Tescheniceras gen. nov. (Ammonoidea) and the definition of the Valanginian/Hauterivian boundary in Butkov Quarry (Central Western Carpathians, Slovakia)

ZDENĚK VAŠIČEK
Institute of Geonics of the Czech Academy of Sciences, Studentská 1768, CZ-708 00 Ostrava-Poruba, Czech Republic. E-mail: Zdenek.Vasiczek@ugn.cas.cz

ABSTRACT:
Vašíček, Z. XXXX. Tescheniceras gen. nov. (Ammonoidea) and the definition of the Valanginian/Hauterivian boundary in Butkov Quarry (Central Western Carpathians, Slovakia). Acta Geologica Polonica, XX (X), xxx–xxx. Warszawa.

Jurassic and Lower Cretaceous successions of the Manín Unit of the Central Western Carpathians are exposed in Butkov Quarry in the Middle Váh Region, Slovakia. A significant part of the macrofauna belonging to neocomitid ammonites, formerly classified under the genus Teschenites Thieuloy, 1971, occurs in deposits spanning the Valanginian/Hauterivian boundary. The original definition of Teschenites was accompanied by uncertainties in the taxonomic and stratigraphic position of its original type species, i.e., Hoplites neocomiensiformis Uhlig, 1902. The present contribution focuses on and provides a possible taxonomic solution by establishing the new genus Tescheniceras. In Butkov Quarry, the new genus includes five species. Tescheniceras flucticulum (Thieuloy, 1977), the type species, is the most abundant. Tescheniceras callidiscum (Thieuloy, 1971), the subzonal species for the uppermost Valanginian (Thieuloy 1971b), occurs only sporadically. Because Acanthodiscus radiatus (Bruguière, 1789), the index species for the basal Hauterivian (radiatus Zone) in the international ammonite zonation, does not occur in the locality, the basal Hauterivian is indicated by the first appearance of the genus Spitidiscus Kilian, 1910.

Keywords: Tescheniceras gen. nov.; Manín Unit; Valanginian/Hauterivian boundary; Taxonomy; Western Carpathians.

INTRODUCTION
Lower Cretaceous marly deposits exploited as raw material for cement manufacture in the active Butkov Quarry near the municipality of Ladce (Slovakia) are rich in ammonites. They belong to the Manín Unit of the Central Western Carpathians. The quarry, which at present has fifteen levels, provides on nine of them suitably exposed sections in which faunas may be collected bed-by-bed. The collecting and detailed stratigraphy are somewhat complicated by the geology of the Manín Nappe which is associated with the fold structure of the deposits accompanied by many local tectonic phenomena and faults. ‘Teschenites’-type ammonites occur in beds spanning the Valanginian/Hauterivian boundary, where olive coloured marlstones of the Ladce Formation alternate with grey marls of the Mráznica Formation. The first macropalaeontological collections in Butkov Quarry combined with detailed documentation of sections and the taking of samples for thin sections began in 1982. The first results of a consequent long-lasting study of the Lower Cretaceous ammonites were given by Vašíček and Michalík (1986). In that paper, basic knowledge of the local ammonite association documenting the Valanginian and Early
Hauterivian age was presented and two new species were established. Previous results were complemented by a comprehensive taxonomic study of the cephalopod fauna (Vašíček et al. 1994), i.e., the study of ammonites, aptychi and belemnites. Amongst other things, our previous knowledge was extended by the finding of evidence of the wider stratigraphic range of the Lower Cretaceous deposits from the Valanginian to the Barremian (the Neocomian in the older concept). Later, Late Valanginian representatives of the subfamily Crioceratitinae were studied, including a new collection of Early Barremian ammonites including also four new species (Vašíček 2006). Consequently, it turned out that the so-called Neocomian in Butkov Quarry yields also ammonites of Late Berriasian age (Vašíček 2010). This record of the first occurrence of boreal (cold-water) species in this locality was remarkable.

The objective of the present contribution on Butkov Quarry was to establish the boundary between the Valanginian and Hauterivian stages. It was assumed that this boundary should be determined on the basis of the succession of representatives of Teschenites Thieuloy, 1971, given that the index species Acanthodiscus radiatus (Bruguière, 1879) does not occur in Butkov Quarry. A detailed taxonomic study of the Teschenites-group fauna has resulted in the definition of Tescheniceras gen. nov. (see below).

Furthermore, the significance of this new taxon for the definition of the Valanginian/Hauterivian boundary in Butkov Quarry is discussed.

**GEOLOGICAL SETTING**

Butkov Quarry (Text-fig. 1) is situated near the municipality of Ladce, about 10 km NE of the town of Dubnica upon Váh, Slovakia. Jurassic and Cretaceous deposits of the Manín Nappe of the Central Western Carpathians are exposed in the quarry. The Manín Unit is in tectonic contact with the Pieniny Klippen Belt. The structural interpretation of the unit was discussed in Michalík and Vašíček (1987), who considered the Manín Unit as a part of the Fatricum Super Unit.

The Lower Cretaceous succession exposed in the quarry is assigned to several lithostratigraphic units. According to Borza et al. (1987), Cretaceous strata start with the beige-coloured marly pelagic deposits of the Ladce Formation. In the upper part, the formation alternates with the grey-coloured marly-calcareous Mráznica Formation. Above follows the pale grey limestone of the Kališčo Formation, characterised by the occurrence of cherts. A comprehensive summary of the geological setting and structure, detailed biostratigraphy and sequence stratigraphy based on mi-
DESCRIPTION OF THE SUCCESSION

The Lower Cretaceous marly-calcareous strata in Butkov Quarry represent pelagic deposits. According to the macrofaunal content, they belong to the cephalopod facies characterised by the occurrence of ammonites, aptichy and belemnites. Brachiopods occur only occasionally (for more information, see Michalík et al. 2013). Neocomitid ammonites, formerly classified under the genus *Teschenites*, occur sporadically to abundantly in Levels 1 and 5–12 in documented horizons at the transition between the Ladce and Mráznica Formations. Based on the evaluation of ammonite associations in the nine sections under study, the findings classifiable by stratigraphic meth-

![Table 1](image-url)

Table 1. Measurements of some species of *Tescheniceras* gen. nov. from Butkov Quarry, Slovakia. Symbols: Dmax – maximal preserved shell diameter; Dphr – approximate diameter at the end of the phragmocone or presupposed end of phragmocone; D – whorl diameter; H – whorl height; M – macroconch; m – microconch; U – umbilicus diameter; calculated ratios of H/D and U/D; UR – number of ribs near umbilicus per half-whorl; V/R – equivalent number of ribs at whorl periphery; – probable value.
ods are related to the most fully documented section, e.g., the section in Level 10. The section thickness around the Valanginian/Hauterivian boundary exceeds 20 m. The section length in meters related to the horizontal level of the quarry wall base is 50 m. The bedding dip reaches about 60°. With regard to the current activities in the quarry, preservation of the original numbering of the inclined layers visible in the wall was not possible.

**Systematic part**

The history of the study of the old genus *Teschenites* and its numerous species (about 20 species according to Klein 2005) represents a complicated, in places contradictory matter. The genus *Teschenites* (originally a subgenus of the genus *Neocomites* Uhlig, 1905) with type species *Hoplites neocomiensiformis* Uhlig, 1902 was established by Thieuloy (1971a) based on the material of Uhlig (1902) which was collected by Hohenegger from the Silesian Unit of the Outer Western Carpathians. In the original description of the material by Uhlig (1902, p. 54), the name ‘*Hoplites neocomiensis* d’Orb. sp.’ appears first. In the following text on p. 56, Uhlig admitted that part of the described material should represent a new species, i.e., ‘*Hoplites neocomiensiformis*’ referring here to specimens in the collection of Hohenegger. In reality, the name ‘*A. neocomiensiformis* Hohenegger msc.’ occurs on Hohenegger’s original labels. In particular, this is the case with two specimens illustrated by Uhlig (1902, pl. 3, figs 1 and 2a, b). In Uhlig’s explanatory notes to plate 3, these specimens already occur under Hohenegger’s species name. As the type specimen of *H. neocomiensiformis*, Uhlig (1902) selected a specimen from pl. 3, fig. 2a, b (its suture line is figured in his pl. 4, fig. 11). Thieuloy (1971a, p. 2298) accepted the mentioned specimen and species as the type species of his subgenus *Teschenites* (which in the last 25 years is treated at generic rank).

As revealed by Reboulet (1996), and later confirmed by Busnardo et al. (2003, p. 43), the type specimen of *H. neocomiensiformis* described by Uhlig differs both morphologically and stratigraphically from the French specimens from the Upper Valanginian to the lowermost Hauterivian designated by Thieuloy (1977, pl. 2, figs 1–3) as *Neocomites (Teschenites) neocomiensiformis*. As far as the stratigraphic value of the original Hohenegger material processed by Uhlig (1902) is concerned, it should be added that the exact stratigraphic position of the Silesian *H. neocomiensiformis* is unclear (it can be only stated that Early Valanginian species prevail in the same strata).

Busnardo et al. (2003) established a new type species for the genus *Teschenites*, namely *Neocomites (Teschenites) flucticulus* Thieuloy, 1977. According to Busnardo et al. (2003, p. 43), the specimens identified as *Teschenites neocomiensiformis* in Thieuloy (1977) belongs to a new species, namely *Teschenites robustus* Busnardo, Charollais, Weidmann and Clavel, 2003. Although Busnardo et al. (2003) chose the specimen illustrated by Thieuloy (1977, pl. 2, fig. 1) as the holotype for their new species *T. robustus*, they stated that the species was better illustrated by the specimen illustrated by Thieuloy (1977) in pl. 2, fig. 3. Analysis of pl. 2 in Thieuloy (1977) shows that the specimen in fig. 1, which is laterally deformed, has a narrow umbilicus, whereas the flatly deformed specimen in fig. 3, as well as the fragment of the whorl in fig. 2, have a wider umbilicus and also somewhat vigorous ribbing. These morphological differences were already described by Reboulet (1996, p. 112), who put both specimens of *Neocomites (Teschenites) neocomiensiformis* illustrated by Thieuloy (1977, pl. 2, figs 2, 3) in synonymy with *Teschenites subpachydicranus* Reboulet, 1996. Moreover, Reboulet (1996) considered the specimen of *N. (T) neocomiensiformis* illustrated by Thieuloy (1977, pl. 2, fig. 1) as *Teschenites flucticulus* Thieuloy, 1977. He also suggested (Reboulet 1996, p. 104) that *N. (T) neocomiensiformis* and *N. (T) aff. neocomiensiformis sensu* Thieuloy could be the macroconchs of *Teschenites subpachydicranus* (now *Tescheniceras subpachydicranum*) and *Teschenites pachydicranus* (now *Tescheniceras pachydicranum*), respectively. Consequently, the establishment of the species *T. robustus* by Busnardo et al. (2003) is groundless; it is rather the synonym of *Teschenites flucticulus* (now *Tescheniceras flucticula*).

According to Reboulet (1996, p. 104), the lectotype of *T. neocomiensiformis* corresponds to the inner whorls of a macroconch of *Busnardoites campylo toxus* (Uhlig, 1902). Busnardo et al. (2003) considered *Hoplites neocomiensiformis sensu* Uhlig as a species of the genus *Busnardoites* Nikolov, 1966. Moreover, Company and Tavera (2015) assigned *Hoplites neocomiensiformis sensu* Uhlig to the genus *Neocomites* and used *Neocomites neocomiensiformis* to characterise the middle ammonite zone of the Lower Valanginian zonation in southern Spain. Their proposal was accepted by the Kilian Group and incorporated into the current version of the standard Mediterranean ammonite zonation (Reboulet et al. 2018).

The original designation of *Hoplites neocomiensiformis* by Thieuloy (1971a) as the type species of
the subgenus *Teschenites* fulfills the requirements of the ICZN (articles 13.1, 13.3, 67.5 and 68.2), and therefore, the valid name *Teschenites* may be used (if necessary) for a group of neocomitid species of Early Valanginian age. However, the change of the type species proposed by Busnardo *et al.* (2003) is not valid; it is explicitly against article 67.2 of the ICZN. Their proposal is not justified, as the nominal species *Teschenites flucticulus* was originally not included in the genus (or subgenus) *Teschenites*.

Consequently, there are 4 possibilities for the solution of these taxonomical problems:

1) When Thieuloy (1971a) defined the subgenus *Teschenites*, he assigned to it the following nominal species: *Hoplites neocomiensiformis*, *Neocomites* (*Teschenites*) *scioptychus* (Uhlig, 1902), *Neocomites* (*Teschenites*) *paraplesius* (Uhlig, 1902), *Neocomites* (*Teschenites*) *transsylvanicus* (Jekelius, 1915), *Neocomites* (*Teschenites*) *jodariensis* (Douville, 1906), *Neocomites* (*Teschenites*) *muretensis* (Breistroffer, 1936) and *Neocomites* (*Teschenites*) aff. *scioptychus*. For a better definition of *Teschenites*, it may be preferable to select another type species from this list of species. However, all mentioned species (except *Hoplites neocomiensiformis*) are poorly known or partly identified with doubt. It is thus impossible to find a suitable type species for *Teschenites* among these nominal species.

2) Another possibility is to retain using the genus *Teschenites* based on an approved request submitted to the International Commission on Zoological Nomenclature. However, the reply of the Commission (to a hypothetical request) could take many years and it is probable that the reply will be rather negative. Considering my advanced age, this is clearly an inappropriate solution.

3) *Teschenites* could be considered as a synonym of the genus *Neocomites*. However, I prefer to restrict the use of *Neocomites* only for neocomitids from around the Lower/Upper Valanginian boundary, and to use *Tescheniceras* gen. nov. for neocomitids around the Valanginian/Hauterivian boundary.

4) I prefer to establish a new genus for the studied group of neocomitids of Valanginian/Hauterivian age due to the morphological differences with the genus *Neocomites* (described below) and especially due to the different stratigraphic position of both species that has already been mentioned above. In my opinion, this option, presented below in more detail, seems to be the best solution.

Stratigraphic data used for the distribution of the species are based on the ammonite zonation according to Reboulet *et al.* (2018).

Superfamily Perispinchoidea Steinmann, 1980
Family Neocomitidae Salfeld, 1921
Subfamily Neocomitinae Salfeld, 1921

**Genus Tescheniceras gen. nov.**

**TYPE SPECIES: Neocomites (Teschenites) flucticulus** Thieuloy, 1977 (p. 98, pl. 3, fig. 7).

**DERIVATIO NOMINIS:** From the historical name of the city of Teschen lying on the Czech-Polish national border, the current double city – Cieszyn (Poland) and Český Těšín (Czech Republic). The generic name for the neocomitid ammonites around the Valanginian/Hauterivian boundary should recall the old name *Teschenites*.

**DIAGNOSIS:** A semi-involute shell with narrow, slightly arched whorls. Neocomitid ornamentation of phragmocone is created by ribs that begin individually or in pairs in weak umbilical tubercles on the umbilicus edge. The falcoid ribs can be bifurcated on flanks, or inserted ribs also occur. All ribs inflate and form weak ventrolateral tubercles followed by a smooth siphonal band. In some species, the ribs on the body chamber disappear on the flanks. The ribs on the body chamber bear weak ventrolateral tubercles and cross the ventral side without interruption in form of a chevron. Some species show dimorphism.

**DESCRIPTION:** Semi-involute shells with thin, rather high whorls. The base of whorls is accompanied by the umbilical edge. The ornamentation of the phragmocone is typically neocomitid. Juvenile ribs are thin and dense. They begin in umbilical tubercles. S-shaped bent ribs are bifurcated on the flanks. Inserted ribs also occur. All ribs bear weak ventrolateral tubercles followed by a smooth siphonal band. On the body chamber, the ribs cross the venter without interruption in the form of chevron. The ribs are thicker and more sparsely distributed. Umbilical tubercles can become bullate. In some species, the ribs on the flanks dissipate in the adult stage. Macroconchs reach the diameter of 90 mm and more (for example, the diameter of *Tescheniceras pachydiceranum* in Uhlig 1902, pl. 8, fig. 2 is $D = 155$ mm). *Tescheniceras* gen. nov. differs from the closely related genus *Neocomites* in that the ribs on the body chamber of *Tescheniceras* gen. nov. cross the venter without interruption, trituberculur ribs do not develop in all stages of growth, and in some specimens the ribs become thinner or disappear on flanks of the adult whorls. In addition, the adult specimens are
usually bigger in size. The morphological differences compared to Neocomites are not very significant, similarly as in the case of the previously established genera Erístavites Nikolov, 1966 or Varlheideites Rawson and Kemper, 1978, which are currently considered as synonyms of Neocomites (see e.g., Reboulet 1996). The main difference is represented by a different stratigraphical range (Neocomites is from the Lower to Lower/Upper Valanginian, Tescheniceras gen. nov. is from around the Valanginian/Hauterivian boundary).

OCCURRENCE: Tescheniceras occurs in the Mediterranean region from the uppermost Valanginian (furcillata Zone) to the Lower Hauterivian (radiatus Zone).

Tescheniceras callidiscum (Thieuloy, 1971)
(Text-fig. 2C)

1971b. Neocomites (Teschenites) callidiscus n. sp.; Thieuloy, p. 104, pl. 1, figs 1–4, text-fig. 1.

1996. Teschenites callidiscus (Thieuloy); Reboulet, p. 108, pl. 10, figs 1–8.


2005. Neocomites (Teschenites) callidiscus Thieuloy; Klein, p. 315 (cum syn.).

MATERIAL: A single fragment of an external mould of a poorly preserved microconch (SNM Z 40062 = BK10-65/5).

DESCRIPTION: Semi-involute small specimen with a narrow umbilicus and a high whorl. The ribbing is apparent especially in the ventral area and partially around the umbilicus. The whorl flanks are relatively smooth. The ribs in the peripheral area are thin and dense. Near the umbilicus, the ribs bear weak umbilical tubercles. The specimen reaches a diameter of about 35 mm.

REMARKS: The incomplete specimen from Butkov Quarry is characterised by a narrow umbilicus and suppressed (weakened) ribbing on the flanks. In general, Tescheniceras callidiscum differs from other related species by a considerably suppressed ribbing in maturity.

OCCURRENCE: Tescheniceras callidiscum is a subzonal species for the uppermost Valanginian (Reboulet et al. 2018). The mentioned species occurs mainly in France and Switzerland, and furthermore in Morocco and in the Silesian Unit of the Western Outer Carpathians. The only microconch comes from the Ladce Formation, Level 10, from 65 m of the section (uppermost Valanginian).

Tescheniceras flucticulum (Thieuloy, 1977)
(Text-fig. 3A)

1901. Hoplites thurmanni Pictet et Campiche; Sarasin and Schönadelmayer, p. 67, pl. 8, figs 4, 5, 76.

1901. Hoplites neocomiensis d’Orb.; Sarasin and Schönadelmayer, p. 70, pl. 9, figs 2, 3.

1991. Hoplites regalis Bean (in Paulow); Sarasin and Schönadelmayer, p. 71, pl. 8, fig. 8 [non pl. 9, fig. 1 = Tescheniceras pachydicranum (Thieuloy, 1977)].

1997. Neocomites (Teschenites) flucticulus n. sp.; Thieuloy, p. 98, pl. 3, figs 7 (holotype), 8, 10, 11 [non fig. 9 = Tescheniceras subflucticulum (Reboulet, 1996)].

1997. Neocomites (Teschenites) flucticulus n. sp.; Thieuloy, p. 95, pl. 2, fig. 1 [non pl. 2, figs 2, 3 = Tescheniceras subpachydicranum (Reboulet, 1996)].

1981. Teschenites flucticulus Thieuloy; Charollais et al., p. 90, pl. 5, fig. 2.

1983. Neocomites (Teschenites) cf. jodariensis Douvillé; Vašíček et al., p. 474, pl. 1, fig. 7.

1986. Neocomites (Teschenites) cf. jodariensis Douvillé; Vašíček and Michalík, p. 462, pl. 2, fig. 1 (figure copied from Vašíček et al. 1983).

1986. Neocomites (Teschenites) flucticulus Thieuloy; Wyssling, p. 197, pl. 8, figs 4, 5.

1987. Neocomites flucticulus Thieuloy; Company, p. 139, pl. 11, fig. 10.

1993. Neocomites (T.) flucticulus Thieuloy; Autran, pl. 2, fig. 10.

1994. Neocomites (Teschenites) flucticulus Thieuloy; Vašíček et al., p. 58, pl. 17, fig. 8 (= Tescheniceras subflucticulum (Reboulet, 1996)).

1995. Neocomites (Teschenites) cf. flucticulus Thieuloy; Avram, pl. 1, fig. 16.

1995. Neocomites (Teschenites) flucticulus Thieuloy; Vašíček, pl. 1, fig. 7 (= Tescheniceras subflucticulum (Reboulet, 1996)).

1996. Teschenites flucticulus (Thieuloy); Reboulet, p. 110, pl. 9, figs 1–13, pl. 10, fig. 14.

1997. Teschenites flucticulus Thieuloy; Vašíček, pl. 1, fig. 6.

1997. Neocomites (Teschenites) flucticulus Thieuloy; Faraoni et al., pl. 7, figs 7, 11.

1999. Teschenites flucticulus Thieuloy; Vašíček and Michalík, p. 254, fig. 6/2, 3.

Scale bar equals 1 cm.

2003. *Teschenites flucticulus* Thieuloy; Busnardo et al., p. 44, pl. 2, fig. 12, pl. 3, fig. 3, pl. 4, ?fig. 1, ?pl. 1, fig. 6.


2010. *Teschenites flucticulus* Thieuloy; Vašíček, pl. 3, fig. 5.

2013. *Teschenites flucticulus* Thieuloy; Michalík et al., p. 113, fig. 93/4.

**MATERIAL:** About twenty flatly deformed external moulds of microconchs (SNM Z 40063 = BK10-83/1, SNM Z 40069 = BK11A-28, SNM Z 40070 = BK7Z-63/2, SNM Z 24740 = BK6-2/1. Moreover, specimens BK1-75/1, BK1-80/23, BK6-2/3, BK8-470/9, 16, 23, 24, 35, BK8-480/13, BK10-80/7, BK10-82/8, 13 and BK10-83/1 usually only with the ultimate whorl preserved. The final parts of most specimens under study belong to body chambers.

**DESCRIPTION:** Semi-involute specimens, with a slightly arched ultimate whorl, low and steep umbilical wall separated from the flanks by an indicated edge and a narrow umbilicus. The venter is narrow (which is often caused by deformation) and quite arched. The phragmocone bears thin and closely spaced, slightly S-shaped ribs. The ribs usually begin in pairs on the umbilical edge in weak umbilical tubercles. Some ribs are simple and without tubercles and are inserted between the paired ribs. Ribs on the whorl flanks, with an exception of some final ribs on the phragmocone, do not bifurcate. On the ventral margin, tiny ventrolateral tubercles are indicated on all ribs. On the body chamber, more distinctly S-shaped ribs are stronger and more widely spaced. They begin in pairs in distinct umbilical tubercles. In vicinity of the venter, the ribs incline markedly towards the aperture and become stronger towards somewhat bullate ventrolateral tubercles. The ribs on the body chamber cross the weathered venter without interruption in the form of the letter S. Sporadically, simple inserted ribs running as far as the lower quarter of whorl height occur between the pairs of ribs. The measurements are presented in Table 1.

**REMARKS:** *Tescheniceras flucticulum* is close to the specimens under the original names of *Teschenites jodariensis* and *Teschenites muretensis*. The distinguishing interspecific feature is the different diameter of the umbilicus (\( U/D \)): \( U/D \) of *T. flucticulum* ranges from 0.23 to 0.25; the \( U/D \) ratio for *T. jodariensis* ranges from 0.17 to 0.19 according to my measurement of the figured holotype by Douvillé (1906, pl. 13, fig. 7). Similarly, the \( U/D \) ratio for *T. muretensis* ranges from 0.17 to 0.20 (ac-
cording to my measurement of the holotype designated as
_Hoplitites_ sp. illustrated by Douvillé 1906, pl. 13, fig. 4). Based on the suggestion of Company (1987), Reboulet (1996, p. 111) considered that the microconchs of _T. flucticulum_ could correspond to _T. jodariensis_. _Tescheniceras flucticulum_ differs from the closely related _Tescheniceras subflucticulum_ (see below) by a narrower umbilicus and a retroverse ribbing in the umbilicus area.

**OCCURRENCE:** According to Reboulet (1996), the type material of _T. flucticulum_ comes from south-eastern France from the radiatus Zone (Lower Hauterivian). Company (1987) states the uppermost Valanginian (_pachydiscum Zone_) and the Lower Hauterivian from the Betic Cordillera in Spain. Busnardo et al. (2003) state the Upper Valanginian to the basal Hauterivian in Switzerland. Other finds come from Morocco, Romania, Italy, western Austria, the Pieniny Klippen Belt in Slovakia, usually from the Lower Hauterivian (according to synonymies of Klein 2005). In Butkov Quarry, _Tescheniceras flucticulum_ occurs sporadically in Level 10 (from 80 m of the succession), more frequently to abundantly in Levels 1, 6, 7 West, Level 8 from 470 m of the succession, Level 10 from 82–83 m of the succession in the transition between the Ladce to Mráznica formations (Valanginian/Hauterivian) and Level 11 in deposits of the Mráznica Formation (basal Hauterivian).

_Tescheniceras subflucticulum_ (Reboulet, 1996)  
(Text-fig. 2D)

1977. _Neocomites_ ( _Teschenites_ ) _flucticulus_ n. sp.; Thieuloy, pl. 3, fig. 9.

1994. _Neocomites_ ( _Teschenites_ ) _flucticulus_ Thieuloy; Vašíček et al., p. 58, pl. 17, fig. 8.

1995. _Neocomites_ ( _Teschenites_ ) _flucticulus_ Thieuloy; Vašíček, pl. 1, fig. 7.

1996. _Teschenites subflucticulus_ n. sp.; Reboulet, p. 106, pl. 8, figs 1–9.

2004. _Neocomites_ cf. _subflucticulus_ Reboulet; Ettachfini, pl. 17, fig. 8.

2005. _Neocomites_ ( _Teschenites_ ) _subflucticulus_ (Reboulet); Klein, p. 320 (cum syn.).

2009. _Teschenites flucticulus_ Thieuloy; Vašíček et al., p. 134, fig. 3.5, 3.6.

2013. _Teschenites subflucticulus_ Reboulet; Michalík et al., p. 113, fig. 93/5.

**MATERIAL:** Two incomplete, flatly deformed microconch specimens preserved as external moulds coated with limonite (SNM Z 40071 = BK7Z-51/5, SNM Z 21133 = BK12-debris). Moreover, one larger, similarly preserved specimen SNM Z 40064 = BK11-33.8/1 (macroconch) with the impression of juvenile whorls. The terminal half of the ultimate whorl belongs to the body chamber.

**DESCRIPTION OF MICROCONCHS:** Specimens semi-evolute, medium in size, with little arched whorl flanks, comparatively high whorls, with a wider umbilicus. Most thin, closely spaced, S-shaped ribs begin in short bullate umbilical tubercles. A simple rib reaching the lower part of the flanks is inserted in places between the isolated ribs on the body chamber. In vicinity of the venter, all ribs incline towards the aperture and have very thin bullate ventral tubercles. In the terminal part of the ultimate whorl, the ribs are stronger and more widely spaced. The ribs cross the venter without interruption. Exceptionally, rib bifurcation may occur in the upper part of the flanks.

**DESCRIPTION OF MACROCONCH:** The body chamber bears a high whorl with slightly arched flanks. Inner whorls bear thin and closely spaced, S-shaped ribs. Around the line of coiling, there are distinct umbilical tubercles. On the body chamber, ribs are still closely spaced, but more robust. They begin on the umbilical seam in distinct bullate umbilical tubercles. Primary ribs that are concavely bent towards the aperture over a rather short distance run out from them. On their posterior side, thinner ribs split off or are inserted a little higher above the tubercles; the ribs are S-shaped similarly as the stronger primary ribs. Some ribs bifurcate even in the upper fifth of the whorl height. On the venter, all ribs are equally strong and highly inclined towards the aperture. The ribs cross the venter without interruption in the form of a chevron. The figured macroconch from Butkov Quarry has a more closely spaced ribbing than the specimens of Reboulet (1996, pl. 8, figs 1–9). The measurements of a microconch and a macroconch are presented in Table 1.

**REMARKS:** Reboulet (1996) states a possibility that _Teschenites subflucticulus_ (now _Tescheniceras subflucticulum_) could be the initial species for _Teschenites callidiscus_ (now _Tescheniceras callidiscum_).

**OCCURRENCE:** The type material comes from the Vocontian Basin, where it occurs mainly in the furcillata Zone and terminates in the lowermost part of the radiatus Zone (across the Valanginian/Hauterivian boundary); in Serbia (radiatus Zone) and probably also in Morocco in the uppermost Valanginian (Ettachfini
2004). In Butkov Quarry, *T. subflucticulum* occurs in Level 7 West, Levels 11 and 12 in the uppermost part of the Ladce Formation (Upper Valanginian).

*Tescheniceras pachydicranum* (Thieuloy, 1977)  
(Text-fig. 2A, B)

1901. *Hoplites regalis* Bean (in Paulow); Sarasin and Schön della Mayer, pl. 9, fig. 1.
1902. *Hoplites n. sp.* ind.; Uhlig, p. 58, pl. 8, fig. 2 a, b.
1976. *Neocomites (Teschenites) transylvanicus* (Jeke- 
lius); Mandov, p. 75, pl. 12, fig. 6.
1977. *Neocomites (Teschenites) pachydicranus* n. sp.;  
Thieuloy, p. 100, pl. 1, fig. 2, pl. 3, ?figs 1–4, pl. 3, ?figs 5, 6 [= *Tescheniceras subpachydicranum*  
(Reboulet, 1996)].
1981. *Tescheniceras pachydicranum* Thieuloy; Charollais  
et al., p. 90, pl. 5, figs 5, 6.
1986. *Neocomites (Teschenites) pachydicranus* Thieu- 
loy; Wyssling, p. 197, pl. 8, figs 1, 2.
1987. *Neocomites pachydicranus* Thieuloy; Company,  
p. 135, pl. 11, figs 6, 7, pl. 19, fig. 8, ?pl. 11, fig. 5.
1988. *Neocomites (Teschenites) pachydicranus* Thieu- 
loy; Wilke, p. 12, pl. 1, fig. 1.
1991. *Neocomites (Teschenites) pachydicranus* variant  
A Thieuloy; Thieuloy et al., p. 68, pl. 1, fig. 6  
[= *Tescheniceras subpachydicranum* (Reboulet, 1996)].
1993. *Neocomites (Teschenites) subpachydicranum* Thieu- 
loy; Aturan, pl. 2, fig. 2 [= *Tescheniceras sub-  
pachydicranum* (Reboulet, 1996)].
1993. *Neocomites (Teschenites) neocomiensiformis*  
(Uhlig); Aturan, pl. 2, fig. 13.
1995. *Neocomites (Teschenites) pachydicranus* Thieu- 
loy; Avram, pl. 2, fig. 1a, b.
1996. *Tescheniceras pachydicranum* (Thieuloy); Rebou- 
et, p. 114, pl. 12, figs 1, 3, 5, pl. 13, figs 1–7, 9.
1996. *Neocomites pachydicranus* Thieuloy; Vašíček  
and Faupl, p. 109, pl. 2, figs 5, 6.
2003. *Tescheniceras pachydicranum* Thieuloy; Busnardo  
et al., p. 44, pl. 1, fig. 8, pl. 2, fig. 11.
2004. *Neocomites pachydicranus* Thieuloy; Ettachfini,  
p. 137, pl. 17, figs 4a, b, 5, pl. 17, ?figs 6, 7.
2005. *Neocomites (Teschenites) pachydicranus* Thieu- 
loy; Klein, p. 318 (cum syn.).
2013. *Tescheniceras pachydicranum* Thieuloy; Michalík  
et al., p. 113, fig. 93/3.

**MATERIAL:** Comparatively large external moulds,  
sometimes coated with limonite on the ultimate  
whorl, usually slightly deformed by lateral shear  
(SNM Z 40065 = BK8-450/22, SNM Z 40061 = BK  
10-80/6, SNM Z 40066 = BK6-1/9 – fragment of the  
last whorl). Moreover, specimens BK5-270/17, 22  
and BK8-450/7.

**DESCRIPTION:** Semi-involute specimens, with  
medium-high whors and a comparatively narrow  
umbilicus. On the beginning half of the ultimate  
whorl, medium strong, slightly S-shaped ribs  
begin in umbilical tubercles. Occasionally, two ribs  
rut out from the tubercles. Some ribs bifurcate at  
different whorl heights, somewhere at one to three  
fifths of whorl height. All ribs bear only weak  
ventralateral tubercles. The ribs gradually strengthen  
in direction of the aperture. In the final part of  
the whorl, the ribs are more distinctly S-shaped. On  
some specimens, feeble constrictions are indicated.  
The ribs cross the venter in the form of a chevron.  
Towards the venter, the ribs disappear. In wider  
or narrower interspaces bounded by ribs running out  
from the tubercles, incomplete to indistinct subsidiary  
ribs occur. The body chamber of macroconch  
(Text-fig. 2A) bears distinct umbilical tubercles. On  
the venter, the ribs are inclined towards the apert-  
ure. The whorl flanks seem to be smooth. Only in  
the place of the expected aperture, several S-shaped  
growth lines are evident. This macroconch could  
reach a diameter of about 155 mm. The measure- 
ments are presented in Table 1.

**REMARKS:** *Tescheniceras pachydicranum* is, in  
contrast to the previous species, characterised by  
coarser and more widely spaced ribs of somewhat  
faloid shape. It differs from the closely related  
*T. subpachydicranum* by a narrower umbilicus and  
by the dominance of simple ribs in vicinity of the  
umbilicus. The microconch of *T. pachydicranum*  
illustrated in Vašíček and Faupl (1996, pl. 2, fig. 5) has a  
preserved rostrum. The fragment of the macroconch  
from Butkov Quarry illustrated herein (Text-fig. 2A)  
corresponds to the macroconch of *T. pachydicranum*  
illustrated by Reboulet (1996, pl. 13, fig. 1).

**OCCURRENCE:** *Tescheniceras pachydicranum*  
comes mainly from strata encompassing the upper- 
most Valanginian to the basal Hauterivian in France,  
Spain, Western Austria, Romania and Morocco (e.g.,  
dicranum* as the zonal species of the uppermost  
Valanginian, similar as Reboulet et al. (1992). In  
Butkov Quarry, the specimens come from the Ladce  
Formation and from the layers where the Ladce  
Formation multiply alternates with the Mrázínica  
Formation: Level 8, from 450 m of the succession.
(Ladce Formation, approximately the uppermost Valanginian), Level 6 (Mráznica Formation), Level 5, from about 270 m of the succession, and Level 10, from about 80 m of the succession near the Valanginian/Hauterivian boundary.

_Tescheniceras subpachydicranum_ (Reboulet, 1996) (Text-fig. 3B)

pars 1977. _Neocomites_ (Teschenites) _neocomiensiformis_ (Uhlig), Thieuloy, p. 95, pl. 2, figs 2, 3 [non pl. 2, fig. 1 = _Tescheniceras fluctulum_ (Reboulet, 1996)].


1991. _Neocomites_ (Teschenites) _pachydicranus_ Variant _A_; Thieuloy et al., p. 68, pl. 1, fig. 6.

1993. _Neocomites_ (Teschenites) _pachydicranus_ variant _A_; Autran, pl. 2, fig. 1.

1993. _Neocomites_ (Teschenites) _pachydicranus_ Thieuloy; Autran, pl. 2, fig. 2.

1996. _Tescheniceras subpachydicranum_ n. sp.; Reboulet, p. 112, pl. 11, figs 1–7, pl. 12, figs 2, 4, 6, pl. 13, fig. 8.

1996. _Teschenites aff. subpachydicranus_ n. sp.; Reboulet, p. 116, pl. 14, fig. 22.

1996. _Tescheniceras subpachydicranum_ Reboulet; Atrops et al., p. 724, fig. 19 (figure copied from Reboulet 1996, pl. 14, fig. 22). 20.

2005. _Neocomites_ (Teschenites) _subpachydicranus_ (Reboulet); Klein, p. 320 (cum syn.).

2013. _Tescheniceras subpachydicranum_ Reboulet; Michałik et al., p. 94, fig. 66/6.

2018. _Neocomites subpachydicranus_; Aguado et al., p. 128, fig. 5 F.

MATERIAL. Comparatively favourably preserved, flatly deformed external moulds (SNM Z 40067 = BK11A-11, SNM Z 40068 = BK11A-17; and specimen BK11-34/3) with the end of the phragmocone and part of the body chamber, and similarly preserved juvenile external moulds (SNM Z 40072 = BK11/10-04/9; and specimen BK11/10-04/6).

DESCRIPTION. Umbilicus rather wide. Juvenile whorls bear thin and closely spaced, equally strong, proverse, slightly S-shaped ribs. The ribs run out from the umbilical tubercles. Between the bundled ribs, one rib may be inserted in places. On the periphery, ventrolateral tubercles are indicated. Gradually, ribs become somewhat stronger, and from the umbilical tubercles, one or two ribs run out. At the beginning of the not high ultimate whorl, ribbing changes with the beginning of the body chamber. The ribs and the umbilical tubercles gradually strengthen, gaps between them increase. From the umbilical tubercles, two S-shaped ribs run out. Sporadically, some of the ribs bifurcate on the flank, at about two thirds of whorl height. On the final half of the whorl, the S-shaped ribs are distinctly stronger and more widely spaced. They begin individually or in pairs in distinct umbilical tubercles. The tubercles are somewhat bulate, concavely bent towards the aperture. Majority of the ribs bifurcate at about half the whorl height or even higher. They cross the venter without interruption in the form of a chevron. The measurements are presented in Table 1.

OCCURRENCE: _Tescheniceras subpachydicranum_ is known from the Vocontian Basin in France (uppermost Valanginian), from southern Spain (Pérez Valera and Company 2001) and Butkov Quarry (Slovakia), Level 11, layer of grey limestones in the transition between the Ladce and Mráznica formations (uppermost Valanginian).

**Biostratigraphic implications**

The classical area for the study of biostratigraphy and development of ammonites across the Valanginian/Hauterivian boundary is the Vocontian Basin in SE France. For example, Reboulet et al. (1992) and Bulot et al. (1993) analysed the distribution of species of the genus _Teschenites_ occurring there. According to these authors, the first _teschenitids_ appear in the _callidiscum_ Subzone (sensu Reboulet et al. 2018). Text-fig. 4 shows the recent international ammonite zonation of the studied part of the Lower Cretaceous.

Based on the stratigraphic evaluation of all the ammonites in Butkov Quarry correlated with equivalent findings made in significant European localities, it can be stated that the studied succession (Text-fig. 5) belongs to the _furcillata_ Zone (uppermost Valanginian) and the _radius_ Zone (lowermost Hauterivian) according to Reboulet et al. (2018).

The distribution of ammonite species in deposits across the Valanginian/Hauterivian boundary in Level 10 in Butkov Quarry is presented in Text-fig. 5. From among the neocomitid species determined in the quarry, only _Tescheniceras callidiscum_ occurs sporadically in the lower part of the succession in Level 10 (65 m). The index species _Himantoceras trinodosum_ Thieuloy, 1965 and _Olcostephanus nicklesi_ Wiedmann and Dieni, 1968 (_peregrinus_ Zone) are known from the underlying deposits with the first
representative of *Tescheniceras* gen. nov.; followed by the sporadic *Criosarasinella furcillata* Thieuloy, 1977 (Level 10, from 55 m of the succession; Level 11, from 25 m of the succession). *Tescheniceras subflucticulum* and *T. subpachydicranum* (furcillata Zone) sporadically occur in stratigraphically higher quarry levels. Compared to the previously mentioned species, *Tescheniceras pachydicranum* has a wider stratigraphic range. It occurs in deposits of the Ladcce Formation as well as, rarely, in deposits corresponding to the overlying Mráznica Formation, thus spanning the interval between the uppermost Valanginian and the Valanginian/Hauterivian boundary.

The upper boundary of the *callidiscum* Subzone in the classical areas (such as the Vocontian Basin) is marked by the first occurrence (FO) of *Acanthodiscus radiatus* (Bruguière, 1789) and related species, e.g., *Breistrofferella castellanensis* (d’Orbigny, 1840). Representatives of *Acanthodiscus* and *Breistrofferella*, classically used to indicate the base of the Hauterivian, have not been found in Butkov Quarry. Vašíček (2010, p. 410) stated that, instead of *Acanthodiscus radiatus*, *Teschenites callidiscus* (now *Tescheniceras flucticulum*) could be used as an index taxon for the basal Hauterivian in the Carpathian Region.

The *radiatus* Zone, in which *Tescheniceras* spp. occur most frequently, is evidenced by some Lower Hauterivian species accompanying *Tescheniceras flucticulum*, such as *Leopoldia* cf. *leopoldina* (d’Orbigny, 1840), *Olcostephanus hispanicus* Mallada, 1882, *Sarasinella subdensicostata* Vašíček, 2010, *Spitidiscus ex gr. rotula* (Sowerby, 1827), and *Oostellerella ondulata* Reboulet, 1996 (*O. ondulata* occurs already in the *furcillata* Zone). With the exception of *S. subdensicostata*, all other taxa are represented by single specimens.

According to Reboulet (1996), Busnardo et al. (2003) and Melliti et al. (2019), the first representatives of the genus *Spitidiscus* Kilian, 1910 occur in the base of Hauterivian. The first occurrence of *Spitidiscus* (Level 10, from 82 m) is thus used for the determination of the base of the Hauterivian in Butkov Quarry.

Altogether, the ammonite association occurring in Butkov Quarry across the Valanginian/Hauterivian boundary is similar to other successions in Europe, especially in the Vocontian Basin in France, Spain, and others. However, with regard to the composition of the index species, some substantial species of the basal Hauterivian, especially *Acanthodiscus radiatus* and *Breistrofferella castellanensis*, are missing in Butkov Quarry. Both mentioned species are connected with a more shallow-water environment in SE France. According to Reboulet (1996, 2002), repre-
Text-fig. 5. Composite distribution of ammonites across the Valanginian/Hauterivian boundary in Butkov Quarry, Slovakia. The main source of the material is a section in Level 10 (BK 10) with the larger black circles indicating the abundant occurrence of *Tescheniceras* gen. nov. In the right part of the figure, numerical symbols are used to indicate the stratigraphic equivalents in other levels bearing representatives of *Tescheniceras* gen. nov. and other stratigraphically important species. For reasons of space, the symbol BK is omitted in this part of the figure. Only the number of the level and its particular length are marked (e.g., BK 8-450 = Level 8–450 m).
sentatives of Breistrofferella and Acanthodiscus are more frequent in shallow platforms than in basinal settings. In Butkov Quarry, they do not occur because the pelagic deposits are of more deep-water type, which is indicated by the character of sediments, layers of turbidites, and composition of macrofauna.

Acknowledgments

The author would like to warmly thank the colleagues J. Michalík (Bratislava) and P. Skupien (Ostrava), with whom he collected fossils and documented the sections in Butkov Quarry. The author is grateful to K. Mezihoráková (Ostrava) for tak-collected fossils and documented the sections in Butkov Quarry. Michalík (Bratislava) and P. Skupien (Ostrava), with whom he reviews that significantly contributed to the rearrangement and Reboulet (University of Lyon) for their critical and constructive thanks the Institute of Geonics, Czech Academy of Sciences. Special by the Project for the Long-Term Strategic Development of

CONCLUSIONS

Neocomitid ammonites from Butkov Quarry (a total of 5 species) which occur in the succession across the Valanginian/Hauterivian boundary are as-signed to Tescheniceras gen. nov., with Tescheniceras flucticulum as the type species. The older name Teschenites used for this group of neocomitids is not valid. It is considered here that Teschenites robustus is a synonym of Tescheniceras flucticulum. As the first species in the Ladce Formation there appear Tescheniceras callidiscum and Tescheniceras subflucticulum, in the uppermost Valanginian (fur-cillata Zone, callidiscum Subzone; Reboulet et al. 2018). Roughly at the same stratigraphic level, within the grey-coloured Mráznica Formation, occurs Tescheniceras subpachydicranum. In the vicinity of the expected Valanginian/Hauterivian boundary, Tescheniceras pachydicranum appears as well. The most abundant is Tescheniceras flucticulum, whose maximum abundance in the quarry indicates the base of the Hauterivian (radiusus Zone). As representatives of Acanthodiscus and Breistrofferella are absent from the succession in the quarry, the first occurrence of Spiliticus is used to characterise the base of the Hauterivian. The presented paper contributes to the extention of knowledge concerning the ammoni-te association across the Valanginian/Hauterivian boundary in the pelagic realm.

REFERENCES


Manuscript submitted: 22nd January 2020
Revised version accepted: 29th July 2020