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The occurrence of *Gastrioceras* in the Moroccan Meseta and mid-Bashkirian ammonoid palaeogeography

Dieter Korn and Martin Rücklin

With 3 figures

Abstract: The Late Carboniferous ammonoids *Gastrioceras listeri* (SOWERBY, 1812) and *Gastrioceras angustum* PATTEISKY, 1965 are reported from Ighr ou Hammoud in the vicinity of Dechra Aït Abdallah (central Moroccan Meseta). The assemblage shows very close relationships to those from the South Portuguese Zone, the British Isles and the Rhenish Mountains, suggesting a contiguous epicontinental sea. These occurrences differ from those of the American Midcontinent on the species level within *Gastrioceras*, but much more prominently in the significantly greater diversity of the assemblages from Arkansas and Oklahoma. These differences are better interpreted as differences in environment than with palaeogeography.

Key words: Late Carboniferous, Moroccan Meseta, Ammonoidea, palaeogeography.

1. Introduction

Gastrioceras HYATT, 1884 is one of the cardinal index ammonoid genera for the subdivision of the Carboniferous. Records of the genus are stratigraphically restricted to strata of a short interval in the late Bashkirian (Late Carboniferous; Pennsylvanian) and have a wide geographic distribution. The first record came from northern England, when the type species *G. listeri* was described by MARTIN (1809) and subsequently by SOWERBY (1812–1814); the latter description was the first ever described Palaeozoic ammonoid applying the Linnaean binominal terminology.

Gastrioceras had already been recorded in North Africa, such as in the vicinity of Kenadsa in western Algeria (DELÉPINE 1941; TERMIER & TERMIER 1952) and in the Jerada coalfield in eastern Morocco (BOUCKAERT & OWODENKO 1965). From the Moroccan Meseta, BENSÂÏD et al. (1980) reported *Gastrioceras* from the area where the new material described here comes from.

The wide geographic distribution of ammonoid assemblages with *Gastrioceras* and the morphological distinctiveness of this genus allow both stratigraphic and palaeobiogeographic analyses, particularly with regard to the changing degree of provinciality during the Carboniferous (KORN et al. 2012).

2. Geological background and material

The area around Dechra Aït Abdallah in the central Moroccan Meseta is particularly well-known for the discovery of a well-preserved flora of Middle Devonian terrestrial plants (TERMIER & TERMIER 1950; GERIENNE et al. 2010; PRESTIANNI et al. 2012). TERMIER (1936) had already illustrated late Emsian (Early Devonian) ammonoids from the area and GROBE (1993) provided Early to Late Devonian conodont data.

The study of two sections north of Dechra Aït Abdallah by TERMIER & TERMIER (1951) led to the description of a SW–NE trending a syncline (called by them Ighou Ammoud Syncline), in which a prom-

inent sandstone package is the youngest formation and forms the crests of Ighr ou Hammoud (= Ighrou Ammoud, Igouer ou Hammoud) and Koudiat Oulabes (= Tichout Ou Labas). A fossil flora from beds below this sandstone package was placed by **TERMIER & TERMIER (1951)** in the “zone known as *Adiantites*, which straddles the Viséan and the Namurian”.

TERMIER & TERMIER (1970) gave a brief overview on the general stratigraphic succession of the area. They listed several horizons with ammonoids, three of which are in the Early and Middle Devonian (with *Mimagoniatites*, *Anarcestes* and *Pinacites*, respectively) and two in the Viséan (“*Goniatites crenistria*” and “*G. striatus*”; “*G. spiralis*” and “*G. subcircularis*”). They have not recorded Late Carboniferous ammonoids, but a “coastal fauna” and a terrestrial flora of “basal Namurian” age.

BENSAÏD et al. (1979) and **BENSAÏD et al. (1980)** carried out more detailed investigations in the area north of Dechra Aït Abdallah and provided a geological map. In the latter paper, they reported the occurrence of *Gastrioceras* at Ighr ou Hammoud and were thus able to identify a Westphalian stratigraphic position.

About 20 mostly fragmentary ammonoid specimens are available from a small area along the old mule track, already mentioned by **TERMIER & TERMIER (1951)**, at the northwestern foot of the Ighr ou Hammoud (33.27423° N, 5.64026° W). It is located 5 km north-northwest of Dechra Aït Abdallah and about 14 km north-northwest of Mrirt in the Moroccan Meseta (Fig. 1). The material was collected by MR in 2007 and DK, together with the late Volker Ebbighausen, in 2010.

All specimens were surface-collected from strongly weathered thin beds or nodules, in which the ammonoid conchs are almost always completely dissolved and therefore only preserved as hollow forms. The beds and nodules are embedded in shales, which lie below a series of coarse-grained sandstones.

3. Palaeontological notes

Two species of *Gastrioceras* are available from the Ighr ou Hammoud:

Gastrioceras listeri (SOWERBY, 1812)

Specimen MB.C.31973.1 is the only one in three-dimensional preservation (Fig. 2A). It is a preadult

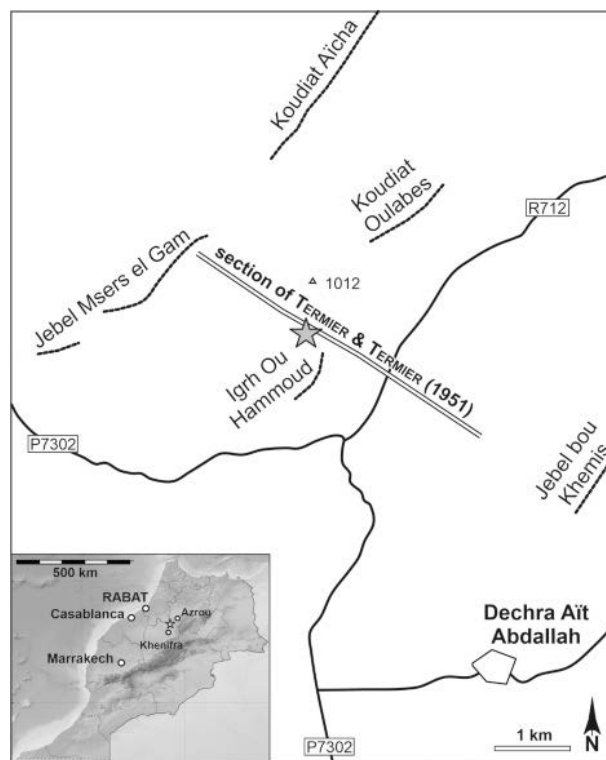


Fig. 1. The geographic position of the Ighr ou Hammoud locality (grey asterisk) north of Dechra Aït Abdallah in the Central Meseta of Morocco.

specimen with 24 mm conch diameter with the characteristic coronate shape, in which the umbilical margin is armed by about 12 sharp, short ribs per half volution. Parts of the shell are preserved, they show lamellar growth lines, which cross the venter with a broad and low projection. The internal mould has constrictions standing about 90 degrees apart. The specimen also shows the suture line with the parallel-sided external lobe that has about the same width as the broadly arched ventrolateral saddle.

Specimen MB.C.31973.2 (Fig. 2B) is a hollow form of a specimen with about 45 mm diameter and allows insight into the inner whorls, which are ribbed beginning with a conch diameter of 5 mm or less.

The specimens are very similar, in conch shape, ornament and sculpture, to the material that was described from Northern England (**RAMSBOTTOM & CALVER 1962**), the Rhenish Mountains (**PATTEISKY 1965**; **KORN 2007**) and the South Portuguese Zone (**KORN 1997**). Most probably the specimen illustrated as “*Gastrioceras subcrenatum*” by **BENSAÏD et al. (1980)** belongs to this species.

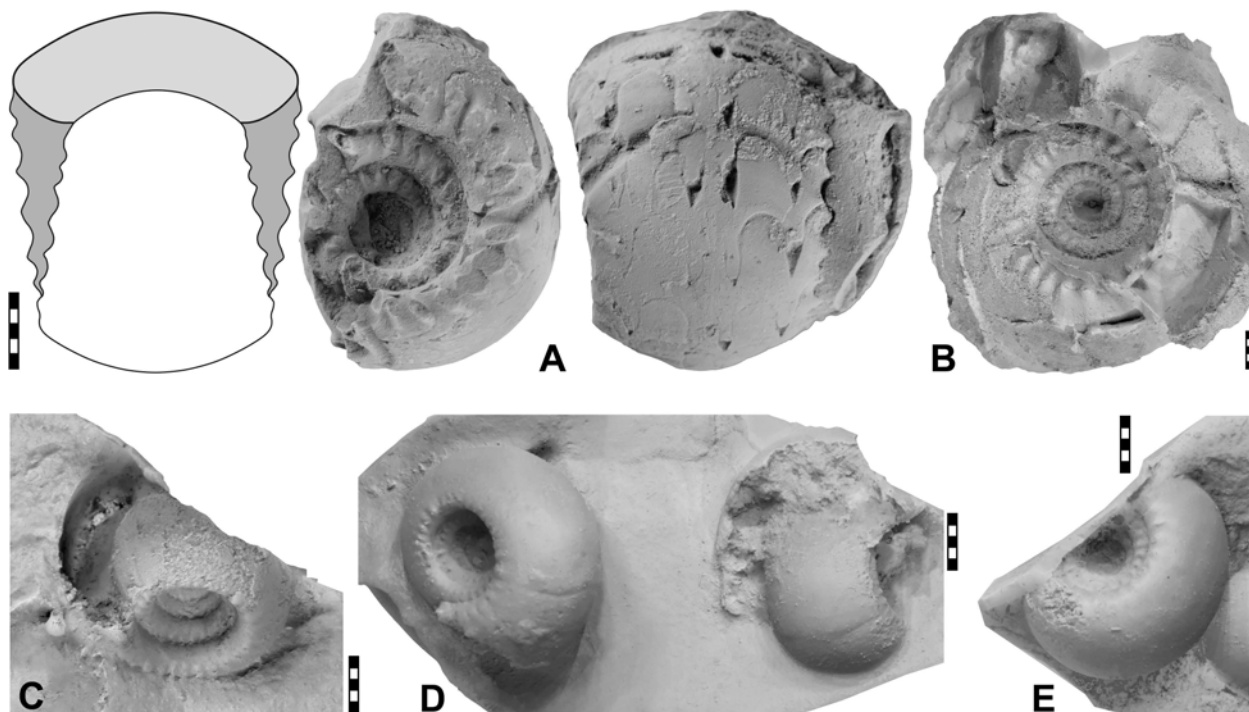


Fig. 2. Specimens of *Gastrioceras* from Ighr ou Hammoud. **A** – *Gastrioceras listeri* (SOWERBY, 1812); specimen MB.C.31973.1; reconstruction of dorsal projection, lateral and ventral views. **B, C** – *Gastrioceras listeri* (SOWERBY, 1812); specimens MB.C.31973.2 and MB.C.31973.3; silicon casts. **D, E** – *Gastrioceras angustum* PATTEISKY, 1965; specimens MB.C.31974.1 and MB.C.31974.2; reconstruction of dorsal projection, lateral and ventral views. Scale bar units = 1 mm.

Gastrioceras angustum PATTEISKY, 1965

Only hollow forms are available, which were casted with silicone for photography (Fig. 2D, E). Specimens MB.C.31974.1 and MB.C.31974.2 show the pachyconic, subevolute conch with a hemispherical rounded area of flanks and venter and the sculpture with numerous small umbilical nodes. The material closely resembles the specimens found in the Rhenish Mountains (PATTEISKY 1965; KORN 2007) and the South Portuguese Zone (KORN 1997).

4. Palaeogeobiographic implications

Gastrioceras was described from the classic regions in England (FOORD & CRICK 1897; RAMSBOTTOM & CALVER 1962), Belgium (DE KONINCK 1844; DEMANET 1943), the Netherlands (DORSMAN 1945), the Rhenish Mountains of Germany (SCHMIDT 1924;

SCHMIDT 1925; PATTEISKY 1965; DAHM 1966; KORN 2007) and the Silesian Coal Basin of Poland (SCHMIDT 1925). In these regions, species of *Gastrioceras* were usually used to define the base of the classic Westphalian stage. *Gastrioceras listeri* or similar species were also recorded from the South Portuguese Zone (KORN 1997), the Lublin Basin of Poland (BOJKOWSKI 1979), the Donets Basin of Ukraine (POPOV 1979) as well as Gansu and Ningxia in North China (YIN 1935; RUAN & ZHOU 1987; SHENG 1987; YANG 1987; KORN et al. 2021). Species commonly considered to belong to *Gastrioceras* (sometimes assigned to the subgenus *Lissogastrioceras*) were reported from numerous places in the American Midcontinent (MILLER & OWEN 1944; UNKLESBAY 1962; GORDON 1965; MCCAULEY 1968) and the Northwest Territories of Canada (NASICHUK 1975).

In all the European and North African regions (Fig. 3), *Gastrioceras* is represented by the very conspicuous species *G. listeri*, which is commonly accompanied by other species of the genus (e.g.,

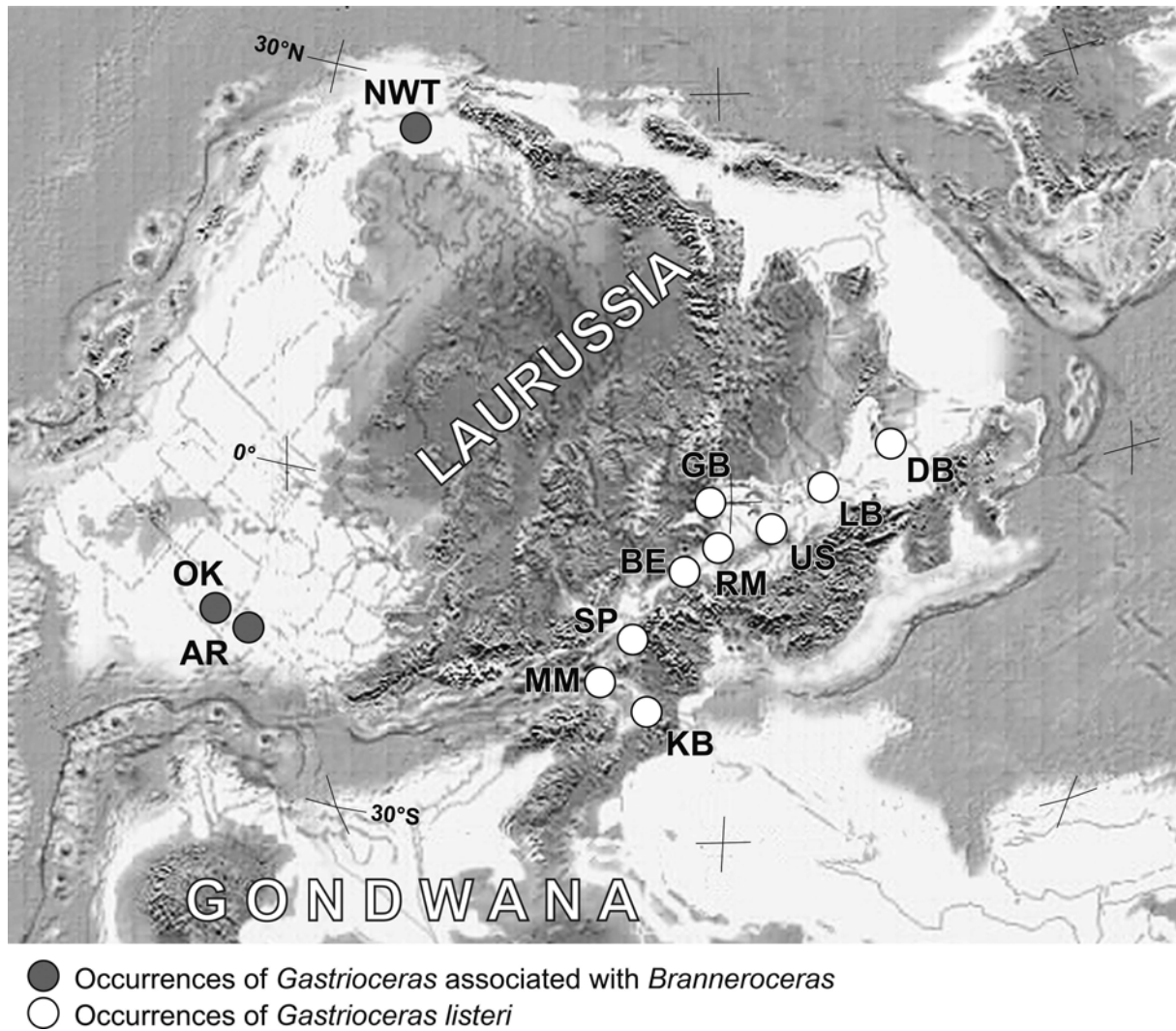


Fig. 3. Palaeogeographic reconstruction for the North Atlantic region of the mid-Bashkirian (after SCOTSE 1997); modified after an image by RON BLAKEY, <http://jan.ucc.nau.edu/~rcb7/>). NWT = Northwest Territories; OK = Oklahoma; AR = Arkansas; MM = Moroccan Meseta; KB = Kenadsa Basin; SP = South Portugal; BE = Belgium; RM = Rhenish Mountains; GB = England; LS = Lower Silesia; LU = Lublin Basin; DB = Donets Basin.

G. angustum, *G. carbonarium*). These species are not known from North America, where the Bashkirian occurrences of *Gastrioceras* are represented by *G. fittsi* and *G. adaense*. GORDON (1965) placed the latter two in the subgenus *Gastrioceras* (*Lissogastrioceras*) because of their weakly ornamented venter compared to *G. listeri*. However, the major difference between the European/North African assemblages on the one side and the North American occurrences on the other side is the unequal diversity of the assemblages. While *Gastrioceras* occurs in low-diverse assemblages in

Europe, it is accompanied by numerous other genera in the North American assemblages. *Gastrioceras* usually co-occurs with *Branneroceras*, *Cymoceras*, *Diaboloceras*, *Gaitherites*, *Glaphyrites*, *Phaneroceras*, *Proshumardites*, *Pseudobisatoceras*, *Pseudopronorites*, *Ramosites* and *Syngastrioceras* in the Union Valley Formation of Oklahoma (UNKLESBAY 1962) and the Brentwood Limestone of the Bloyd Formation of Arkansas and Oklahoma (GORDON 1965; MCCALED 1968).

The mid-Bashkirian assemblages known from Xiaoyuchuan (Ningxia, North China) have a similar composition to the European occurrences; they are also dominated by *Gastrioceras* with only a few subordinate forms (KORN *et al.* 2021). As in the European/North African occurrences, these assemblages come from sediments of the marine ingression and represent a nearshore environment.

Previous studies have shown that increasing provincialism occurred during the Late Viséan and Serpukhovian (KORN *et al.* 2012). The close relationships between the *Gastrioceras*-bearing assemblages indicate a return to cosmopolitanism during the Bashkirian. Differences in the diversity of the ammonoid communities are more likely due to environment, with low-diversity assemblages in the near-shore occurrences and diverse assemblages in the open shelf settings.

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