Cretaceous Research 56 (2015) 647–650

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Short communication

Rediscovery of the holotypes of the Cenomanian (Upper Cretaceous) ammonites *Vascoceras gamai* Choffat, 1898, and *Vascoceras barcoicense* (Choffat, 1898)

Fernando Barroso-Barcenilla [a, b, *], José Manuel Brandão [c], Pedro Miguel Callapez [d, e], Vanda Faria dos Santos [e, f]

[a] Grupo de Investigación IberCreta, Departamento de Geología y Geografía, Facultad de Ciencias, Universidad de Alcalá de Henares, 28871 Alcalá de Henares, Spain
[b] Grupo de Investigación Procesos Bióticos Mesozoicos, Departamento de Paleontología, Facultad de Ciencias Geológicas, Universidad Complutense de Madrid, 28040 Madrid, Spain
[c] Instituto de História Contemporânea, Centro de Estudos de História e Filosofia da Ciência, Universidade de Évora, 7000-554 Évora, Portugal
[d] Departamento de Ciências da Terra, Faculdade de Ciências e Tecnologia, Universidade de Coimbra, 3030-790 Coimbra, Portugal
[e] Centro de Investigação da Terra e do Espaço, Universidade de Coimbra, 3000-134 Coimbra, Portugal
[f] Museu Nacional de História Natural e da Ciência, Universidade de Lisboa, 1250-102 Lisboa, Portugal

ARTICLE INFO

Article history:
Received 23 January 2015
Received in revised form
10 June 2015
Accepted in revised form 27 June 2015
Available online 30 July 2015

Keywords:
Systematics
Ammonoidea
Vascoceratidae
Holotypes
Upper Cenomanian
Portugal

ABSTRACT

The historical holotypes of the Cenomanian (Upper Cretaceous) ammonites *Vascoceras gamai* Choffat, 1898 (type of the genus), and *Vascoceras barcoicense* (Choffat, 1898), thought to be destroyed by the fire of March 1978 at the National Museum of Natural History, Lisbon, Portugal, have been rediscovered in good state of preservation. Based on the study of the originals, these upper Cenomanian specimens can be rehabilitated as holotypes, maintaining and justifying the status of both taxa as well as of *Vascoceras cauvini* Chudeau, 1909.

1. Introduction

On March 18th, 1978, a fire destroyed much of the building of the National Museum of Natural History, currently the National Museum of Natural History and Science (Museu Nacional de História Natural e da Ciência: MUHNAC), University of Lisbon, Portugal, affecting both the exhibition and the storage rooms and implying the loss of most scientific and historical collections. The recovered material was cleaned and stored for re-cataloguing in the basement of the building that has been slowly rebuilt. Recently, while searching for cephalopods among the recovered fossil collections of the MUHNAC, the historical holotypes of the Upper Cretaceous ammonite species *Vascoceras gamai* Choffat, 1898 (type of the genus), and *Vascoceras barcoicense* (Choffat, 1898) have been found in good state of preservation and studied in detail.

Institutional abbreviations. MG: Museu Geológico (Geological Museum), formerly Museu dos Serviços Geológicos, Lisbon, Portugal; MNHNP: Muséum National d'Histoire Naturelle (National Museum of Natural History), Paris, France; MUHNAC: Museu Nacional de História Natural e da Ciência (National Museum of Natural History and Science), formerly Museu Nacional de História Natural, Lisbon, Portugal.

2. Geological background

The holotypes of *Vascoceras gamai* Choffat, 1898, and *V. barcoicense* (Choffat, 1898) were selected from specimens

* Corresponding author. Grupo de Investigación IberCreta, Departamento de Geología y Geografía, Facultad de Ciencias, Universidad de Alcalá de Henares, 28871 Alcalá de Henares, Spain. Tel.: +34 657349077.
E-mail address: fbarroso@geo.ucm.es (F. Barroso-Barcenilla).

http://dx.doi.org/10.1016/j.cretres.2015.06.017
0195-6671/

collected at Condeixa-a-Nova and Barcoiço, North-Central Portugal, where the main lithofacies are fine grained greyish marls interbedded with nodular marly limestones, and ammonites occur as internal moulds with the suture lines preserved in detail (Fig. 1A–B). Both holotypes were collected from the stratigraphic interval with *Euomphaloceras* (*Kanabiceras*) *septemseriatum* Cragin, 1893, and *Rubroceras* spp. This succession overlies limestones with *Neolobites vibrayeanus* (d'Orbigny, 1841) and is positioned below a sequence with *Spathites* (*Jeanrogericeras*) *subconciliatus* (Choffat, 1898) and *Pseudaspidoceras pseudonodosoides* (Choffat, 1898) (Callapez, 2001, 2003; Callapez and Soares, 2001; Barroso-Barcenilla, Callapez, Soares, Segura et al., 2011). These findings date the two holotypes as mid-late Cenomanian, correlating with the upper part of the European *Metoicoceras geslinianum* standard zone (Kennedy, 1984).

3. The holotype of *Vascoceras gamai* Choffat, 1898 (Fig. 1A, 2A–D)

The ammonite of Choffat (1898, p. 54, pl. 7, Fig. 1a, b; pl. 21, Fig. 1) from Condeixa-a-Nova, to the south of Coimbra, North-Central Portugal, was selected by original designation as holotype of *V. gamai*, and held in the MUHNAC, under catalogue number MNHN/UL.I.Am35. Subsequently, the holotype of *V. gamai* was refigured by Wright in Moore (1957) and Wright in Kaesler (1996). After the holotype allegedly had been destroyed by the fire of 1978, Berthou, Chancellor and Lauverjat (1985) proposed as lectotype the specimen of Choffat (1898, pl. 7, Fig. 2), from Meirinhas de Baixo, to the south of Coimbra, held in the MG with the inventory number 808-2. Berthou et al. (1985), as already suggested by Berthou, Brower and Reyment (1975), also regarded *V. gamai* var. *subtriangularis* Choffat, 1898, *Vascoceras mundae* Choffat, 1898, *Vascoceras adonense* Choffat, 1898 and *Ammonites* (?*V.*) *grossouvrei* Choffat, 1898, as synonyms of *V. gamai*. Soon after, the specimen of Meirinhas de Baixo was correctly proposed as neotype by Cobban, Hook, Kennedy (1989).

3.1. Complementary description

The holotype (MNHN/UL.I.Am35) is a composite internal mould of a medium sized, compressed and evolute specimen of *Vascoceras* (Diameter: 153 mm; Umbilical ratio: 0.35; Whorl height: 70 mm; Whorl breadth: 66 mm). It is a large and mature specimen, slightly crushed on a flank of the body chamber. The aperture is not preserved. The body chamber is entirely smooth and extends over three quarters of the last whorl. The whorl section is well rounded ventrally, slightly higher than broad, with flattened flanks, a rather abruptly rounded umbilical shoulder, and a moderately deep umbilicus. The last quarter of the phragmocone is exposed, and the umbilical areas of the remaining inner whorls are still visible, only partly covered by the body chamber. The inner whorls are ornamented with large, prominent, unequal and irregularly spaced umbilical tubercles, which become progressively weaker in the last half of the phragmocone. There are ten tubercles, including an example of paired tubercles typical of this species (Callapez and Soares, 2001). The suture lines are well incised on both sides of the phragmocone and closely spaced (nine in a quarter of a whorl). The holotype typifies the suture of the genus, which is characterised by "*variable, irregular, short, feebly indented elements*" (Wright and Kennedy, 1981). The intermediate saddle (E/L), with smaller indentations than in the first lateral lobe (L), is considerably large and shallow, with a few round indentations. There is also an asymmetrically bifid lateral saddle and a narrow second umbilical lobe (U2), followed by a third smaller saddle and a short lobe positioned over the umbilical shoulder.

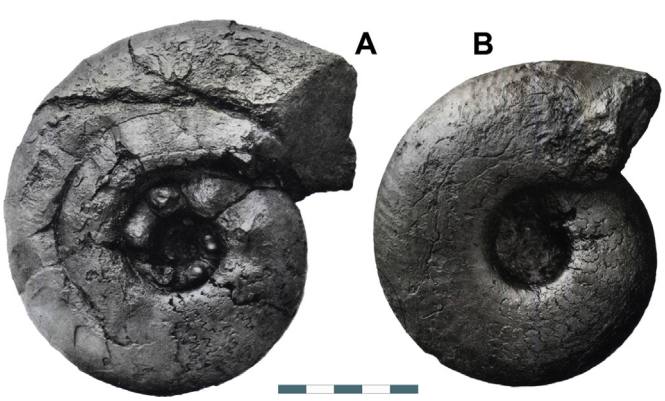

Fig. 1. Original illustrations of the holotypes of *Vascoceras gamai* Choffat, 1898, and *Vascoceras barcoicense* (Choffat, 1898), specimens MNHN/UL.I.Am35 and MNHN/UL.I.Am37. A, *V. gamai*, lateral view (Choffat, 1898, pl. 7, Fig. 1a), from Condeixa-a-Nova. B, *V. barcoicense*, lateral view (Choffat, 1898, pl. 17, Fig. 1a), from Barcoiço. Note the darkening and the mirror-inverted orientation of both specimens in the original photographic reproductions. Scale bar 5 cm.

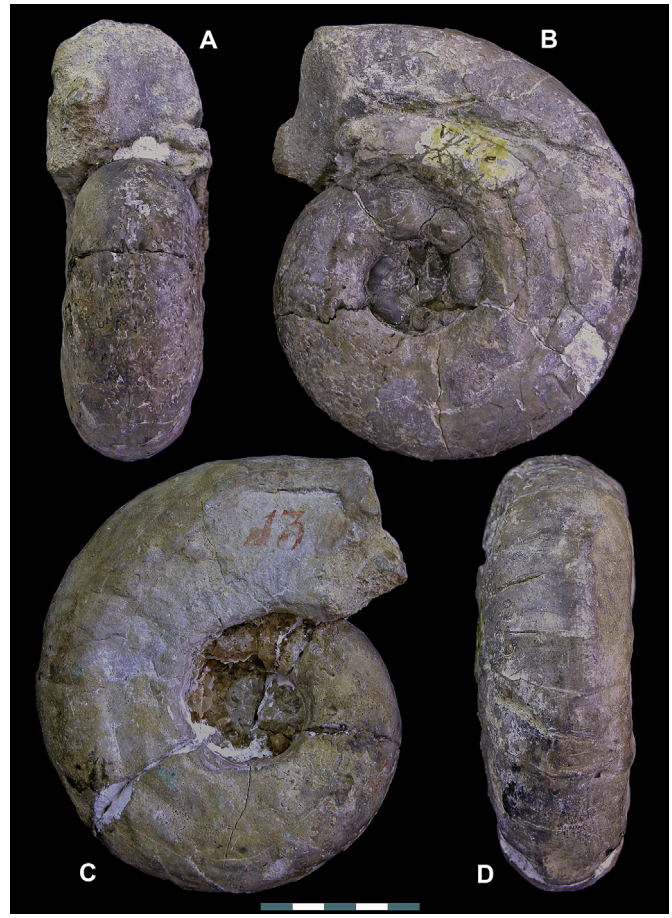

Fig. 2. Holotype of *Vascoceras gamai* Choffat, 1898, MUHNAC, specimen MNHN/UL.I.Am35 from Condeixa-a-Nova. A, apertural, B,C, lateral, D, ventral views. Scale bar 5 cm.

4. The holotype of *Vascoceras barcoicense* (Choffat, 1898) (Fig. 1B, 3A–E)

The ammonite of Choffat (1898, p. 67, pl. 17, Fig. 1a–c; pl. 22, Fig. 35) from Barcoiço, to the north of Coimbra, was selected by original designation as holotype of *Ammonites* (*Vascoceras*?)

barcoicensis, and held in the MUHNAC, under catalogue number MNHN/UL.I.Am37. After the holotype allegedly had been destroyed by the fire of 1978, Berthou et al. (1985) proposed as lectotype the non-illustrated specimen of Choffat (1898, p. 67), from Moinho do Almoxarife, to the west of Coimbra, held in the MG with the inventory number 831. The same specimen was correctly proposed as neotype by Callapez and Soares (2001).

4.1. Complementary description

The holotype (MNHN/UL.I.Am37) is a well preserved composite internal mould of a medium sized, compressed and moderately evolute specimen of *Vascoceras* (Diameter: 135 mm; Umbilical ratio: 0.32; Whorl height: 60 mm; Whorl breadth: 55 mm). It is an almost complete specimen, except for the contour of the aperture. The body chamber extends over half of a whorl and it is faintly ribbed with numerous, slightly proverse ribs, more prominent in the siphonal and ventrolateral areas and weakening on the flanks (Fig. 3E). The whorl section is rounded ventrally, higher than broad, with almost flattened flanks, a round umbilical shoulder, and a deep umbilicus. The maximum whorl breadth occurs just above the umbilical shoulder. The last half whorl of the phragmocone is well visible, but the remaining inner whorls are not visible and there is thus no evidence of umbilical tubercles, ribbing or constrictions. The ribs on the body chamber also do not extend to the phragmocone. The suture lines are remarkably well incised on both sides of the phragmocone and are very closely spaced (17 on the last half whorl). They include a large bifid E/L saddle, a large asymmetrically bifid first lateral lobe (L) with the ventral branch smaller and higher than the dorsal one, a large and bifid lateral saddle and a narrow second umbilical lobe (U2). Another small umbilical saddle and lobe are still visible over the umbilical shoulder.

Fig. 3. Holotype of *Vascoceras barcoicense* (Choffat, 1898), MUHNAC, specimen MNHN/UL.I.Am37 from Barcoiço. A, apertural, B,C, lateral, D, ventral views. E, detail of the ornamentation. Scale bars (horizontal for A–D, vertical for E) are 5 cm.

5. Discussion

Based on observations on many hundreds of specimens collected from different Upper Cretaceous basins, it is evident that *Vascoceras gamai* is a morphologically very variable species (Berthou et al., 1985; Callapez and Soares, 2001; Barroso-Barcenilla and Goy, 2010). Significant differences occur in the degree of coiling from in-to evolute forms, the overall shell shape with compressed to depressed forms, and the whorl section that can be subtriangular, oval or rounded. For Choffat (1898), these differences were enough to propose separate species (*Vascoceras mundae*, *V. adonensis*, *Ammonites* (*V.*?) *grossouvrei*) and a variety (*V. gamai* var. *subtriangularis*) that seem to be regarded as mere synonyms of *V. gamai* (Berthou et al., 1985; Callapez and Soares, 2001; Barroso-Barcenilla and Goy, 2010). For this reason, the strict original diagnosis of *V. gamai* should be considered in the present broader interpretation of this species.

The numerous and closely-spaced suture lines near the end of the phragmocone suggest that the holotype of *V. barcoicense* is a mature specimen, showing that this species is smaller than *V. gamai*. The possibility that these forms would be sexual dimorphs does not seem probable because the stratigraphic ranges and the geographic distributions of both species are only partially overlapped, and their morphological differences are shown not only by the adult specimens but also by the immature representatives of *V. gamai* and *V. barcoicense*. A further complete additional topotype specimen collected at the type locality and figured by Callapez and Soares (2001) allows us to confirm the same overall dimensions and shape of the holotype. Regarding the difficulties encountered in distinguishing *V. barcoicense* from *V. gamai* and from *Vascoceras cauvini* Chudeau, 1909, Berthou et al. (1975, 1985) emphasised that the main problem in identifying and establishing the taxonomic status of these species is related to the lack of knowledge of the morphology and ornamentation of the inner whorls of the here studied holotype. Berthou et al. (1985) also remarked that if the early whorls of the (to that date) missing holotype showed some umbilical tubercles or a nearly smooth external surface, it would be difficult to maintain the specific separation between *V. barcoicense* and *V. gamai* in the first case, or between *V. barcoicense* and *V. cauvini* in the second. Berthou et al. (1985) also stated that *V. barcoicense* has compressed and moderately involute morphology and, apparently, lacks umbilical tubercles during early ontogeny. However, these authors maintained the specific distinction because *V. cauvini* shows a subtriangular and more involute whorl section and strong ribbing at maturity. Cobban et al. (1989) described *V. barcoicense exile* as a new subspecies from New Mexico (USA), even smaller and more compressed and involute than the holotype. They also compared *V. barcoicense* with *V. cauvini*, suggesting that the latter is more evolute and more variable, including much more coarsely ribbed morphs. Zaborski (1996) separated both species on the basis of the reduced ornamentation of *V. barcoicense* during maturity. Barroso-Barcenilla and Goy (2010) observed the presence of tenuous ornamentation in some of the smallest specimens of *V. barcoicense*, and suggested a close phylogenetic relationship of this species with *V. gamai*.

In view of the rediscovery holotypes of *V. gamai* and *V. barcoicense*, and their comparison with the lectotype of *V. cauvini* proposed by Kennedy, Cobban, Hancock and Hook (1989), nowadays held in the MNHNP, under catalogue number R52488 (Fig. 4A–C),

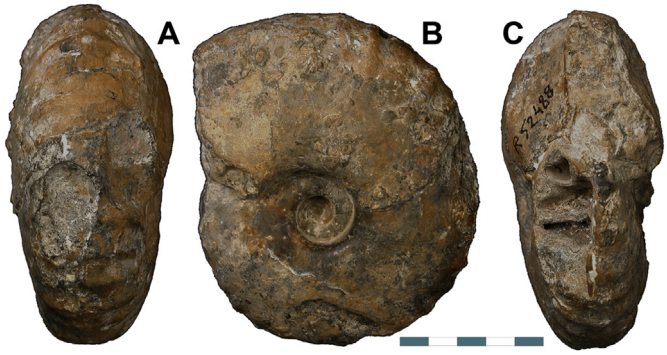

Fig. 4. Lectotype of *Vascoceras cauvini* Chudeau, 1909, designated by Kennedy et al. (1989), MNHNP, specimen R52488 of Chudeau (1909, p. 68, pl. 1, Fig. 1a; pl. 3, Fig. 1b) from Gjadjidouma, Niger. A, apertural, B, lateral, C, ventral views. Scale bar 5 cm.

and additional conspecific material, it could be concluded that those specimens of *Vascoceras* with compressed and evolute whorls, juvenile ribs, strong umbilical tubercles and relatively large adult size must be assigned to *V. gamai*; those with slightly compressed and moderately evolute whorls, lack of (or only feeble umbilical tubercles) juvenile ornamentation, and fine and dense adult ribbing belong to *V. barcoicense*; and those with moderately depressed and involute whorls, as well as strong and distant ribbing should be assigned to *V. cauvini*. Thus, it is suggested to maintain the specific status of *V. gamai*, *V. barcoicense* and *V. cauvini*. In support of this, the stratigraphic distribution, although with partially overlapping upper Cenomanian ranges, shows that *V. gamai* appeared first, followed by *V. barcoicense* and finally by *V. cauvini* (Barroso-Barcenilla and Goy, 2010; Nagm and Wilmsen, 2012). The successive FOs of these taxa may reflect a gradual phylogenetic lineage in which the separation of morphospecies is relatively difficult due to their partly overlapping ranges.

6. Conclusions

This re-discovery of the allegedly lost type specimens enables the rehabilitation of the holotypes of *Vascoceras gamai* Choffat, 1898 (type species of *Vascoceras* Choffat, 1898) and of *V. barcoicense* (Choffat, 1898), allowing to detract the subsequently designated lecto- and neotypes (Berthou et al., 1985; Cobban et al., 1989; Callapez and Soares, 2001). The complementary descriptions and re-illustration of the holotypes show clear differences between the two species that allow to determine with more precision the characteristics and morphological limits of the genus *Vascoceras* and, thus of the family Vascoceratidae Douvillé, 1912: *V. gamai* shows juvenile ribs, strong umbilical tubercles and relatively large adult size, whereas *V. barcoicense* exhibits slightly compressed and moderately evolute whorls, a lack of juvenile ornamentation (or at most feeble umbilical tubercles) as well as fine and dense adult ribbing, reaching a smaller mature size. These morphological differences strongly support the taxonomic separation of these two species, along with *V. cauvini* Chudeau, 1909, a likewise separate species with moderately depressed and involute whorls and strong and distant ribbing.

Acknowledgements

The first author is grateful to a Research Mobility Grant of the Universidad de Alcalá de Henares, Spain, during October–November 2014 in the MG. He also appreciates the help offered by Drs. M. Ramalho and J. Sequeira in the MG, by Mr. J.P. Carreiro Lopes in the MUHNAC, and by Drs. A. Cornée, D. Merle, J.M. Pacaud and J.P. Saint Martin in the MNHNP. The authors recognize the useful comments of Dr. M. Wilmsen from the Senckenberg Naturhistorische Sammlungen Dresden, Germany, and an anonymous reviewer on the original manuscript. Research Projects CGL2011-25894 and CGL2012-35199 of the Ministerio de Ciencia e Innovación (Spain), and Centro de Investigação da Terra e do Espaço (CITEUC-FCT) of the Universidade de Coimbra (Portugal).

References

Barroso-Barcenilla, F., Goy, A., 2010. The ammonite genus *Vascoceras* Choffat, 1898 (family Vascoceratidae Douvillé, 1912) in the Iberian Trough, Spain. Palaeontographica, Abteilung A 290, 199–235.
Barroso-Barcenilla, F., Callapez, P.M., Soares, A.F., Segura, M., 2011. Cephalopod associations and depositional sequences from the upper Cenomanian and lower Turonian of the Iberian Peninsula (Spain and Portugal). Journal of Iberian Geology 37, 9–28.
Berthou, P.Y., Brower, J.C., Reyment, R.A., 1975. Morphometrical study of Choffat's vascoceratids from Portugal. Bulletin of the Geological Institutions of the University of Uppsala, N.S 6, 73–83.
Berthou, P.Y., Chancellor, G.R., Lauverjat, J., 1985. Revision of the Cenomanian-Turonian ammonite *Vascoceras* Choffat, 1898, from Portugal. Comunicações dos Serviços Geológicos de Portugal 71, 55–79.
Callapez, P.M., 2001. Upper Cenomanian and lower Turonian ammonite biostratigraphy of west-central Portugal. Bulletin de la Société d'études de Sciences Naturelles d'Elbeuf 87, 63–68.
Callapez, P.M., 2003. The Cenomanian-Turonian transition in West Central Portugal: ammonites and biostratigraphy. Ciências da Terra 15, 53–70.
Callapez, P.M., Soares, A.F., 2001. Fósseis de Portugal: Amonóides do Cretácico Superior (Cenomaniano-Turoniano). Museu Mineralógico e Geológico da Universidade de Coimbra, Coimbra, p. 106.
Choffat, P.L., 1898. Recueil d'études paléontologiques sur la Faune Crétacique du Portugal, 2: Les Ammonées du Bellasien, des Couches à *Neolobites vibrayeanus*, du Turonien et du Sénonien. In: Section des Travaux Géologiques du Portugal, p. 45. Lisbonne.
Chudeau, R., 1909. Ammonites du Damergou (Sahara méridional). Bulletin de la Société Géologique de France 4 (9), 67–71.
Cobban, W.A., Hook, S.C., Kennedy, W.J., 1989. Upper Cretaceous rocks and ammonite faunas of southeastern New Mexico. New Mexico Bureau of Mines and Mineral Resources Memoir 45, 1–137.
Cragin, F.W., 1893. A contribution to the invertebrate paleontology of the Texas Cretaceous. Texas Geological Survey 1892, 139–246.
Douvillé, H., 1912. Évolution et classification des Pulchelliidés. Bulletin de la Société Géologique de France 4 (11), 285–320.
Kennedy, W.J., 1984. Ammonite faunas and the "standard zones" of the Cenomanian to Maastrichtian stages in their type areas. Bulletin of the Geological Society of Denmark 33, 147–161.
Kennedy, W.J., Cobban, W.A., Hancock, J.M., Hook, S.C., 1989. Biostratigraphy of the Chispa Summit formation at its type locality. Bulletin of the Geological Institutions of the University of Uppsala, N.S 15, 39–119.
Nagm, E., Wilmsen, M., 2012. Upper Cenomanian-Turonian (Cretaceous) ammonoids from Wadi Qena, central Eastern Desert, Egypt. Acta Geologica Polonica 62, 63–89.
Orbigny, A. d', 1841. Paléontologie Française, Térrains Crétacées, Céphalopodes, 1. Masson, Paris, pp. 121–430.
Wright, C.W., 1957. Ammonoidea (Part L, Mollusca 4). In: Moore, R.C. (Ed.), Treatise on Invertebrate Paleontology. Geological Society of America & University of Kansas Press, Lawrence, 1–490.
Wright, C.W., 1996. Cretaceous Ammonoidea (Part L, Mollusca 4). In: Kaesler, R.L. (Ed.), Treatise on Invertebrate Paleontology. Geological Society of America & University of Kansas Press, Lawrence, 1–362.
Wright, C.W., Kennedy, W.J., 1981. The Ammonoidea of the Middle Chalk. Monograph, Palaeontographical Society 134, 1–148.
Zaborski, P.M.P., 1996. The upper Cretaceous ammonite *Vascoceras* Choffat, 1898, in north-eastern Nigeria. Bulletin of the British Museum of Natural History, Geology Series 52, 61–89.