less than 2.5 mm wh, six U lobes (three outer U lobes) are

developed (MB.C.22130.15). The internal U_7 appears before 4 mm wh (MB.C.22130.10), the external U_8 at 4-4.5 mm wh (MB.C.22130.14, MB.C.22130.9; see suture of MB.C.22130.6 in Fig. 51F), the U_9 just inside the umbilical seam at 6.5-7 mm wh (MB.C.22130.14), the external U_{10} at ca. 8 mm wh (MB.C.22130.2), the internal U_{11} at ca. 10 mm wh (MB.C.22130.17, see septal face of MB.C.22130.2 at 12 mm wh, Fig. 51B), and the sixth outer U lobe (U_{12}) between 15 and 20 mm wh (MB.C.22130.8). MB.C.22130.7 (Fig. 51G) still has five outer U lobes at 30 mm dm. Only few specimens show plurilobes in the U_8 U_{10} (MB.C.22130.8) or U_{10} U_{12} saddles (MB.C.22130.3). The latter specimen gives evidence of an internal plurilobe in the U_7 U_9 saddle (Fig. 51C).

Discussion. The identification of the species is hampered by the limited knowledge of German type material and by the fact that all species of *Synpharciceras* have rather similar adult conchs. The original description, summarized subsequently in Giebel (1852), gives credit to the distinctive spiral furrows on the ventral margins on the mould of the holotype. Bockwinkel et al. (2009) noted that this peculiar feature is not seen in other specimens from Germany or Morocco. The umbilicus of the medium-sized holotype is filled on the previously figured side with matrix (see Fig. 52E) and completely sealed by shell flares on the other side (compare Bockwinkel et al. 2009, fig. 27D). The re-examination of the original gives no indication for an overlap of adult whorls over the umbilicus. There is a small raised shell rim at the seam at the beginning of the last preserved whorl (at ca. 10 mm wh) which fits the short umbilical thorns shown at the same size in *clavilobum* cross-sections from Dar Kaoua (Bockwinkel et al. 2009, figs 27D-E). Waldschmidt (1885) mentioned seven flank lobes ("Lateralloben") at 37 mm dm in a specimen from the Kellerwald, which translates into the L lobe and six outer U lobes, as at the same size in MB.C.22130.8 (Fig. 51H). Kayser (1873) illustrated the suture of a large probable topotype with six outer U lobes at 70 mm dm. This agrees with the maximum number of lateral U lobes, seen in Hassi Nebech material. Schindewolf (1940: fig. 30, outer part) published a corrected suture of the same specimen, which, together with a different topotype that provided the dorsal suture, is evidence for internal (in the U_9 U_{11} saddle) and external (in the U_8 U_{10} saddle) plurilobes in the type area. Plurilobes occur in German, Maroccan and Algerian specimens (see Petter 1959, pl. 7, fig. 15).

Matern (1931) had 35 specimens from 10 different localities/mines of the Lahn-Dill area including 22 topotypes. He did not mention specimens with a wide umbilicus. He also rejected Wedekind´s (1918) claim that *Syn. clavilobum* becomes oxyconic at maturity. Earlier, Holzapfel (1895) emphasized the high mature whorls. Frech (1902) illustrated a submature *Syn. clavilobum* from the Anna Mine near Oberscheld with a fine, radial wrinkle layer (compare Bockwinkel et al. 2009) and growth lines with a rather wide lateral sinus and a high ventrolateral projection, unlike that in *Syn. frequens* n. sp. (see below).

The presence of the species in North Africa was first noted by Menchikoff (1930), but this record, as those in Roch (1950) and Choubert (1952), could be based on any *Synpharciceras*. The supposed separate species from the Tafilalt illustrated in open nomenclature by Schindewolf (1940) falls within the variability range of *clavilobum*; Schindewolf thought that this specimen has fewer U lobes.

There are differences between the goethitic Hassi Nebech material and the slightly older Dar Kaoua population. Currently we regard these as evidence of microevolutionary or ecophenotypic change within the species and not sufficient for taxonomic separation. The Hassi Nebech material includes some more globular forms with ww/dm reaching 0.85 (only 0.80 at Dar Kaoua). On the other hand, thin and more involute morphotypes are lacking. In other words, the species morphology appears to have shifted towards more pachyconic juvenile and median conchs. At maturity the whorls remain lower than at Dar Kaoua, never crossing the 2.00 mark of WER. Even more distinctive is the acceleration of the suture ontogeny. Lobes are introduced at smaller size, which is also true in comparison with the suture ontogeny shown by Petter (1959) for Algerian specimens. At Dar Kaoua the outer U_8 is first seen at 11mm wh, in Algerian forms at ca. 7 mm wh (15 mm dm), and at Hassi Nebech already at 4-4.5 mm wh. The accelerated suture ontogeny could be used to recognize early

(*Sympharciceras clavilobum* Zone) and late (*Taouzites taouzensis* Zone) morphotypes within the species.

The specimens from the eastern Rhenish Massive (Martenberg) described by Kullmann & Ziegler (1970) show the narrow, very gradually opening and then static umbilicus, similar to the Hassi Nebech specimens (compare Bensaïd 1974: pl. 4, fig. 11 and pl. 5, fig. 2). Other Bensaïd specimens fall in *Syn. frequens* n. sp. and *Syn*. aff. *frequens* n. sp. *Syn. spirale* Bockwinkel et al.2009 is more subevolute until 20 mm dm, thinner, and has two U lobes less than *Syn. clavilobum*.

Stratigraphic range and geographic distribution. Late Givetian (MD III-C/E) of Germany (Rhenish Massive; Denckmann 1901b: Nordsauerland; Denckmann 1900, 1901a; Henke & Schmidt 1922: Meggen area; Denckmann 1903; Kullmann & Ziegler 1970: Ostsauerland; Waldschmidt 1885: Kellerwald; Sandberger & Sandberger 1850; Matern 1931: Dill Syncline; Beushausen 1900: Harz Mountains), southern Morocco (Tafilalt), and southern Algeria (Petter 1959: Ougarta,).

Sympharciceras frequens n. sp.

? 1872 *Goniatites clavilobus*. - Kayser, p. 667, fourth suture [only].
? 1895 *Goniatites clavilobus*. - Holzapfel, p. 327 [Kayser specimen].
? 1925 *Pharciceras clavilobum*. - Andree, p. 870, 872 [Kayser specimen].
1950 *Pharciceras tafilense* Termier & Termier, pl. 151, figs 22-24 [nom. nud.].
? 1950 *Pharciceras lunulicosta*. - Termier & Termier, p. 54, pl. 150, figs 43-45.
1959 *Sympharciceras clavilobum*. - Petter, p. 147-148, pl. 8, fig. 8 [only].
1974 *Sympharciceras clavilobum*. - Bensaïd, p. 115, pl. 5, fig. 5 [only].
2002 *Sympharciceras clavilobum*. - Korn & Klug, p. 145, figs 134C, 135C.
2002 *Sympharciceras tafilense*. - Korn & Klug, p. 145.

Description. The post-embryonic conch ontogeny is slightly triphasic, with ontogenetic changes near 3 and 7 mm dm (Figs 53A ,B, J-K). The ww/wh values peak at 2.50, the ww/dm values at ca. 0.70. The WER ratios decline steadily from 2.00 to slightly > 1.50 at the end of the second stage (Fig. 53L). Figs 54C,D illustrate two subglobular paratypes (MB.C.22131.4 and MB.C.22131.12), which show the constant opening of the umbilicus. The absolute reduction of the umbilicus by whorl overlap begins at 13-14 mm dm (paratypes MB.C.22131.14 and MB.C.22131.18, compare paratype MB.C.22131.10, Fig. 54E), the onset of compressed whorl form at ca. 20 mm dm. Even larger moulds with dm > 25 mm, such as the holotype, display the continuing absolute uw reduction. Adult whorls do not expand fast; WER values do not reach 2.00.

Only a few specimens display impressions of an ornament. Paratypes MB.C.22131.11, MB.C.22131.25, and MB.C.22131.26 possess weak, convex lateral ribbing caused by bundled growth lines. They are strongly arched over the flanks in paratype MB.C.22131.24 at 8 mm wh and there is no evidence for a projecting ventrolateral salient. Rather dense lines are visible around the umbilical wall of the juvenile MB.C.22131.18. Impressions of the wrinkle layer protract spirally on the lower flanks of MB.C.22131.24, similar to *Syn. spirale*, but are straight and radial in paratype MB.C.22131.21. Paratypes MB.C.22131.16 and MB.C.22131.27 bear very weak ventrolateral furrows until ca. 10 and 8.5 mm dm, respectively.

The many specimens makes it possible to reconstruct the suture ontogeny. Paratype MB.C.22131.12 shows a lateral U_6 at less than 2.5 mm wh, whilst the septal face of MB.C.22131.4 (Fig. 53C, see also an earlier suture in Fig. 53E) has only two inner and outer U lobes at ca. 3 mm wh. Therefore, this specimen with delayed suture complication is not selected as a paratype. The outer U_6 is present at 3.4 mm wh in paratype MB.C.22131.6 (Fig. 53F), the inner U_7 appears at ca. 4.5 mm wh (paratype MB.C.22131.15), the outer U_8 at 4.5 to 5 mm wh (paratype MB.C.22131.12, compare outer suture of paratype MB.C.22131.7 in Fig. 53G), the inner U_9 at ca. 6-7 mm wh (paratype MB.C.22131.22), the outer U_{10} at 9-10 mm wh (paratype MB.C.22131.8, Fig. 53H, paratype MB.C.22131.20), the inner U_{11} only very slightly later (paratype MB.C.22131.20, see septal face of paratype MB.C.22131.5 in Fig.

53D), and the outer U_{12} at ca. 15 mm wh (paratype MB.C.22131.17). Plurilobes are rarely developed, for example in the inner U_9 U_{11} saddle of MB.C.22131.5 (Fig. 53D).

Discussion. Termier & Termier (1950), referring to a manuscript by E. Clariond, illustrated a single small synpharciceratid from "Oued Kseir " (= Hassi Nebech) as *Ph. tafilense*. Unlike other goniatites named in this monograph, he provided no description or characterization on the text pages; hence, the name became a nom. nud. that was also ignored by Petter (1959). The original illustration suggests that *Ph. tafilense* is identical with our new species. A second pachyconic, slightly compressed (ww/wh = ca. 0.97, measurements taken from the drawing) and involute pharciceratid from Taouz illustrated by Termier & Termier (1950: pl. 150, figs 43-45) as *Ph. lunulicosta* appears to have an overlap of whorls over the umbilical space and shows synpharciceratid sutures with four outer U lobes. The suture illustration of fig. 45 is inconsistent with the drawing of the specimen in fig. 43. It could belong to *Syn. frequens* n. sp., but only if the given magnification (allegedly x 2) is incorrect. None of the Hassi Nebech pharciceratids is compressed below 10 mm dm, as suggested by the given size. The only Oued Kseir *clavilobum* specimen illustrated by Petter (1959: pl. 8, fig. 8) shows well the spiral absolute closure of the umbilicus which is characteristic of our new species.
The conch ontogeny of *Syn. frequens* n. sp. is very different from *Syn. clavilobum* but large specimens are difficult to distinguish if the umbilicus is not to see. The biggest difference of *Syn. frequens* n. sp. below 10 mm dm is the much wider umbilicus, resulting in much higher ww/wh ratios and lower ww/dm values. The abrupt and absolute closure of the umbilicus is the easiest way to distinguish the two species. *Syn. spirale* is less evolute and thinner than *frequens* n. sp., with a very gentle transition from depressed to compressed cross-section. It also lacks the U_{11} und U_{12} lobes.
Kayser (1872) mentioned that his *clavilobum* specimen from the Brilon area (Grottenberg, see Holzapfel 1895 and Andree 1925) had a wider umbilicus than the holotype. It may belong to our new species.
Stratigraphic range and geographic distribution. Southern Morocco (Tafilalt), ?Germany (Kayser 1872: Rhenish Massive). Late Givetian.

Synpharciceras aff. *frequens* n. sp.

1974 *Synpharciceras clavilobum*. - Bensaïd, p. 115, fig. 19d [only].
1974 *Synpharciceras* aff. *clavilobum*. - Bensaïd, pl. 5 figs 6, 6a .

Description. The sectioning of Hassi Nebech synpharciceratids suggests the presence of a third *Synpharciceras* species, which differs from *Syn. frequens* n. sp. only in early whorls up to ca. 10 mm dm. Distinctive features are a slightly triphasic post-embryonic conch ontogeny, with a change from nearly constant uw/dm ratios around 0.30 at 3 mm dm (Fig. 55F) to increasingly cadiconic whorls until 9-10 mm dm, with uw/dm up to > 0.40 and ww/wh up to 2.50 (Fig. 55G). The cross-sections, especially of MB.C.22132.3 (Fig. 55C) and MB.C.22132.1 (Fig. 55A), show that the second whorl is already rather wide, resulting in an early increase of ww/dm ratios from 0.70 to 0.80. At the end of the second post-embryonic stage whorls expand very slowly and WER values rise only slowly to 1.60 to 1.70 at 20 mm dm. There is evidence for some variability of the conch parameters, especially of ww/wh. MB.C.22132.2 (Fig. 55D) shows that there are only 3 outer U lobes at ca. 5 mm wh, but U_8 and U_{10} lobes are present at ca. 10 mm wh in MB.C.22132.1 (Fig. 55E), similar to *Syn. frequens* n. sp.

Discussion. The early ontogenety of the three available cross-sections is so different from the relatively invariable *Syn. frequens* n. sp. that they must represent a different species. Especially characteristic are the less evolute and much wider 2nd to 5th inner whorls. The sutures give no difference. Since a clear separation from *Syn. frequens* n. sp. is currently not possible, the three

sectioned specimens are kept in open nomenclature, as *Syn*. aff. *frequens* n. sp. It is probable that some specimens included in *Syn. frequens* n. sp. belong in fact to aff. *frequens*.

The rather wide early whorls with uw/dm = 0.40 at 5 mm dm of a sectioned *clavilobum* specimen in Bensaïd (1974: fig. $19d_1$ in the text) clearly place it in *Syn*. aff. *frequens* n. sp. A different specimen (STIPB-Bensaïd-46, old: GPI Bo 46) illustrated as *Syn*. aff. *clavilobum* (his pl. 5, fig. 6, 6a) is very pachyconic. The umbilicus remains slightly wider than in typical *frequens* but at this diameter the distinction of aff. *frequens* is equivocal.

Stratigraphic range and geographic distribution. Hassi Nebech, Section 2, SE Tafilalt. Late Givetian

Family Petteroceratidae Becker & House, 1993

Diagnosis (emend). Moderate to large-sized, early whorls depressed, subinvolute to evolute, mature whorls compressed, subinvolute, with rounded or oxyconic venter. Sutures with incipient to fully developed third E lobe and six to thirteen U lobes, often with more outer than inner ones.

Discussion. Our new observations at Hassi Nebech specimens show that the U lobes do not develop in the regular, alternating way as in typical Pharciceratinae and Synpharciceratinae. *Petteroceras* specimens display more outer than inner U lobes, which was first noted in Petter (1959, fig. $33H_2$). As discussed under *Extropharciceras* n. sp., it is possible that *Clariondites*, despite its incipient E_3 lobe, is not related to *Petteroceras*.

Petteroceras Bogoslovsky, 1962

Included species.

Pharciceras? errans Petter, 1959

Petteroceras n. sp. in Bensaïd (1974) [= *Pett. errans*]

?Petteroceras feisti House & Kirchgasser in House et al.,1985

Petteroceras n. sp. 1 in Becker & House (2000a)

Petteroceras n. sp. 2 in Becker & House (2000b)

Petteroceras n. sp. Becker in Aboussalam (2003)

Discussion. The ontogeny of the type species (see below) suggests that the "normal" alternating development of inner and outer U lobes is reversed by the U_5 lobe, which develops on the outer umbilical wall before a third internal U lobe is formed.

The lobe ventral of the largest/highest flank saddle is normally an E lobe in pharcicerataceans. Consequently, it is possible that *Pett. feisti* possesses four, not three E lobes, which would exclude this youngest known member of the Petteroceratidae from the genus. The *Petteroceras* marker bed of the Tafilalt Platform yielded a number of distinctive new species (Becker & House 2000a; Becker in Aboussalam 2003; Aboussalam & Becker 2004) which so far have only been listed in open nomenclature.

Stratigraphic range. If the basal Frasnian *?Pett. feisti* is excluded, the genus is restricted to the topmost Givetian (*Petteroceras errans* Zone, MD III-E).

Geographic distribution. ?Southern France (House et al. 1985: Montagne Noire), Spain (Montesinos & Henn 1986: Cantabrian Mountains), southern Morocco (Petter 1959:Tafilalt).

Petteroceras errans (Petter, 1959)

1950 *Beloceras Denckmanni*. - Termier & Termier, p. 54, pl. 151, figs 28-31.

1959 *Pharciceras (?) errans* Petter, p. 142, figs 33H, 37A, pl. 8, figs 11-12.

1974 *Petteroceras errans*. – Bensaïd, p. 116, figs 20c, 23a-b, pl. 5, figs 1, 1a.

1974 *Petteroceras* n. sp. Bensaïd, p. 116-117, fig. 23c, pl. 5, fig. 10.1985 *Petteroceras errans*. - Bensaïd et al: figs 299, 2, 4, 8.

non 1986 *Petteroceras errans*. - Montesinos & Henn, p. 69-70, figs 4, 5I, $5I_1$, 6A [new species].

non 1999 *Petteroceras errans*. - Belka et al., fig. 8, pl. 4, figs 9-10 [= n. sp.].

2002 *Petteroceras errans*. - Korn & Klug, p. 145, figs 135D, 136A, 136C.

2003 *Petteroceras errans*. – Aboussalam, fig. 14.

2003 *Petteroceras errans*. - Korn & Klug, p. 346.

non 2010 *Petteroceras errans*. - García-Alcalde, p. 49 [= Montesinos & Henn specimen].

Description. The Hassi Nebech material documents the complex ontogenetic changes of the species and its intraspecific variability, which concerns umbilical and whorl width, the timing of the onset of suture elements, and the development of ventrolateral furrows. Most characteristic is the change from juvenile, increasingly depressed and evolute conches (e.g., MB.C.22133.11, Fig. 57C) from ca. 10 mm dm on to gradually less depressed to compressed, suboxyconic (at ca. 10 mm wh, MB.C.22133.9 and MB.C.22133.12, Fig. 57D) to oxyconic whorls (at 29 mm wh, MB.C.22133.10 and MB.C.22133.9, Fig. 57B). Ventrolateral double furrows are present in many medium-sized specimens until ca. 30 mm dm and are pronounced in MB.C.22133.3 and MB.C.22133.2 (Fig. 56B), but lacking in MB.C.22133.4. MB.C.22133.9 even shows two spiral ridges flanked by three faint depressions at 28 mm dm. Inner whorls are smooth but some representatives (e.g., MB.C.22133.8, MB.C.22133.13, and MB.C.22133.15) display weak, dense, concave ribbing of the inner flanks. At larger size few specimens have very low and straight, undulose flank ribs (MB.C.22133.5). MB.C.22133.8 shows the strongly biconvex growth lines, with a very short subumbilical salient, a deep flank sinus, and a very pronounced ventrolateral salient corresponding to the spiral double furrows.

The characteristic E_3 lobes develops in the submature stage but a faint depression on the late inner slope of the median saddle can be discerned at 3.7 to 4.0 mm wh (MB.C.22133.8, MB.C.22133.15). In MB.C.22133.9 the E_3 is sharpened at 15 mm wh, somewhat later in MB.C.22133.9 (Fig. 56I). MB.C.22133.10 (Fig. 56J) shows its deep and asymmetric shape at maturity. Fully septate specimens and septal facies provides insights into the suture ontogeny (Fig. 56D). Until ca. 3 mm wh there are two internal and external U lobes (MB.C.22133.15, MB.C.22133.6, Fig. 56F). At ca. 4.5 mm wh (MB.C.22133.8) an incipient U_5 lobe develops on the outer umbilical wall, which becomes clearer at 5 (MB.C.22133.11) to 6 mm wh (MB.C.22133.17). At this stage, there are only two internal U lobes (MB.C.22133.11, MB.C.22133.17). MB.C.22133.19 shows a septal face with an internal U_6 lobe at 7.5 mm wh whilst there are still only three outer U lobes. An outer U_7 is present at 8.5 to 9 mm wh (MB.C.22133.4, Fig. 56D, MB.C.22133.9, MB.C.22133.7, Fig. 56G) and an internal U_8 follows at 12.5 mm wh (MB.C.22133.18), whilst the U_7 is already pronounced. A fifth outer U lobe (U_9) is developed in the lectotype and in the fragmentary MB.C.22133.5. In MB.C.22133.10 there is a U lobe (U_8 or U_9) on the umbilical seam. MB.C.22133.5 shows that the dorsal suture does not develop an additional U lobe (Fig. 56E), which justified the suture formula included in the diagnosis.

Discussion. The conch parameters of the lectotype fall in the variability field of the Hassi Nebech population. The fragment assigned to an unnamed new species in Bensaïd (1974) (Pl. 5, Fig. 10) represents an adult with characteristic, pointed E_3 lobe, which is curved inwards. A supposed representative from Ouidane Chebbi illustrated in Belka et al. (1999) retains a rounded venter and small E_3 at 56 mm dm and is slightly more evolute. It belongs to a different, new species. The Spanish specimen identified as *Pett. errans* by Montesinos & Henn (1985) possesses seven outer umbilicus lobes, which excludes it from the species and perhaps even from the genus. Early juveniles of *Pett. errans* resemble early stages of *Extropharciceras* but do not show their clear decline of WER.

Stratigraphic range. Topmost Givetian (MD III-E).

Geographic distribution. Southern Morocco (Tafilalt and Maider).

Order **Goniatitida** Hyatt, 1884
Suborder **Tornoceratina** Wedekind, 1918
Superfamily **Tornocerataceae** von Arthaber, 1911
Family **Tornoceratidae** von Arthaber, 1911

Subfamily **Tornoceratinae** von Arthaber, 1911

Included genera.
Tornoceras Hyatt, 1884
Epitornoceras Frech, 1902
Lobotornoceras Schindewolf, 1936
Linguatornoceras House, 1965
Simicheiloceras Becker, 1993
Oxytornoceras Becker, 1993.
Domanikoceras Becker & House, 1993
Discussion. As noted by Becker (1993), iterative evolution within the Tornoceratidae makes it difficult to establish clear and simple diagnoses of its systematic subunits. Three lineages, one with involute conchs (Tornoceratinae), one with involute conchs, ventrolateral furrows and a trend towards suture complication (Falcitornoceratinae), and one with openly umbilicate conchs and a trend towards suture simplification (Aulatornoceratinae), were rooted deep in the early Givetian, history of the family. They were established as tribi of the Tornoceratinae by Becker (1993) but raised to separate subfamilies by Korn & Klug (2002), which is followed here. We also agree that the Parodiceratidae can be recognized as a separate family, characterized by shallow dorsal lobes without a dorsal septal fold.
Stratigraphic range. Basal Givetian to early Famennian.

Epitornoceras **Frech, 1902**

Type species. *Goniatites mithracoides* Frech, 1888 (OD).
Diagnosis, included species, stratigraphic range and geographic distrubution. See Bockwinkel et al. (2009).

Epitornoceras mithracoides **(Frech, 1888)**

1888 *Goniatites (Tornoceras) mithracoides* Frech, p. 30-31, pl. 2, figs 1a-1ß.
2005 *Epitornoceras mithracoides*. - Aboussalam & Becker, p. 5.
2009 *Epitornoceras mithracoides*. - Bockwinkel et al., p. 65-67, fig. 1A-H, 2 [further synonymy].

Description. The limonitic Hassi Nebech material allows insights into the development of early to median stages. The material documents little variability in conch shape (Figs 58G-H) and sutures. Whorls are compressed from ca. 5 mm dm. The oblique, flat umbilical wall is established from ca. 5 mm wh on and may lead to the formation of a subumbilical edge on the internal moulds (MB.C.22101.6 and MB.C.22101.1, Fig. 58A). The flanks converge from the first whorl on to a narrowly rounded venter (MB.C.22101.1, Fig. 58A). Early ontogenetic WER values are partly slightly higher than in sectioned Dar Kaoua specimens (see Bockwinkel et al. 2009, fig. 1H). There is some conch variability between 10 and 30 mm dm (Fig. 58I). Growth lines are biconvex, sometimes bundled to weak lateral flank lirae (MB.C.22101.4, MB.C.22101.6), with a moderately high ventrolateral salient that becomes broader with growth (MB.C.22101.9).
At 3.5 mm wh (MB.C.22101.7) the A lobe is broadly and asymmetrically rounded but the ventrolateral saddle is already as high as the dorsolateral saddle. The deepening of the A lobe proceeds

rapidly (Figs 58D-F) and the ventrolateral saddle becomes subangular at the same size. The diverging E lobe has a very narrow basal tip, which gives a funnel-shape. The I lobe is narrow, parallel-sided (e.g., MB.C.22101.2, Fig. 58B, and MB.C.22101.9) and subangular at maturity (MB.C.22101.5, Fig. 59A).

Discussion. The well-preserved small Hassi Nebech specimens have more acute ventrolateral saddles than in the older Dar Kaoua material and this may reflect a morphological trend.
Stratigraphic range and geographic distribution. ?USA (cf. New York), Germany (Rhenish Massive), southern Morocco (Tafilalt, Dra Valley), possibly (cf.) Algeria (Ougarta),.

Lobotornoceras Schindewolf, 1936

Included species.
Goniatites strangulatus Keyserling, 1844
Goniatites Ausavensis Steininger, 1849
Lobotornoceras hassoni House, 1978
Lobotornoceras bensaidi n. sp.
Lobotornoceras aff. *hassoni* in House & Kirchgasser (1993, 2008)
?Lobotornoceras n. sp. in Becker & House (2000a)
Lobotornoceras ausavense n. ssp. in Becker et al. (2004)
Lobotornoceras n. sp. in Becker et al. (2004)
Discussion. *Lobotornoceras* currently includes two species groups. Givetian to early
 Frasnian forms lack the typical and marked constrictions seen in the Middle/Late Frasnian type species and in the Middle Frasnian *L. strangulatum*. However, some still unnamed Middle/Late Frasnian forms are intermediate and possess only short mould constrictions that are restricted to the venter (taxa briefly described in open nomenclature in Becker & House 2000a and Becker et al. 2004). Small size and very compressed conches are invariable characteristics of the genus.
Stratigraphic range. The new species from Hassi Nebech significantly extends the lower range of the genus. The total range is now late Givetian (probably *Taouzites taouzensis* Zone, MD III-D to late Frasnian (e.g., *Neomanticoceras paradoxum* zone of Büdesheim, Eifel). The genus became extinct in the course of the Lower Kellwasser Event.
Geographic distribution. USA (House 1978: West Virginia; House & Kirchgasser 1993, 2008: New York State); ?SW England (Anniss 1933), Germany (Steininger 1849; Schindewolf 1936: Rhenish Massive), southern Morocco (Bensaïd 1974; Becker & House 2000: Tafilalt; Becker et al. 2004: eastern Dra Valley), Russia (Keyserling 1844; Becker et al. 2000: Timan). Records of the type species from the Chudleigh and Saltern Cove areas of South Devon by Anniss (1927, 1933) could not be substantiated during revisions (House 1963, 2002). The absence of *Lobotornoceras* from extremely rich Frasnian populations in NW Australia (Glenister 1958; Becker et al. 1993; Becker & House 2009) suggests a palaeobiogeographic restriction to a realm around the Old Red Continent, including the narrow western Prototethys/NW Gondwana.

Lobotornoceras bensaidi n. sp.

1974 *Tornoceras frechi*. - Bensaïd, p. 118-119, pl. 5, figs 4, 4a [only].

Description. The holotype is a well-preserved, complete internal mould that is fully septate. The umbilicus is very narrow and was certainly closed by the shell. The umbilical wall is very short and shallow, the flanks are flat, the venter is narrowly rounded. The maximum whorl width occurs in the region one-third of the distance from the umbilicus to the venter. There is no evidence of ventrolateral

furrows. The paratypes (Figs 61A-C) very closely resemble the holotype . The conch ontogeny is only partly preserved in paratype MB.C.22102.2, which was photographed before sectioning. The conch parameter plots in Figs 60D-F show the steady decline of ww/dm and ww/wh ratios in stages larger than 3.5 mm dm, the WER falls to a minimum of 1,83 between 6 and 7 mm dm and thereafter rises to values near 2.00. The biconvex growth lines are easily visible on the holotype.

Septal spacing is very dense in the four specimens, with 22 to 26 chambers per whorl, with evidence of septal crowding towards the body chamber in the holotype and in paratype MB.C.22102.3. There is a slight variation in the shape of the A L saddle (Figs 60B-C), which is always higher than the asymmetric ventrolateral saddle. Exposed septal faces prove the existence of a saddle at the seam and an inner L lobe (holotype).

Discussion. Since only the figured material is housed in the Bonn collection, it is not clear, how many of the seven tornoceratids included by Bensaïd (1974) in *Tornoceras frechi*, apart from G.P.I Bo 44, conform with *L. Bensaïdi* n. sp. It can be easily distinguished from the Middle/Late Frasnian lobotornoceratids with mould constrictions. The Lower Frasnian *L. hassoni* has more elevated dorsolateral saddles with steep external slope; the ventrolateral saddles are also higher.
The small size of the types, with septal crowding in half of them, suggests small mature size, which is typical for all other species of the genus.
Stratigraphic range and geographic distribution. Type locality and horizon.

Subfamily **Falcitornoceratinae** Becker, 1993

Included genera.
Falcitornoceras House & Price, 1985
Phoenixites Becker, 1993
Gundolficeras Becker, 1995
Nebechoceras n. gen.
N. Gen. I (oxyconic group starting from *"Tornoceras" subacutum* Makowski, 1991; compare Becker 1995, Dzik 2006, and the discussion in Niechwedowicz & Trammer 2007)
N. Gen. II ("*Falcitornoceras*" *korni* Group, see comments in Becker 1995 and Becker & House 2009)
Kourazoceras Becker in Becker et al. (2002)
N. Gen. III (*Exotornoceras fezzouense* Group, see discussion in Becker 2002)

Discussion. Currently there are two groups within the subfamily, one with simple L lobes (*Phoenixites*, N. Gen. I, *Nebechoceras* n. gen.), one with subdivided L-lobes (all other genera). This may warrent a future subdivision.
Stratigraphic range. Late Givetian to latest Famennian (see review in Becker 1995).
Geographic distribution. Canada (NW Territorries), USA (New York State), Germany (Rhenish Massive, Harz Mountains, Thuringia, Saxony), Austria/Italy (Graz Palaeozoicum, Carnic Alps), France (Armorican Massif, Montagne Noire), Spain (Cantabrian Mountains, Iberian Chains, Guadalmez Syncline/SW Spain), Morocco (Meseta, Dra Valley, Tafilalt, Maider), Algeria (Gourara, Saoura Valley), Czechia (Moravia), Poland (Holy Cross Mountains), Russia (?Novaya Zemlya, Timan, Western Urals/Bashkiria), Kazakhstan (Karaganda Basin, Semipalatinsk region), SW Tien Shan (Alai Range), Iran (Shotori Range), South China (Guangxi), Australia (Canning Basin).

Nebechoceras **n. gen.**

Discussion: The sudden opening of the umbilicus in mature internal moulds of *Nebechoceras* forms a striking contrast to the related *Phoenixites*, where even very large-sized specimens (> 100 mm dm)

lack an open umbilicus or umbilical plug. A similar feature, however, may have been present within the Falcitornoceratinae in adult, stratigraphically much younger (late Famennian) *Gundolficeras bicaniculatum* (see neotype in Becker 1995). Umbilical shell thickenings have also been described in barytized specimens of the unrelated, Middle Frasnian *Tornoceras obesum* (*Tornoceras uniangulare* in Clarke 1899, re-figured by Miller 1938, re-assigned and figured by House 1965, fig. 12H), where they begin at a slightly earlier ontogenetic stage (4th whorl).

Nebechoceras excentricum n. sp.

Description. It is possible to distinguish two morphotypes, based on the presence or absence of ventrolateral furrows. Morphotype I includes the holotype and all other specimens without distinctive ventrolateral furrows. The fully septate holotype is also the largest available specimen that shows very clearly the sudden umbilical uncoiling at ca. 20 mm dm (Fig. 63A). This is also evident in the partially preserved last whorl of the sectioned paratype MB.C.22103.8 (Fig. 62G). In paratype MB.C.22103.14 the same pattern can be weakly observed at 21 mm dm. It is assumed that the growing umbilical opening was sealed by a massive shell plug. The umbilical wall is short and occasionally slightly oblique (paratype MB.C.22103.13). Figs 62B-I illustrate the rather uniform conch shape with rounded venter in a cross-section series. Some variability of ww/dm and WER values is documented in Figs 62M-O but all specimens have markedly compressed, rapidly expanding mature whorls.
The characteristic, strongly biconvex growth lirae can be seen in the holotype and in many other well-preserved moulds (MB.C.22103.11, MB.C.22103.17). Paratype MB.C.22103.20 displays weak spiral lines on the outer flank. In Morphotype II weak to distinctive ventrolateral furrows can be discerned in juvenile stages (paratypes MB.C.22103.19 and MB.C.22103.21: at ca. 3 mm wh) or up to 8 mm wh (paratype MB.C.22103.12, Fig. 63C, and paratype MB.C.22103.6). The rather poorly preserved MB.C.22103.16 possesses rounded ventrolateral edges. In the furrowed paratypes MB.C.22103.15 and MB.C.22103.19 regular growth lirae are preserved that are typical for the more common Morphotype I. Paratype MB.C.22103.8 combines the umbilical opening at the end of the last preserved whorl (Fig. 62G) with shallow furrows until 8 mm wh, an oblique umbilical wall on the last preserved whorl, and impressed ornament; this specimen is crucial to demonstrate that forms without or with furrows belong to the same, somewhat variable species.
A typical septal face is illustrated in Fig. 62A. Sutures of individual specimens vary in the height of saddles and in the depth of the A lobe. The holotype has a relatively shallow A lobe, which is deeper, with a more inclined ventrolateral saddle, in paratypes MB.C.22103.9 (Fig. 62L) and MB.C.22103.14. The ventrolateral saddle is always lower than the dorsolateral saddle, with the exception of MB.C.22103.22 that displays weak ventrolateral furrows and lirae. The small, mostly divergent (funnel-shaped) E lobe often has a closed base but it is open, based on a very strictly ventral siphuncle, and with parallel sides, in paratypes MB.C.22103.1 (Fig. 62K) and MB.C.22103.14.

Discussion. The Givetian age and the presence of two morphotypes with or without distinctive ventrolateral furrows suggests a position at the transition from the Tornoceratinae to the Falcitornoceratinae. Because of the similar sutures, it is likely that *N. excentricum* n. gen. n. sp. is phylogenetically related to early *Phoenixites*, such as the associated *P. lenticulus* n. sp.
The spiral structures of paratype MB.C.22103.20 may represent tracking or drag bands caused by the forward movement of the soft body with growth (for a review see Checa & Garcia-Ruiz 1996).
Stratigraphic range and geographic distribution. Type locality and horizon.

Phoenixites Becker, 1993

Included species.

?*Tornoceras circumflexum* var. *incrassata* Gürich 1896 (= var. *inflata* Gürich, 1896 nom. vad.)
?*Tornoceras circumflexum* var. *applanata* Gürich, 1896.
Tornoceras frechi Wedekind, 1918
Tornoceras frechi var. *varicata* Wedekind, 1918
Tornoceras (Tornoceras) concentricum House, 1965
Tornoceras frechi parvum Makowski, 1991 (synonym of *P. frechi*, see also Dzik 2006)
Phoenixites sulcatus Becker, 1993
Phoenixites lenticulus n. sp.
Phoenixites aff. *frechi* in Becker et al. (2004)
Phoenixites n. sp. in Becker et al. (2004)
The Dra Valley of SW Morocco (Becker et al. 2004; Aboussalam et al. 2004) includes various
Givetian forms (listed in open nomenclature as "*Phoenixites*") which generic position needs to be
settled by further study. Becker (1993) quoted *Goniatites nummularius* Roemer, 1843 as a possible
synonym of *Ph. frechi* but, following the re-discovery of its type, the species was re-assigned to
Linguatornoceras in Becker et al. (2000). The same authors transferred *Tornoceras (Aulatornoceras)
keyserlingi* Müller, 1956 with reservation (?) from *Phoenixites* to *Truyolsoceras*.
*Stratigraphic range.*Late Givetian (*Taouzites taouzensis* Zone, MD III-D) to upper part of lower
Famennian (*Paratorleyoceras globosum* Zone, UD II-D).
Geographic distribution. USA (New York State), Germany (Rhenish Massive, ?Harz Mountains,
?Thuringia), France (Montagne Noire), Spain (Cantabrian Mountains, Guadalmez Syncline/SW
Spain), Morocco (Meseta, Tafilalt, Maider), Algeria (Gourara), Poland (Holy Cross Mountains),
?Russia (Novaya Zemlya)

Phoenixites lenticulus n. sp.

Description. The new species is easily recognizable by its peculiar lenticular cross-section (Fig. 64B-
C). Large specimens are not known. Some medium-sized representatives (e.g., paratype
MB.C.22104.10) are less lenticular than typical small specimens; their umbilical wall is slightly
oblique but short. The umbilicus was probably completely sealed by shell; it does not increase its
absolute width in post-embryonic whorls (Fig. 64G). Ww/dm ratios decrease continuously from early
post-embryonic values of 0.65 to 0.45 in the larger holotype (Fig. 64G); ww/wh ratios decrease
correspondingly (Fig. 64H). WER rises steadily from 1.80 to 1.90 in the 2nd to 4th whorl (up to 6 mm
dm) to ca. 2.20 towards maturity (Fig. 64I).
Healed shell fractures are preserved in paratypes MB.C.22104.14 and MB.C.22104.2 and are well
visible in paratype MB.C.22104.11. While the conch shape and ontogeny shows little variability, the
ventrolateral furrows can be weak or distinct and they may disappear at 3-4 mm wh (e.g., in paratype
MB.C.22104.16) or continue until 8 mm wh (e.g., in paratype MB.C.22104.7, Fig. 65A).
MB.C.22104.8 differs from all other specimens by very strong furrows (Fig. 65C) and by a less
lenticular conch shape; it is here regarded as an intraspecific extreme. The strongly biconvex growth
lines are barely discernible on the moulds (only under strongly oblique light), especially the low and
wide inner flank salient.
During ontogeny the saddles become slightly higher but the ventrolateral saddle always remains lower
than the dorsolateral saddle (paratype MB.C.22104.6, Fig. 64F, paratype MB.C.22104.7, Fig. 65A).
The divergent E lobe is moderately narrow (Fig. 64E) to narrow (Fig. 64F). A gradual narrowing of
the dorsal lobe is visible in the series from paratypes MB.C.22104.2 (septal face of Fig. 64A) and
MB.C.22104.9 to paratype MB.C.22104.15, and finally to paratypes MB.C.22104.11 and
MB.C.22104.7. The number of septa/whorl varies between 15 and 21, with evidence of episodic septal
crowding in several specimens, including the holotype (Fig. 65B).

Discussion. The new species differs from the younger *P. frechi, ?P. applanatus,* and *P. concentricus*
by its distinctive, lenticular conch shape. Its small size suggests that it is micromorphic. The lower

Famennian *P. varicatus* and *P. sulcatus* posses mould constrictions. The poorly known *?P. incrassatus* from the Frasnian (as stated in the original description), not early Famennian (as claimed in Dzik 2006), of the Holy Cross Mtns was also characterized in Gürich (1896) by a lenticular cross-section. However the original drawing depicts this as a late ontogenetic feature. Its early stages are unknown and consequently, the generic assignment must remain questionable until revision. *N. excentricus* n. gen. n. sp. has less convergent flanks and a different ornament.

Stratigraphic range and geographic distribution. Type locality and horizon.

3. Conch dimensions

Pseudoprobeloceras pernai (Wedekind, 1918) from Hassi Nebech in comparison with the lectotype and types of synonymized other species

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
lectotype *pontiforme*	38.5	-	15.0	12.0	-	-	-	0.31	-	-
lectotype *pernai*	38.0	12.0	14.6	11.5	-	0.32	0.82	0.30	-	-
paratype MB.C.22134.16	32.0	9.7	13.5	10.8	11.4	0.30	0.72	0.34	2.41	0.15
paratype MB.C.22134.17	27.0	8.2	11.0	9.1	9.2	0.30	0.75	0.34	2.30	0.16
paratype MB.C.22134.18	26.9	8.6	11.4	8.7	9.7	0.32	0.75	0.32	2.45	0.15
paratype MB.C.22134.19	24.9	8.0	10.0	7.4	8.0	0.32	0.80	0.30	2.17	0.20
paratype MB.C.22134.6	24.5	7.9	10.4	8.6	8.3	0.32	0.76	0.35	2.29	0.20
lectotype *pernai*	22.0	8.2	9.5	7.2	-	0.37	0.86	0.33	-	-
paratype MB.C.22134.1	18.7	5.8	7.3	6.4	5.7	0.31	0.80	0.34	2.06	0.22
holotype *nebechense*	18.0	5.9	7.4	6.1	-	0.33	0.80	0.34	-	-
paratype MB.C.22134.8	16.8	5.7	6.6	5.3	5.1	0.34	0.86	0.32	2.06	0.23
paratype MB.C.22134.20	16.0	5.2	6.2	5.6	4.9	0.33	0.85	0.35	2.08	0.21
lectotype *costulatum*	13.0	4.5	5.0	4.0	-	0.35	0.90	0.31	-	-
paratype MB.C.22134.7	11.7	4.4	4.7	4.3	3.7	0.38	0.94	0.37	2.15	0.21

Pseudoprobeloceras praecox n. sp. in comparison with an Algerian specimen identified by Petter (1959) as *Probeloceras pernai*

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
pernai of Petter (1959)	29.0	6.6	8.0	6.0	-	0.23	0.83	0.21	-	-
holotype MB.C.22135.1	25.5	7.5	12	6.3	10	0.29	0.63	0.25	2.71	0.17
paratype MB.C.22135.4	18.6	6.2	8.9	4.4	7.0	0.33	0.69	0.24	2.56	0.22
paratype MB.C.22135.8	17.6	6.0	7.4	5.1	6.0	0.34	0.81	0.29	2.30	0.19
paratype MB.C.22135.9	16.3	5.9	7.5	5.1	5.9	0.36	0.79	0.31	2.46	0.21
paratype MB.C.22135.10	14.3	5.9	5.9	4.3	-	0.41	1.00	0.30	-	-
paratype MB.C.22135.11	13.1	5.3	5.6	4.0	4.3	0.40	0.95	0.31	2.22	0.23
paratype MB.C.22135.2	11.5	4.8	5.6	3.0	4.3	0.42	0.86	0.26	2.56	0.23
paratype MB.C.22135.4	7.6	3.5	3.3	2.2	2.5	0.46	1.05	0.29	2.21	0.25
paratype MB.C.22135.4	3.7	2.0	1.4	1.3	1.0	0.55	1.48	0.35	1.92	0.24
paratype MB.C.22135.4	1.9	1.1	0.7	0.7	0.5	0.58	1.48	0.36	1.89	0.31

Scaturites minutus n. gen. n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22136.8	14.9	4.8	6.1	4.6	5.4	0.32	0.79	0.31	2.46	0.11
paratype MB.C.22136.5	12.4	3.5	5.1	4.0	4.3	0.28	0.68	0.32	2.35	0.15
paratype MB.C.22136.2	12.3	4.0	5.2	3.8	4.5	0.33	0.77	0.31	2.49	0.13
paratype MB.C.22136.4	12.2	4.0	5.1	3.8	4.2	0.33	0.79	0.31	2.30	0.18
paratype MB.C.22136.7	11.3	4.2	4.3	3.6	-	0.37	0.98	0.32	-	-
paratype MB.C.22136.3	10.5	3.3	4.8	2.9	4.0	0.32	0.69	0.27	2.57	0.18
holotype MB.C.22136.1	10.3	3.6	3.8	3.0	-	0.35	0.95	0.29	-	-
paratype MB.C.22136.10	9.4	3.1	4.3	3.0	3.5	0.33	0.72	0.32	2.54	0.19
paratype MB.C.22136.12	9.4	3.1	3.9	3.1	3.4	0.33	0.79	0.33	2.45	0.13
paratype MB.C.22136.11	7.8	2.9	3.3	2.5	2.8	0.37	0.88	0.32	2.43	0.15
paratype MB.C.22136.4	5.3	2.0	2.1	1.9	1.7	0.37	0.92	0.37	2.23	0.19
paratype MB.C.22136.4	1.8	0.7	0.6	0.8	0.5	0.39	1.21	0.44	1.98	0.10

Darkaoceras velox n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22105.10	25.4	8.9	13.0	6.0	9.0	0.35	0.68	0.24	2.40	0.31
paratype MB.C.22105.15	21.1	8.2	10.6	4.5	7.8	0.39	0.77	0.21	2.52	0.26
holotype MB.C.22105.1	20.3	8.1	10.3	4.4	6.7	0.40	0.79	0.22	2.23	0.35
paratype MB.C.22105.12	16.4	6.4	7.9	4.0	-	0.39	0.81	0.24	-	-
paratype MB.C.22105.14	17.0	7.0	8.8	4.0	6.2	0.41	0.80	0.24	2.48	0.30
paratype MB.C.22105.2	16.6	6.7	7.8	3.2	5.7	0.40	0.86	0.19	2.29	0.27
paratype MB.C.22105.3	15.3	6.4	7.4	3.6	5.5	0.42	0.86	0.23	2.42	0.26
paratype MB.C.22105.5	10.7	5.3	4.8	2.9	3.3	0.50	1.10	0.27	2.11	0.31
paratype MB.C.22105.2	4.9	3.3	2.2	1.4	1.4	0.67	1.49	0.29	1.99	0.36
paratype MB.C.22105.2	3.5	2.4	1.3	1.3	1.0	0.69	1.88	0.36	1.89	0.25
paratype MB.C.22105.2	2.5	1.7	1.0	0.9	0.6	0.66	1.75	0.36	1.76	0.35

Taouzites taouzensis (Termier & Termier, 1950) from the type locality

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22106.7	41.8	9.5	24.1	4.5	-	0.23	0.39	0.11	-	-
MB.C.22106.11	28.1	7.7	15.1	4.5	11.0	0.27	0.51	0.16	2.70	0.27
MB.C.22106.3	27.6	7.2	14.2	4.7	10.4	0.26	0.50	0.17	2.58	0.27

MB.C.22106.12	25.3	7.0	13.8	4.5	9.7	0.28	0.51	0.18	2.63	0.30
MB.C.22106.4	23.2	5.8	11.5	5.2	8.3	0.25	0.51	0.22	2.41	0.28
lectotype	22.0	6.0	12.0	4.0	-	0.27	0.50	0.18	-	-
MB.C.22106.2	20.1	6.1	10.9	3.2	8.0	0.30	0.56	0.16	2.76	0.27
MB.C.22106.14	17.4	5.4	9.0	3.8	7.0	0.31	0.60	0.22	2.80	0.22
MB.C.22106.10	16.2	5.2	8.3	3.4	6.1	0.32	0.63	0.21	2.57	0.26
MB.C.22106.13	14.5	4.8	7.7	3.0	5.5	0.33	0.62	0.21	2.60	0.29
MB.C.22106.21	9.5	3.6	4.5	2.5	3.6	0.38	0.80	0.26	2.55	0.21
MB.C.22106.15	8.3	3.5	3.6	2.7	2.7	0.42	0.97	0.33	2.16	0.26
MB.C.22106.10	6.6	2.9	2.6	2.3	2.1	0.44	1.12	0.35	2.16	0.19
MB.C.22106.10	2.3	1.2	0.8	0.9	0.7	0.52	1.47	0.38	1.97	0.19

Pharciceras decoratum n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22107.4	22.2	11.8	6.0	12.0	4.0	0.53	1.97	0.54	1.49	0.33
paratype MB.C.22107.5	19.4	11.2	5.0	10.6	3.8	0.58	2.24	0.55	1.55	0.24
holotype MB.C.22107.1	14.4	7.5	3.1	8.6	2.6	0.52	2.42	0.60	1.49	0.16
paratype MB.C.22107.7	14.1	7.7	3.3	7.5	-	0.55	2.33	0.53	-	-
paratype MB.C.22107.2	12.5	6.0	2.7	7.6	2.2	0.48	2.21	0.61	1.46	0.20
paratype MB.C.22107.2	7.5	3.2	1.7	4.6	1.3	0.43	1.89	0.61	1.48	0.20
paratype MB.C.22107.2	3.5	1.7	0.8	1.9	0.7	0.48	2.04	0.55	1.54	0.18
paratype MB.C.22107.2	2.2	1.1	0.5	1.1	0.4	0.51	2.05	0.51	1.52	0.24

Pharciceras. aff. *tridens* (Sandberger & Sandberger, 1850)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22108.3	19.0	10.8	5.5	9.6	4.1	0.57	1.96	0.51	1.63	0.25
MB.C.22108.1	14.6	8.4	3.8	7.9	2.7	0.58	2.20	0.54	1.49	0.31
MB.C.22108.4	13.1	7.5	2.9	7.2	1.9	0.57	2.59	0.55	1.37	0.34
MB.C.22108.1	9.7	5.4	2.2	5.8	1.6	0.56	2.49	0.60	1.45	0.24
MB.C.22108.5	7.3	4.0	1.8	3.9	1.2	0.55	2.22	0.53	1.43	0.33
MB.C.22108.1	2.8	1.4	0.8	1.4	0.7	0.49	1.72	0.50	1.74	0.15

Pharciceras lateseptatum (Frech, 1902)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
Morphotype I										
MB.C.22109.4	14.8	9.6	4.6	6.5	2.8	0.65	2.09	0.44	1.52	0.39
MB.C.22109.17	12.7	9.0	4.6	5.6	2.6	0.71	1.98	0.44	1.58	0.43
MB.C.22109.15	12.4	7.5	3.9	5.5	2.6	0.61	1.95	0.44	1.60	0.32
MB.C.22109.16	24.5	12.5	8.6	10.3	5.9	0.51	1.45	0.42	1.74	0.31
MB.C.22109.15	20.7	11.0	7.6	7.9	4.9	0.53	1.45	0.38	1.71	0.36
MB.C.22109.1	18.1	10.8	5.6	8.1	3.4	0.60	1.92	0.45	1.52	0.39
MB.C.22109.2	17.3	10.6	6.2	6.8	4.1	0.61	1.71	0.39	1.71	0.34
MB.C.22109.15	15.9	9.5	5.2	6.8	3.5	0.60	1.82	0.43	1.64	0.33
MB.C.22109.14	11.7	8.4	3.9	5.5	-	0.72	2.15	0.47	-	-
MB.C.22109.15	9.8	6.3	3.0	4.6	2.1	0.64	2.08	0.47	1.62	0.31
MB.C.22109.15	7.7	4.8	2.1	3.9	1.5	0.62	2.24	0.51	1.56	0.28
MB.C.22109.2	2.4	1.6	0.8	1.0	0.6	0.67	2.05	0.42	1.73	0.27
Morphotype II										
MB.C.22109.12	14.0	10.5	5.1	5.3	3.1	0.75	2.07	0.38	1.66	0.38
MB.C.22109.9	11.3	8.7	3.4	5.0	2.3	0.77	2.56	0.44	1.58	0.32
MB.C.22109.18	10.6	7.3	3.0	4.7	2.4	0.69	2.43	0.44	1.67	0.20
MB.C.22109.11	6.3	4.7	1.5	3.0	1.1	0.75	3.13	0.48	1.47	0.27
MB.C.22109.12	2.0	1.2	0.6	0.9	0.5	0.61	2.06	0.44	1.77	0.16

Pharciceras fornix n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22110.9	32.8	17.0	13.5	10.5	8.5	0.52	1.26	0.32	1.82	0.37
holotype MB.C.22110.1	29.1	16.4	12.7	8.3	7.6	0.56	1.29	0.29	1.83	0.40
paratype MB.C.22110.10	25.6	16.0	10.0	8.5	-	0.63	1.60	0.33	-	-
paratype MB.C.22110.11	18.8	11.6	7.4	6.3	4.8	0.61	1.57	0.34	1.79	0.35
paratype MB.C.22110.11	10.8	8.2	3.8	4.4	2.3	0.76	2.19	0.41	1.62	0.38
paratype MB.C.22110.11	8.5	6.3	2.6	3.7	1.8	0.75	2.40	0.44	1.61	0.32
paratype MB.C.22110.11	4.1	3.1	1.3	1.8	0.9	0.74	2.33	0.44	1.63	0.32
paratype MB.C.22110.11	2.5	1.8	0.8	1.0	0.6	0.72	2.18	0.40	1.66	0.32

Pharciceras subconstans n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype MB.C.22111.1	15.9	10.4	6.2	4.4	3.8	0.65	1.66	0.27	1.72	0.39

paratype MB.C.22111.2	13.0	9.5	5.2	3.2	-	0.73	1.83	0.25	-	-
cf. MB.C.22112.1	11.5	8.5	4.5	3.3	2.9	0.74	1.89	0.28	1.79	0.36
holotype MB.C.22111.1	9.1	6.8	4.0	2.1	2.2	0.75	1.72	0.23	1.75	0.45
holotype MB.C.22111.1	6.9	5.3	3.0	1.8	1.6	0.77	1.76	0.25	1.70	0.47
holotype MB.C.22111.1	5.3	4.0	2.1	1.4	1.3	0.75	1.87	0.27	1.79	0.37
holotype MB.C.22111.1	2.1	1.6	0.9	0.7	0.6	0.74	1.88	0.34	1.91	0.30

Pharciceras involutum n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22113	44.0	14.4	21.2	6.7	12.0	0.33	0.68	0.15	1.89	0.43
MB.C.22113	32.0	12.3	16.1	5.1	9.7	0.38	0.76	0.16	2.06	0.40
MB.C.22113	22.3	9.5	10.8	-	6.9	0.42	0.88	-	2.10	0.36

Extropharciceras arenicum (Petter, 1959)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
lectotype	35.0	14.1	17.5	7.3	10.0	0.40	0.81	0.21	1.96	0.43
cf. MB.C.22139.2	33.2	13.5	16.9	5.7	9.6	0.41	0.80	0.17	1.98	0.43
MB.C.22114.2	31.8	15.2	15.5	7.4	8.9	0.48	0.98	0.23	1.93	0.43
MB.C.22114.6	25.6	13.1	12.0	6.2	6.8	0.51	1.09	0.24	1.85	0.43
MB.C.22114.1	24.4	11.6	12.5	4.9	7.2	0.48	0.93	0.20	2.01	0.42
MB.C.22114.8	21.5	10.7	10.8	3.9	6.1	0.50	0.99	0.18	1.95	0.44
syntype (Petter. pl. 7. fig. 6)	21.4	10.5	9.1	5.2	6.4	0.49	1.16	0.24	2.04	-
MB.C.22114.4	18.9	9.5	9.1	3.7	5.3	0.50	1.04	0.20	1.91	0.43
MB.C.22114.9	18.9	9.8	9.0	4.0	-	0.52	1.09	0.21	-	-
MB.C.22114.5	18.0	9.0	9.3	3.2	5.3	0.50	0.97	0.18	2.01	0.43
MB.C.22114.3	17.3	9.0	8.5	3.2	4.7	0.52	1.07	0.19	1.89	0.45
cf. MB.C.22115.1	16.5	9.3	8.5	3.5	4.3	0.56	1.09	0.21	1.83	0.49
MB.C.22114.10	16.0	8.4	7.9	3.3	4.6	0.53	1.06	0.21	1.97	0.42
MB.C.22114.11	15.9	9.0	7.4	3.6	4.4	0.57	1.22	0.23	1.91	0.41
MB.C.22114.12	15.0	8.7	7.7	3.1	4.3	0.58	1.13	0.21	1.97	0.44
MB.C.22114.4	13.7	7.5	6.1	3.3	3.6	0.55	1.23	0.24	1.84	0.41
MB.C.22114.13	11.8	6.9	5.0	3.3	2.7	0.58	1.38	0.28	1.68	0.46
MB.C.22114.4	7.8	4.7	3.0	2.4	1.8	0.61	1.56	0.31	1.67	0.42
MB.C.22114.4	4.7	3.0	1.7	1.7	1.0	0.64	1.78	0.35	1.60	0.42
MB.C.22114.4	2.3	1.5	0.9	0.8	0.6	0.65	1.78	0.36	1.74	0.34

Extropharciceras applanatum (Bensaïd, 1974) and *Extropharciceras* cf. *applanatum*

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
Morphotype I										
MB.C.22116.9	50.8	18.6	20.8	12.5	-	0.37	0.89	0.25	-	-
MB.C.22116.2	45.0	18.2	19.4	11.3	12.0	0.41	0.94	0.25	1.85	0.38
holotype STIPB-Bensaïd-36	37.0	15,7	15,8	8,8	9,7	0,42	0,97	0,24	1,84	0,39
paratype STIPB-Bensaïd-39	32.6	14.2	14.2	8.3	9.1	0.43	1.00	0.26	1.92	0.36
MB.C.22116.5	30.3	13.5	12.8	8.6	7.9	0.45	1.05	0.28	1.83	0.38
MB.C.22116.10	25.4	12.0	11.8	6.2	6.9	0.47	1.02	0.24	1.89	0.42
MB.C.22116.11	19.8	9.7	7.9	6.4	4.9	0.49	1.22	0.32	1.76	0.38
MB.C.22116.4	16.4	9.5	6.3	6.2	3.9	0.58	1.51	0.37	1.72	0.38
MB.C.22116.4	12.5	7.4	4.0	5.6	2.4	0.59	1.86	0.44	1.52	0.41
MB.C.22116.4	10.2	6.1	3.0	4.9	2.0	0.60	2.03	0.49	1.54	0.33
MB.C.22116.4	6.7	4.0	1.7	3.6	1.2	0.60	2.36	0.54	1.47	0.30
MB.C.22116.4	3.7	2.2	1.0	1.8	0.7	0.60	2.19	0.48	1.56	0.27
MB.C.22116.4	2.9	1.8	0.9	1.3	0.6	0.60	1.99	0.44	1.62	0.29
Morphotype II										
MB.C.22116.14	15.5	7.3	6.2	5.5	4.0	0.47	1.17	0.35	1.81	0.36
MB.C.22116.14	11.5	6.6	3.8	5.0	2.4	0.57	1.74	0.43	1.60	0.37
MB.C.22116.14	9.1	5.4	2.7	4.3	1.7	0.59	1.98	0.47	1.53	0.36
MB.C.22116.14	6.0	3.6	1.6	3.1	1.1	0.59	2.20	0.52	1.48	0.35
MB.C.22116.14	4.9	2.9	1.3	2.6	0.9	0.58	2.28	0.52	1.50	0.28
MB.C.22116.14	3.3	1.9	0.9	1.6	0.7	0.59	2.22	0.49	1.56	0.25
MB.C.22116.14	2.1	1.2	0.6	0.9	0.5	0.59	1.91	0.43	1.66	0.27
cf. *applanatum*										
MB.C.22117.1	15.5	8.4	6.7	4.5	-	0.54	1.25	0.29	-	-
MB.C.22117.2	11.9	7.0	4.9	4.1	-	0.59	1.43	0.34	-	-
MB.C.22117.3	10.2	5.9	3.5	3.9	2.3	0.58	1.69	0.38	1.67	0.34
MB.C.22117.4	9.0	5.1	3.1	3.5	-	0.57	1.62	0.39	-	-
MB.C.22117.5	8.9	5.1	2.9	3.4	-	0.59	1.76	0.39	-	-

Lunupharciceras incisum n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22119.6	23.3	8.1	7.3	11.5	4.9	0.35	1.11	0.49	1.60	0.33

paratype MB.C.22119.5	17.5	6.2	5.3	8.4	4.0	0.35	1.17	0.48	1.68	0.25
holotype MB.C.22119.1	17.3	6.0	4.5	8.8	3.4	0.35	1.33	0.51	1.55	0.24
paratype MB.C.22119.3	17.3	6.1	5.1	8.1	3.9	0.35	1.20	0.47	1.66	0.24
paratype MB.C.22119.2	13.8	5.2	4.0	6.7	3.1	0.38	1.30	0.48	1.65	0.23
paratype MB.C.22119.2	10.7	4.3	3.2	5.2	2.5	0.40	1.35	0.49	1.70	0.21
paratype MB.C.22119.2	6.3	2.5	1.9	3.0	1.6	0.40	1.33	0.48	1.76	0.18
paratype MB.C.22119.2	4.8	2.0	1.4	2.2	1.2	0.42	1.43	0.47	1.78	0.15
paratype MB.C.22119.2	1.9	0.9	0.7	0.7	0.6	0.46	1.31	0.39	2.01	0.16

Lunupharciceras lunulicosta (Sandberger & Sandberger, 1850) from Hassi Nebech and the type region

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
lectotype	38.7	10.8	13.0	14.7	-	0.38	0.83	0.38	-	-
topotype MB.C.22121	30.9	10.5	12	11.6	9.3	0.34	0.88	0.37	2.04	0.23
topotype MB.C.22121	21.7	7.6	7.4	9.3	5.3	0.35	1.03	0.43	1.75	0.28
MB.C.22120.1	19.3	6.9	7.0	7.6	5.2	0.36	0.99	0.39	1.88	0.25
MB.C.22120.2	17.9	6.1	5.5	8.0	4.0	0.34	1.10	0.44	1.66	0.27
MB.C.22120.3	17.1	6.2	6.0	6.9	4.5	0.36	1.04	0.40	1.84	0.25
MB.C.22120.3	12.6	4.7	34.3	5.5	3.2	0.37	1.11	0.44	1.81	0.24
MB.C.22120.3	9.4	3.6	2.8	4.5	2.3	0.38	1.26	0.48	1.75	0.19
MB.C.22120.3	7.1	2.7	2.1	5.0	1.8	0.38	1.28	-	1.76	0.16
topotype MB.C.22121	4.2	2.0	1.4	1.8	1.2	0.49	1.45	0.44	1.91	0.18
topotype MB.C.22121	2.3	1.2	0.8	1.0	0.7	0.52	1.55	0.41	1.98	0.13

Transpharciceras procedens n. gen. n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype MB.C.22122.1	16.5	7.5	6.8	6.1	4.4	0.45	1.10	0.37	1.86	0.35
paratype MB.C.22122.3	13.7	6.2	4.8	5.5	3.2	0.45	1.29	0.40	1.72	0.32
paratype MB.C.22122.2	12.4	5.6	4.0	5.7	2.8	0.45	1.40	0.46	1.67	0.30
paratype MB.C.22122.2	9.6	4.2	2.7	4.9	1.9	0.44	1.57	0.51	1.55	0.30
paratype MB.C.22122.3	8.0	4.1	2.2	4.2	1.7	0.52	1.87	0.52	1.63	0.22
paratype MB.C.22122.2	7.7	3.8	2.0	4.0	1.5	0.49	1.86	0.52	1.57	0.24
paratype MB.C.22122.2	6.1	2.9	1.7	3.2	1.3	0.48	1.76	0.52	1.59	0.24
paratype MB.C.22122.2	3.1	1.4	0.8	1.8	0.6	0.46	1.76	0.57	1.57	0.22

Stenopharciceras n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22123	13.3	7.8	6.3	2.9	2.9	0.59	1.24	0.22	1.64	0.54

Stenopharciceras kseirense (Termier & Termier, 1950) from the type region

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22124.13	22.0	9.5	11.8	3.3	7.6	0.43	0.81	0.15	2.32	0.36
MB.C.22124.14	19.0	8.7	9.6	3.8	6.0	0.46	0.91	0.20	2.14	0.38
MB.C.22124.2	16.8	8.5	8.2	3.4	4.9	0.51	1.04	0.20	1.99	0.41
MB.C.22124.6	14.5	7.8	7.5	2.7	4.6	0.54	1.04	0.19	2.15	0.39
MB.C.22124.4	14.6	7.6	6.7	3.8	4.4	0.52	1.14	0.26	2.03	0.35
MB.C.22124.15	14.5	7.7	7.3	3.3	4.8	0.53	1.05	0.23	2.21	0.35
MB.C.22124.5	13.9	7.7	6.4	3.9	4.2	0.56	1.21	0.28	2.06	0.34
MB.C.22124.16	13.1	7.5	6.5	3.7	4.1	0.57	1.15	0.28	2.12	0.37
MB.C.22124.2	11.9	7.3	5.1	3.3	3.2	0.62	1.43	0.28	1.86	0.38
MB.C.22124.15	9.8	6.2	3.9	3.2	2.6	0.64	1.59	0.33	1.87	0.33
MB.C.22124.2	8.7	5.9	3.5	2.9	2.3	0.68	1.70	0.33	1.84	0.34
MB.C.22124.2	6.4	4.8	2.4	2.4	1.6	0.74	2.00	0.38	1.78	0.32
MB.C.22124.2	4.8	3.3	1.6	2.0	1.2	0.69	2.04	0.41	1.76	0.27
MB.C.22124.2	2.1	1.2	0.7	0.8	0.5	0.57	1.72	0.39	1.85	0.20

Stenopharciceras progressum n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22125.3	32.3	11.3	18.2	2.8	10.6	0.35	0.62	0.09	2.22	0.42
paratype MB.C.22125.6	27.6	11.0	14.9	3.7	9.0	0.40	0.74	0.13	2.20	0.40
holotype MB.C.22125.1	26.3	10.1	14.3	2.9	8.8	0.38	0.71	0.11	2.26	0.38
paratype MB.C.22125.2	21.2	8.0	11.8	3.0	7.4	0.42	0.76	0.14	2.37	0.37
paratype MB.C.22125.8	18.1	8	9.5	3.8	5.9	0.44	0.84	0.21	2.20	0.38
paratype MB.C.22125.9	12.0	6.0	5.3	3.0	3.4	0.50	1.13	0.25	1.95	0.36
paratype MB.C.22125.2	9.6	6.3	4.1	3.0	2.7	0.65	1.53	0.31	1.94	0.34
paratype MB.C.22125.2	5.1	3.5	1.8	2.0	1.3	0.70	1.95	0.39	1.83	0.27

Pluriphaciceras plurilobatum (Petter, 1959)) from the type locality

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR

Petter syntype 3	45.0	13.5	23.0	3.0	-	0.30	0.41	0.07	-	-
MB.C.22126.13	37.7	10.5	19.8	2.8	12.0	0.28	0.53	0.07	2.15	0.39
Petter lectotype	ca 37	12.0	21.5	2.5	12.5	0.32	0.56	0.07	2.28	0.42
Petter syntype 1	33.0	10.0	17.0	2.5	-	0.30	0.59	0.08		
MB.C.22126.1	29.2	9.4	16.1	2.8	9.8	0.32	0.59	0.09	2.28	0.39
MB.C.22126.14	25.4	9.3	13.7	2.8	8.4	0.37	0.68	0.11	2.23	0.39
cf. MB.C.22127.1	25.4	8.7	13.6	3.2	8.1	0.34	0.64	0.13	2.16	0.40
MB.C.22126.3	20.6	8.2	10.6	3.3	6.2	0.40	0.78	0.16	2.05	0.41
MB.C.22126.12	19.9	8.6	9.3	4.0	5.7	0.43	0.92	0.20	1.96	0.39
MB.C.22126.3	14.4	6.7	6.6	3.4	4.1	0.47	1.01	0.24	1.94	0.39
MB.C.22126.3	7.7	4.8	2.9	2.6	1.9	0.62	1.63	0.33	1.77	0.35
MB.C.22126.3	3.1	1.9	1.2	1.1	0.8	0.61	1.61	0.34	1.87	0.30

Pluripharciceras orbis n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22128.3	17.6	7.2	-	-	-	0.41	-	-	-	-
holotype MB.C.22128.1	17.2	6.8	8.4	3.2	4.5	0.40	0.81	0.19	1.83	0.46
paratype MB.C.22128.2	15.3	6.3	7.2	3.7	4.1	0.41	0.88	0.24	1.87	0.43
paratype MB.C.22128.2	10.1	4.9	4.0	3.3	2.7	0.48	1.23	0.33	1.87	0.32
paratype MB.C.22128.2	5.4	3.3	2.0	1.8	1.5	0.61	1.64	0.34	1.92	0.25
paratype MB.C.22128.2	2.0	1.3	0.8	0.6	0.6	0.64	1.54	0.28	2.04	0.28

Meropharciceras disciforme (Bensaïd, 1974)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype STIPB-Bensaïd-53	55.0	14.6	32.0	3.0	18.2	0.27	0.46	0.05	2.23	0.43
paratype MB.C.22129.1	16.8	8.3	8.1	3.1	4.3	0.50	1.02	0.18	1.80	0.47
paratype MB.C.22129.3	16.0	7.9	7.7	2.9	3.9	0.50	1.04	0.18	1.75	0.49
paratype MB.C.22129.2	13.5	6.8	6.0	3.4	3.3	0.50	1.14	0.25	1.75	0.45
paratype MB.C.22129.4	12.8	7.0	6.1	2.5	3.3	0.55	1.15	0.20	1.82	0.46
paratype MB.C.22129.3	5.4	3.4	2.0	1.9	1.2	0.63	1.71	0.36	1.64	0.40
paratype MB.C.22129.3	4.2	2.5	1.5	1.6	1.0	0.60	1.69	0.38	1.72	0.33
paratype MB.C.22129.3	3.2	2.0	1.1	1.3	0.8	0.61	1.77	0.40	1.74	0.31
paratype MB.C.22129.3	2.5	1.5	0.8	0.9	0.6	0.60	1.77	0.37	1.74	0.28
paratype MB.C.22129.3	1.9	1.2	0.7	0.6	0.5	0.66	1.72	0.30	1.85	0.31

Synphaciceras clavilobum (Sandberger & Sandberger, 1850)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22130.8	38.3	14.0	20.3	3.00	8.80	0.37	0.69	0.08	1.69	0.57
MB.C.22130.7	30.1	12.8	15.8	2.9	7.9	0.43	0.81	0.10	1.84	0.50
MB.C.22130.1	26.3	12.1	14.0	3.2	7.0	0.46	0.89	0.12	1.86	0.48
MB.C.22130.2	20.1	10.4	11.3	1.8	5.2	0.52	0.92	0.09	1.82	0.54
MB.C.22130.14	15.0	10.0	7.3	3.1	4.1	0.67	1.37	0.21	1.89	0.44
MB.C.22130.4	11.7	9.1	5.2	2.8	2.7	0.77	1.76	0.24	1.69	0.48
MB.C.22130.5	9.9	7.5	4.4	2.4	2.4	0.76	1.72	0.24	1.76	0.44
MB.C.22130.12	8.4	7.3	3.6	2.0	1.9	0.87	2.03	0.24	1.72	0.47
MB.C.22130.4	5.2	4.2	2.1	1.6	1.3	0.82	2.07	0.30	1.76	0.38
MB.C.22130.4	3.0	2.1	1.1	1.0	0.8	0.7	1.87	0.33	1.80	0.32

Synphaciceras frequens n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
paratype MB.C.22131.11	27.4	13.1	15.2	3.1	7.1	0.48	0.86	0.11	1.82	0.53
holotype MB.C.22131.1	24.4	12.7	13.9	3.2	6.6	0.52	0.91	0.13	1.88	0.53
paratype MB.C.22131.13	21.8	11.7	11.7	3.0	5.3	0.54	1.00	0.14	1.75	0.55
paratype MB.C.22131.3	20.1	10.6	10.0	3.2	4.7	0.53	1.07	0.16	1.71	0.53
paratype MB.C.22131.2	18.7	10.6	9.1	3.5	4.4	0.56	1.17	0.18	1.71	0.51
paratype MB.C.22131.14	14.3	9.3	6.7	4.4	3.3	0.65	1.39	0.31	1.69	0.51
paratype MB.C.22131.12	11.8	8.1	4.6	4.5	2.4	0.69	1.76	0.38	1.58	0.48
paratype MB.C.22131.2	8.7	6.3	2.7	3.9	1.8	0.72	2.29	0.45	1.59	0.34
paratype MB.C.22131.2	6.9	5.1	2.1	3.3	1.4	0.74	2.50	0.47	1.58	0.31
paratype MB.C.22131.2	5.5	3.8	1.6	2.6	1.1	0.69	2.37	0.47	1.58	0.30
paratype MB.C.22131.2	4.4	2.8	1.3	2.0	1.0	0.64	2.14	0.46	1.63	0.28
paratype MB.C.22131.2	3.4	2.1	1.1	1.6	0.8	0.61	2.00	0.45	1.68	0.25
paratype MB.C.22131.2	2.0	1.2	0.7	0.8	0.5	0.59	1.75	0.40	1.80	0.25

Synphaciceras aff. *frequens* n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22132.1	20.7	12.0	10.2	3.3	4.8	0.58	1.18	0.16	1.71	0.53
MB.C.22132.3	15.9	10.4	7.2	4.0	3.6	0.65	1.44	0.25	1.66	0.51
MB.C.22132.1	15.8	10.3	7.2	3.7	3.5	0.65	1.44	0.24	1.64	0.52
MB.C.22132.2	15.2	10.8	6.0	5.3	3.2	0.71	1.79	0.35	1.59	0.48

MB.C.22132.3	12.3	9.3	4.7	4.4	2.6	0.75	1.99	0.35	1.61	0.44
MB.C.22132.2	12.1	9.1	3.9	5.3	2.4	0.75	2.32	0.44	1.56	0.38
MB.C.22132.1	9.9	7.1	3.4	3.7	1.9	0.72	2.12	0.38	1.54	0.43
MB.C.22132.2	9.6	7.2	2.9	4.7	1.9	0.75	2.53	0.48	1.56	0.33
MB.C.22132.1	5.0	3.7	1.6	2.0	1.1	0.74	2.28	0.39	1.62	0.34
MB.C.22132.3	2.2	1.6	0.9	0.7	0.6	0.75	1.81	0.31	1.87	0.35

Petterocererrans errans (Petter, 1959)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22133.10	50.0	13.5	30.0	-	-	0.27	0.45	-	-	-
MB.C.22133.9	38.9	12.2	16.5	12.0	10.0	0.31	0.74	0.31	1.81	0.39
lectotype	38.6	11.4	16.5	11	10.0	0.30	0.69	0.28	1.82	0.39
MB.C.22133.2	29.7	10.8	12.0	9.1	7.4	0.36	0.90	0.30	1.78	0.38
MB.C.22133.13	24.0	10.0	10.7	8.0	6.3	0.42	0.93	0.33	1.84	0.41
MB.C.22133.1	19.7	9.0	7.2	7.4	4.5	0.45	1.24	0.37	1.68	0.38
MB.C.22133.14	17.5	8.5	5.8	7.5	3.8	0.49	1.47	0.43	1.63	0.34
MB.C.22133.15	14.9	7.5	4.7	6.4	3.5	0.50	1.60	0.43	1.71	0.26
MB.C.22133.16	14.3	7.9	4.6	6.4	2.8	0.55	1.72	0.45	1.55	0.39
MB.C.22133.1	11.8	7.0	3.6	5.5	2.6	0.59	1.93	0.46	1.65	0.27
MB.C.22133.1	5.6	3.4	1.7	2.6	1.3	0.62	2.06	0.46	1.70	0.22
MB.C.22133.1	3.2	2.0	1.1	1.4	0.8	0.63	1.93	0.42	1.81	0.22

Epitornoceras mithracoides (Frech, 1888)

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
MB.C.22101.3	27.4	10.1	16.1	0.4	9.0	0.37	0.63	0.01	2.21	0.44
MB.C.22101.4	18.5	7.8	11.0	0.1	6.4	0.42	0.71	0.01	2.34	0.42
MB.C.22101.3	18.5	7.2	10.9	0.5	6.0	0.39	0.66	0.03	2.22	0.44
MB.C.22101.8	15.3	7.0	9.0	0.3	5.1	0.46	0.78	0.02	2.25	0.43
MB.C.22101.1	11.9	5.3	7.0	0.3	3.8	0.45	0.77	0.02	2.17	0.45
MB.C.22101.1	8.1	3.9	4.7	0.2	2.4	0.48	0.84	0.03	2.02	0.49
MB.C.22101.1	5.7	3.0	3.2	0.4	1.8	0.53	0.95	0.06	2.16	0.43
MB.C.22101.1	2.6	1.5	1.3	0.5	0.8	0.58	1.17	0.20	2.07	0.39
MB.C.22101.1	1.3	1.0	0.6	0.3	0.3	0.77	1.75	0.21	1.75	0.45

Lobotornoceras bensaidi n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype MB.C.22102.1	12.6	4.9	7.2	0.4	3.7	0,39	0,68	0,03	2,00	0,49
paratype STIPB-Bensaïd-44	12.1	4.4	6.8	0.3	3.3	0.36	0.65	0.02	1.93	0.51
paratype MB.C.22102.3	10.0	4.1	5.9	0.4	3.0	0.41	0.69	0.04	2.04	0.49
paratype MB.C.22102.2	9.3	3.9	5.2	0.3	2.6	0.42	0.75	0.03	1.93	0.50
paratype MB.C.22102.2	4.9	2.6	2.7	0.24	1.39	0.53	0.96	0.05	1.93	0.49

Nebechoceras excentricum n. gen. n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
Morphotype I										
holotype MB.C.22103.1	25.0	10.6	13.5	2.6	-	0.42	0.79	0.10	-	-
paratype MB.C.22103.14	21.7	9.6	13.2	0.8	-	0.44	0.73	0.04	-	-
paratype MB.C.22103.4	10.9	5.1	6.3	0.3	3.3	0.47	0.81	0.03	2.08	0.47
paratype MB.C.22103.11	10.1	5.4	6.0	0. 5	3.3	0.53	0.90	0.04	2.21	0.45
paratype MB.C.22103.4	7.6	3.7	4.3	0.4	2.3	0.49	0.87	0.05	2.08	0.46
paratype MB.C.22103.4	5.2	2.7	2.9	0.4	1.5	051	0.93	0.08	2.00	0.47
paratype MB.C.22103.4	3.7	1.9	1.9	0.4	1.1	0.52	0.99	0.11	1.98	0.45
paratype MB.C.22103.4	1.9	1.1	0.9	0.4	0.6	0.61	1.30	0.21	2.03	0.37
Morphotype II										
paratype MB.C.22103.7	14.4	6.2	8.2	0.6	4.1	0.43	0.76	0.04	1.96	0.50
paratype MB.C.22103.6	14.0	6.2	8.1	0.3	4.3	0.44	0.76	0.02	2.08	0.47
paratype MB.C.22103.6	6.7	3.3	3.7	0.4	1.9	0.50	0.90	0.06	1.98	0.48

Phoenixites lenticulus n. sp.

	dm	ww	wh	uw	ah	ww/dm	ww/wh	uw/dm	WER	IZR
holotype MB.C.22104.1	14.8	7.0	8.7	0.1	-	0.47	0.80	0.01	-	-
paratype MB.C.22104.10	13.8	6.4	8.0	0.4	4.2	0.46	0.80	0.03	2.07	0.48
paratype MB.C.22104.11	12.5	6.0	7.3	0.3	3.9	0.48	0.82	0.02	2.11	0.47
paratype MB.C.22104.5	10.1	5.6	6.2	0.4	3.0	0.55	0.90	0.03	2.02	0.52
paratype MB.C.22104.12	9.0	4.5	5.0	0.4	2.9	0.50	0.90	0.04	2.18	0.42
paratype MB.C.22104.13	8.4	4.4	4.5	0.3	2.5	0.52	0.98	0.03	2.03	0.44
paratype MB.C.22104.8	8.0	4.5	5.0	0.3	2.5	0.56	0.90	0.04	2.12	0.50
paratype MB.C.22104.2	6.0	3.3	3.5	0.3	1.6	0.55	0.94	0.05	1.86	0.54

paratype MB.C.22104.4	4.7	2.7	2.6	0.4	1.3	0.57	1.05	0.08	1.91	0.50
paratype MB.C.22104.4	2.4	1.6	1.3	0.4	0.6	0.64	1.22	0.16	1.82	0.51
paratype MB.C.22104.4	1.8	1.2	0.8	-	0.5	0.66	1.56	-	-	-

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