N. Jb. Geol. Paläont. Mh. **2002** (7) 397–425 Stuttgart, Juli 2002

Cenomanian-Coniacian ammonites from the west-central Sinai, Egypt, and their significance in biostratigraphy

Magdy M. El-Hedeny, Alexandria

With 8 figures

EL-HEDENY, M. M. (2002): Cenomanian-Coniacian ammonites from the west-central Sinai, Egypt, and their significance in biostratigraphy. – N. Jb. Geol. Paläont. Mh., **2002**: 397–425; Stuttgart.

Abstract: Ammonites from the Upper Cenomanian to the Middle Coniacian in the west central Sinai, Egypt are described. Taxa recorded are mainly of Tethyan (south-west European, North African, Middle East) character. The species recognized belong to the genera *Neolobites* (lowermost Cenomanian); *Vascoceras* (Uppermost Cenomanian to Lower Turonian), *Mammites, Nigericeras, Thomasites, Choffaticeras* (Lower Turonian). *Coilopoceras* (Upper Turonian) and *Metatissotia* (Middle Coniacian). The chronostratigraphic importance of the ammonite species identified allows a subdivision of the Upper Cenomanian-Coniacian succession into six biostratigraphic units.

Zusammenfassung: Ammoniten vom Oberen Cenoman bis Mittleren Coniac werden vom westlichen und zentralen Sinai beschrieben. Die gefundenen Taxa haben überwiegend einen Tethys Charakter (SW-Europa, Nord-Afrika, Mittlerer Osten). Die untersuchten Arten gehören zu den Gattungen *Neolobites* (unterstes Cenoman), *Vascoceras* (oberstes Cenoman bis Unteres Turon), *Mammites, Nigericeras, Thomasites, Choffaticeras* (Unteres Turon), *Coilopoceras* (Oberes Turon) und *Metatissotia* (Mittleres Coniac). Die chronostratigraphische Bedeutung der Ammoniten-Arten ermöglicht eine Unterteilung der vom oberen Cenoman bis zum Coniac reichenden Sequenz in sechs biostratigraphische Einheiten.

0028-3630/02/2002-0397 $ 7.25

Introduction

Previous studies concerning the Upper Cretaceous sediments in Sinai, particularly from the stratigraphic viewpoint, are numerous. Lithostratigraphically, the subdivisions of the Upper Cretaceous sequence in the Western Sinai and in the Gulf of Suez were presented by many workers notably: GHORAB (1961); EL-SHINNAWI & SULTAN (1973); BARTOV & STEINITZ (1977); KLITZSCH (1978); ISSAWI et al. (1981); DOMINIK (1985); LUGER (1985); BANDEL & KUSS (1987); BARTHEL & HERMANN-DEGEN (1989); CHERIF et al. (1989); KASSAB (1991).

The present contribution concentrates on the taxonomic description of the Upper Cenomanian to the Middle Coniacian ammonites in the west-central Sinai including Wadi Sudr (G. Sinn Bishr and G. Somar), Wadi Matulla, Gebel Musaba Salama and Wadi Feiran (Fig. 1) and presents the palaeontological evidence for the biostratigraphical attribution of the lithological units in this region.

Lithostratigraphy

Four rock units are proposed for the Cenomanian-Coniacian succession exposed in the area studied (Fig. 2): the Cenomanian Raha Formation, the Lower Turonian Abu Qada Formation, the Upper Turonian Wata Formation and the Coniacian-Santonian Matulla Formation.

Raha Formation

The term Raha Formation was introduced to the Egyptian stratigraphy by GHORAB (1961) for the Cenomanian limestone, marl, shale and sandstone succession exposed in the scarp of Gebel El-Raha, west-central Sinai.

Here, in the studied area, the Raha Formation overlies the Lower Cretaceous continental succession of the Malha Formation and conformably underlies the highly fossiliferous Lower Turonian Abu Qada Formation. Besides the ammonites collected from the limestone and indicating Late Cenomanian age, the Raha Formation contains abundant oysters, gastropods and echinoids.

Abu Qada Formation:

This formation was established by GHORAB (1961). It is composed of brown to dark gray marl and grades to marly or sandy marl. It is Early Turonian in age. In the studied area, it is interesting to observe "the ammonites bed"

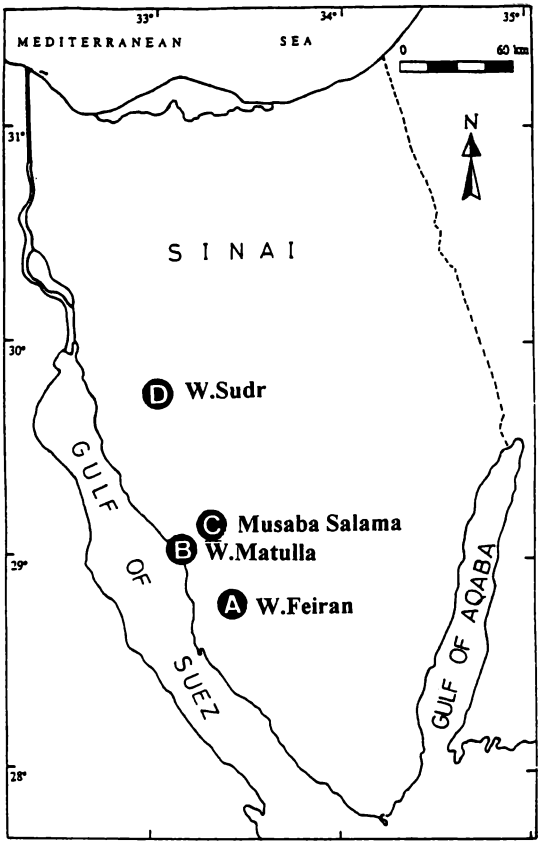

Fig. 1. Location map of the studied sections.

found in the marly limestone at the top of the Cenomanian; this bed is considered as the key to the Cenomanian/Turonian boundary in Egypt (SAID, 1962).

Wata Formation:

The term Wata Formation was first introduced in the Egyptian litho-stratigraphy by GHORAB (1961). The type locality is the Wadi Wata, Raha

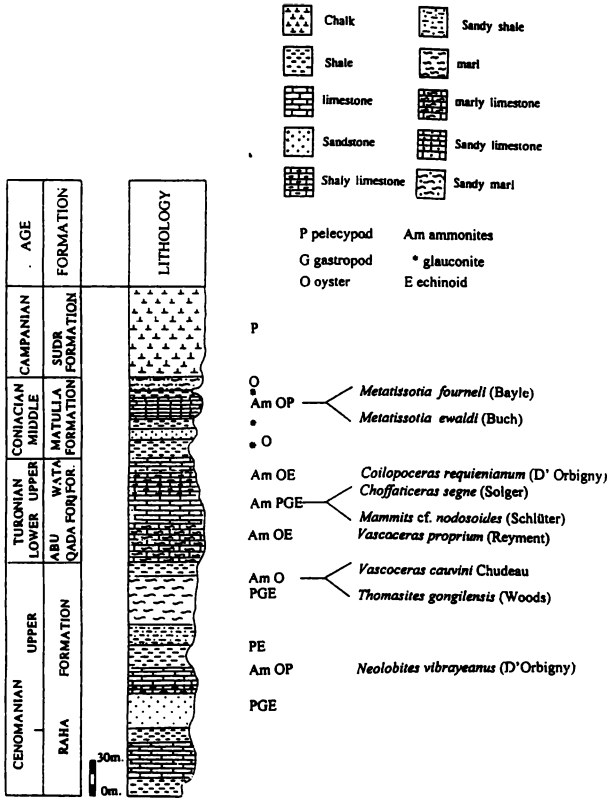

Fig. 2. Generalized composite section of the Cenomanian-Coniacian in the west-central Sinai, Egypt.

plateau in the west-central Sinai. It conformably overlies the Abu Qada Formation and unconformably underlies the Matulla Formation. It is represented mainly by hard siliceous, partly dolomitic, brown to light yellow limestone. It is of Late Turonian age. At the end of the Late Turonian the sea regressed slightly northward of Sinai. The clastic sediments of the Coniacian Matulla Formation overlie the calcareous Wata Formation.

Matulla Formation

The Matulla Formation was introduced by GHORAB (1961) for the Coniacian-Santonian (may extend locally into the Campanian) argillaceous limestone, marl and varicolored glauconitic shale with nodular and chalky limestone exposed in Wadi Matulla, west-central Sinai. This formation unconformably overlies the Wata Formation.

Systematic paleontology

Repository of material: All specimens referred to are in the collection of the Geology Department, Faculty of Science, Alexandria University, Egypt.
Dimensions: Dimensions of specimens are given in millimeters, in the following order: D, Diameter, Wb, Whorl breadth, Wh, Whorl height U, breadth of umbilicus. Figures in parentheses refer to dimensions as a percentage of the diameter.
Suture Terminology: The suture terminology of WEDEKIND (1916) (see KULLMANN & WIEDMANN, 1970) is followed in the present work: I, internal lobe; U, umbilical lobe; L, lateral lobe; E, external lobe.

Order	Ammonoidea ZITTEL, 1884
Suborder	Ammonitida HYATT, 1889
Superfamily	Hoplitaceae H. DOUVILLÉ, 1890
Family	Engonoceratidae HYATT, 1900

Genus *Neolobites* FISHER, 1882

Type species: *Ammonites vibrayeanus* D'ORBIGNY, 1841, p. 322, pl. 96, figs. 1-3, by original designation of FISHER (1882, p. 389).

Neolobites vibrayeanus (D'ORBIGNY, 1841)
Fig. 3 (a-b), Fig. 7d, Fig. 8e

1841 *Ammonites vibrayeanus*. – D'ORBIGNY, p. 322, pl. 96, figs. 1-3
1978 *Neolobites vibrayeanus* (D'ORBIGNY). – WIEDMANN & KAUFFMAN, pl. 6, figs. 7a-b.
1978 *Neolobites vibrayeanus* (D'ORBIGNY). – KENNEDY & HANCOCK, pl. 7, fig. 2.
1981 *Neolobites vibrayeanus* (D'ORBIGNY). – KENNEDY & JUIGNET, p. 23, figs. 3a-c, 4a-b, 5, 6 (a) (with full synonymy).
1989 *Neolobites vibrayeanus* (D'ORBIGNY). – LUGER & GRÖSCHKE, p. 336, 366, pl. 39, fig. 3, text-fig. 5.
1991 *Neolobites vibrayeanus* (D'ORBIGNY). – KENNEDY & SIMMONS, p. 134, pl. 2D-2G.

Material: Three internal moulds (MSC 880- MSC 882).

Dimension:	D	Wb	Wh	U
MSC 880	100	24.5	35	10(10)

Description: Shell involute, with a tiny, shallow umbilicus, low umbilical wall, rounded and compressed whorl section, the greatest breadth away from the umbilicus around mid-flank. Broadly rounded flanks with sharp ventrolateral shoulders and concave venter. Sutare line (Fig. 8 e) with entire elements, the lobes rather narrow and lanceolate, the saddles broader. Weak ornamentation.

Discussion: KENNEDY & SIMMONS (1991) described this species and considered the small umbilicus, the feeble ornamentation and the compressed whorls as characteristic for *N. vibrayeanus*. KENNEDY & JUIGNET (1981) discuss the present species in detail; they review the synonymy and differences from other species of the genus. They regarded *N. choffati* and *N. peroni* as junior synonyms of *N. vibrayeanus* without a detailed discussion. The present specimens differ from *N. vibrayeanus* as figured by LUGER & GRÖSCHKE (1989, Text-fig. 5) by the slightly weaker ornamentation. They (ibid. p. 336, figs. 4-6) described specimens as *Neolobites* sp. and they suggested that KENNEDY & JUIGNET (1981) had drawn their interpretation of *N. vibrayeanus* too widely.

Occurrence: Raha Formation, section C, lower Upper Cenomanian. *N. vibrayeanus* is a Tethyan species. It is known from the lower Upper Cenomanian of Western Europe (France, Portugal, Spain), northern Africa and the Middle East (Morocco, Algeria, Tunisia, Egypt, Israel, Lebanon, Arabia) as well as South America (Peru, Bolivia) (KENNEDY & JUIGNET, 1981).

Superfamily	Acanthocerataceae DE GROSSOUVRE, 1894
Family	Acanthoceratidae DE GROSSOUVRE, 1894
Subfamily	Mammatinae HYATT, 1900

Genus *Mammites* LAUBE & BRUDER, 1887

Type species: *Ammonites nodosoides* (SCHLÜTER, 1871, p. 19, pl. 8, figs. 1-4, by monotypy (see WRIGHT & KENNEDY, 1981, p. 75).

Mammites nodosoides (SCHLÜTER, 1871) Fig. 3 (c)

cf. 1871 *Ammonites nodosoides*. – SCHLÜTER, p. 19, pl. 8, figs. 1-4.
cf. 1981 *Mammites nodosoides* (SCHLÜTER). – WRIGHT & KENNEDY, p. 75 (with synonymy).
cf. 1985 *Mammites nodosoides* (SCHLÜTER). – KASSAB, p. 62, pl. 2, figs. 1-3.
1992 *Mammites nodosoides* (SCHLÜTER). – ABDEL GAWAD et al., p. 328, pl. 1, figs. 3.
1993 *Mammites nodosoides* (SCHLÜTER). – KORA et al., pl. 1, fig. 9.

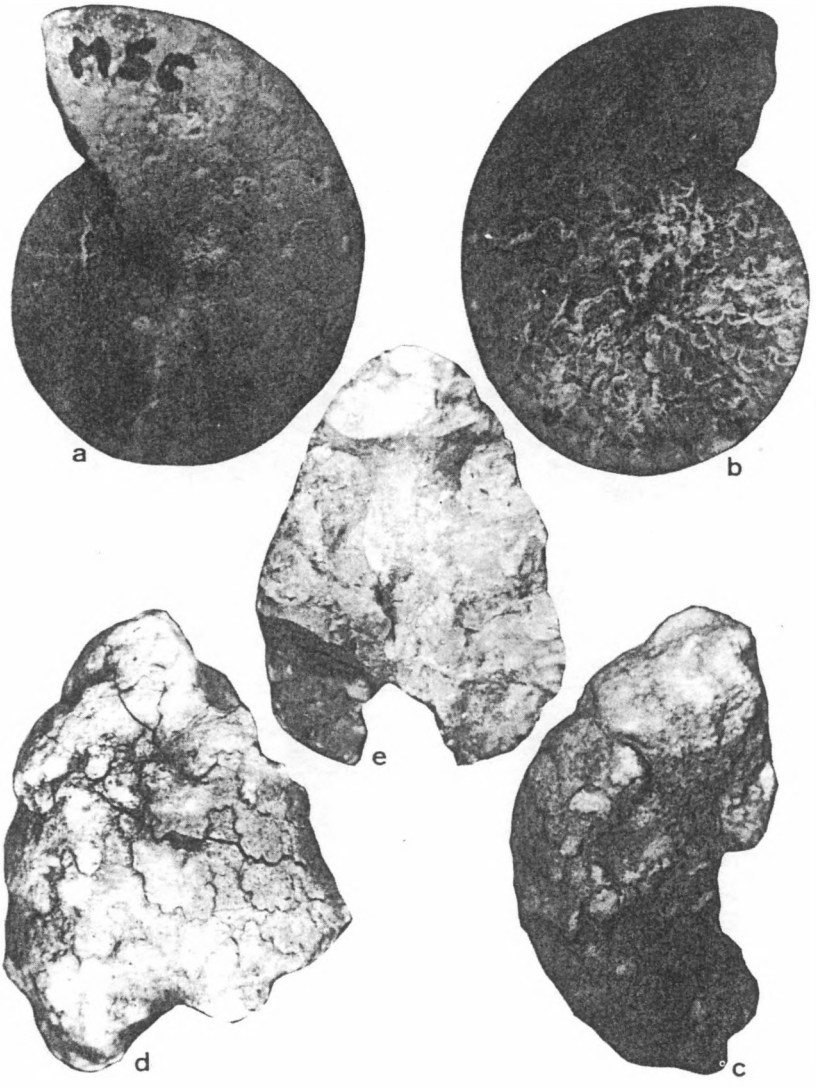

Fig. 3. a-b. *Neolobites vibrayeanus* (D'ORBIGNY) (MSC 880). Section C, Raha Formation. Lower Upper Cenomanian. **c.** *Mammites* cf. *nodosoides* (SCHLÜTER) (MSC 883). Section C, Abu Qada Formation. Lower Turonian. **d-e.** *Nigericeras* sp. (MSC 888). Section A, Abu Qada Formation. Lower Turonian. All x 0.8.

Material: Three fragments of internal moulds (MSC 883 - MSC 885) comprising two phragmocone chambers, each about half whorl, Dimensions could not be determined.

Description: Shell evolute, whorl section is rectangular, slightly wider than high, venter slightly convex. Ornament in the form of straight ribs, well pronounced around the umbilicus with large, projecting ventrolateral nodes. Suture line not visible. Due to the poor preservation the present specimens can not be safely determined.

Discussion: The present specimens are strongly eroded, especially in the ventral regions. However, the mode of coiling and the ornamentation is very similar to that of *M. nodosoides*, but due to the poor preservation the present specimens are only compared with this species. The specimens studied very closely resemble *M. nodosoides* figured by KASSAB (1985, pl. 2, figs. 1-3) and ABDEL GAWAD et al. (1992, p. 328, pl. l, fig. 3).

Occurrence: Abu Qada Formation, section C. Lower Turonian.
The genus *Mammites* had a worldwide distribution in the Lower Turonian (MATSUMOTO 1973). Specifically *M. nodosoides* occurs in the Lower Turonian of England, Spain, Portugal, New Mexico (KENNEDY et al., 1987), Nigeria (ZABORSKI, 1987, 1990), Venezuela (RENZ, 1982).

Family Vascoceratidae DOUVILLÉ, 1912
Subfamily Vascoceratinae DOUVILLÉ, 1912

Genus *Nigericeras* SCHNEEGANS, 1943

Type species: *Nigericeras gignouxi* SCHNEEGANS, 1943, p. 119, pl. 5, fig. 10-15, by subsequent designation of REYMENT (1955).

Nigericeras sp. Fig. 3 (d-e), Fig. 4 (a), Fig. 8a

Material: Seven fragments of internal moulds (MSC 886 - MSC 892), four of phragmocones and three body-chambers, of a half whorl. Dimensions could not be determined.

Fig. 4. a. *Nigericeras* sp. (MSC 886). Section A, Abu Qada Formation. Lower Turonian. **b-c.** *Vascoceras cauvini* CHUDEAU (MSC 893). Section C, Raha Formation. Uppermost Cenomanian. **d-e.** *Thomasites gongilensis* (WOODS) (MSC 895). Section C, Raha Formation. Uppermost Cenomanian All x 0.8.

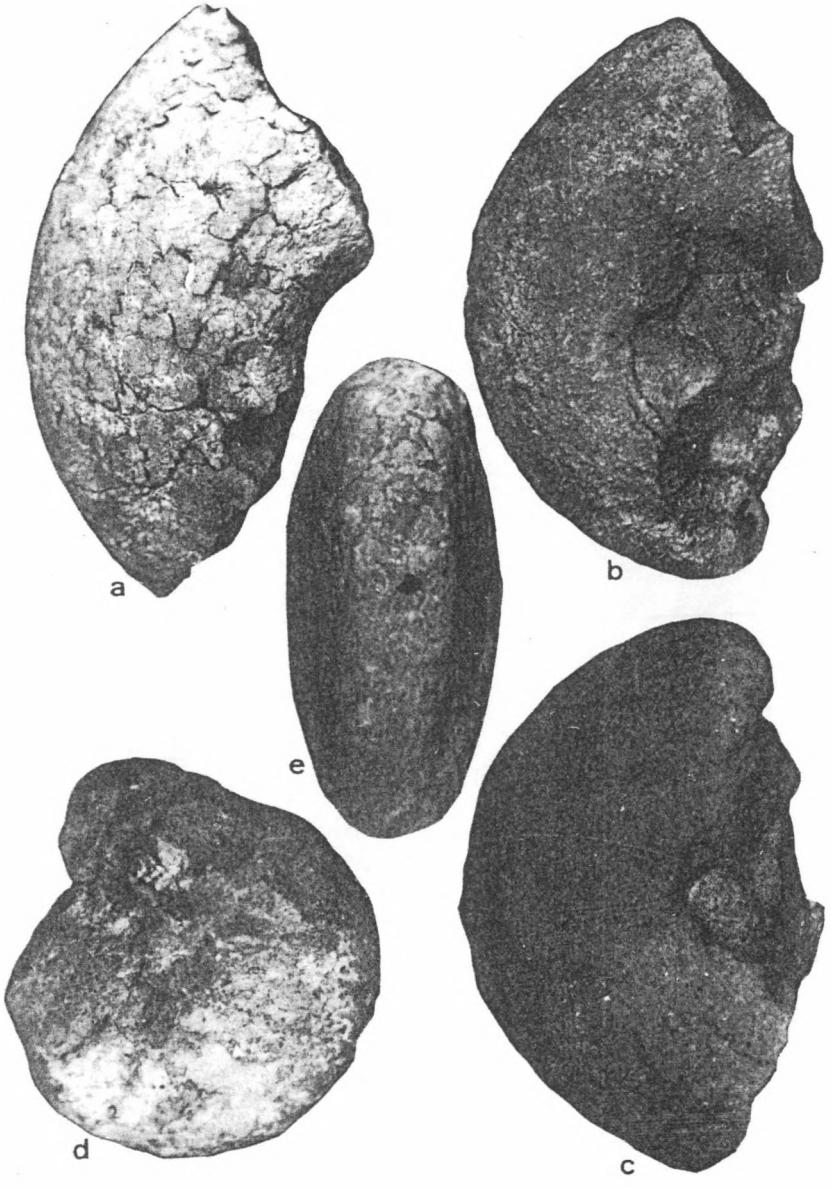

Fig. 4 (Legend see p. 404)

Description: Shell evolute, compressed. Moderately large umbilicus comprising up to 30 % of the diameter, with angularly rounded shoulders and steep vertical walls. Whorl section subquadrate to ovoidal, higher than wide. Venter narrowly rounded. Suture line shown in Fig. 8a.

Discussion: Due to the poor preservation, the present specimens cannot be determined at the specific level. They are regarded as *Nigericeras* rather than *Pseudaspidoceras* because of the absence of the rectangular whorl section and the ventrolateral nodes in the present specimens. However, they are similar to *N. tinrhertense* COLLIGNON & ROMAN figured by AMARD et al. (1981, pl. 8, fig. 2) although the present specimens are compressed and larger than *N. tinrhertense*, also, the present species has most of the morphological features of *N. tinrhertense* as described and figured by LUGER & GRÖSCHKE (1989). The latter has a subsquarish whorl section and is slightly less depressed than the present specimens. However, LUGER & GRÖSCHKE based in their identification on a single specimen.

Occurrence: Abu Qada Formation, section A, Lower Turonian. *N. tinrhertense* is recorded from the Early Turonian Zone V of Tinrhert, Algeria (AMARD et al., 1981).

Genus *Vascoceras* CHOFFAT, 1898

Type species: *Vascoceras gamai* CHOFFAT, 1898, p. 54, pl. 7, figs. 1-4; pl. 8, fig. 1; pl. 10, fig. 2; pl. 21, figs. 1, 2, 5, by subsequent designation of ROMAN (1938).

Vascoceras cauvini CHUDEAU, 1909 Fig. 4(b-c), Fig. 7f

1909 *Vascoceras cauvini*. – CHUDEAU, p. 67, pl. 1, figs. 1a and 2a; pl. 2, figs. 3 and 5; pl. 3, figs. 1b, 2b, 4.
1921 *Thomasites cauvini* (CHUDEAU). – CHUDEAU, p. 463, fig. 1.
1933 *Vascoceras cauvini* CHUDEAU. – FURON, p. 268, pl. 9, fig. 17.
1935 *Vascoceras* (*Paravascoceras*) *cauvini* CHUDEAU. – FURON, p. 60, pl. 5, fig. 1.
1943 *Paravascoceras cauvini* (CHUDEAU). – SCHNEEGANS, p. 128, pl. 4, fig. 2, fig. 9a-f.
1969 *Paravascoceras cauvini* (CHUDEAU). – FREUND & RAAB, p. 20, pl. 3, figs. 1-3; text-fig. 5a-b.
1975 *Paravascoceras cauvini* (CHUDEAU). – SCHÖBEL, p. 119, pl. 4, figs. 1-3; pl. 5, figs. 1-4.
1981 *Paravascoceras cauvini* (CHUDEAU). – AMARD et al., p. 51, pl. 3, fig. 9.
1989 *Vascoceras cauvini* CHUDEAU. – LUGER & & GRÖSCHKE, p. 374, pl. 4, figs. 3, 6, 8-9; pl. 41, figs. 1-4, pl. 42, fig. 1; text-fig. 6 G, H and 8C.

Material: A single internal mould (MSC 893). Dimensions could not be determined.

Description: Shell evolute, compressed. Umbilicus moderately wide with rounded shoulders and vertical walls. Whorl section rounded with slightly inclined flanks (Fig. 7f). No ornamentation observed. Suture line hardly visible.

Discussion: *Vascoceras cauvini* displays variation in the degree of compression and ornamentation (SCHÖBEL, 1975). Therefore, the present specimen represents the unornamented variety in the sense of SCHÖBEL (1975). *V. rumeaui* COLLIGNON was regarded as a junior synonym of *V. cauvini* CHUDEAU, 1909 by SCHÖBEL (1965), but the former species differs from the present species in its slightly inflated cross-section and the narrower umbilicus. *V. cauvini* differ from *V. durandi* in its relatively smaller umbilicus and less depressed whorl section. *V. cauvini* is considered to be a junior synonym of the Portuguese *V. barcoicense* CHOFFAT, 1898.

Occurrence: Raha Formation; section C. upper Upper Cenomanian.
V. cauvini is well known from central and northern Africa, the Middle East and Peru. *V. cauvini* is reported from the Lower Turonian *cauvini* Zone of Israel (FREUND & RAAB, 1969), but KENNEDY et al. (1987) now place it in the Upper Cenomanian. According to LUGER & GRÖSCHKE (1989) the species is known from the Upper Galala Formation of the Upper Cenomanian.

Vascoceras proprium (REYMENT, 1954) Fig. 5 (a-b), Fig. 7c

1954 *Pachyvascoceras proprium*. – REYMENT, p. 258, pl. 5, fig. 1; text-fig. 3d.
1954 *Pachyvascoceras proprium plenum*. – REYMENT, p. 258. Pl. 5, fig. 5; text-figs. 3c & 6.
1954 *Pachyvascoceras costatum*. – REYMENT, p. 257, pl. 3, fig. 6; pl. 4, fig. 3, pl. 5, fig. 2; text-figs. 3a-b, 5.
1954 *Pachyvascocera globosum*. – REYMENT, p. 259, pl. 3, fig. 3; pl. 5, fig. 4, text-figs. 3c & 7.
1955 *Pachyvascoceras costatum*. – REYMENT, p. 65, pl. 14; fig. 2 & 4.
1987 *Vascoceras proprium* (REYMENT). – KENNEDY et al., pl. 4, figs. 1-15, 18-19; pl. 5-6; text-figs. 8A-C (with full synonymy).
1996 *Vascoceras proprium* (REYMENT). – KASSAB, p. 15.

Material: A single internal mould (MSC 894).

Dimension:	D	Wb	Wh	U
MSC 894	90	45(50)	35(39)	22(24)

Description: Shell involute, slightly compressed. Umbilicus comprising 24 % of the total diameter with well rounded umbilical shoulder. Umbilical wall vertical. Whorl section with rounded venter. Whorl breadth to height ratio of 1:3. There is no evidence for any ornamentation due to the badly corroded surface of the shell. Suture line hardly visible.

Discussion: *Vascoceras proprium* is discussed in detail by KENNEDY et al. (1987), who review the synonymy, and the differences from other species of the genus. They emended the definition of *Vascoceras* and included *Paravascoceras* FURON, 1935, *Pachyvascoceras* FURON, 1935, *Paracanthoceras* FURON, 1935, *Broggiiceras* BENAVIDES-CÁCERES, 1956, *Discovascoceras* COLLIGNON, 1957, and *Provascoceras* COOPER, 1979 as synonymous. REYMENT (1979) suggested that the morphological similarites within the Vascoceratidae are often more the result of common palaeoenvironmental influences than of phylogenetic affinity.

Occurrence: Abu Qada Formatiom section C. Lower Turonian.
V. proprium is recorded from the Lower Turonian of Texas, northern Mexico, and Nigeria (KENNEDY et al. 1987). According to KASSAB (1996) the species is known from the basal Turonian of the Egyptian Eastern Desert.

Subfamily Pseudotissotiinae HYATT, 1903

Genus *Thomasites* PERVINQUIÈRE, 1907

Type species: *Pachydiscus rollandi* PÉRON, 1890, p. 25, pl. 17, figs. 1-3, by original designation of PERVINQUIÈRE (1907).

Thomasites gongilensis (WOODS, 1911) Fig. 4 (d-e), Fig. 7h

1911 *Vascoceras gongilensis*. – WOODS, p. 282, pl. 21, fig. 7, pl. 22, fig. 1.
1989 *Thomasites gongilensis* (WOODS). – MEISTER, p. 38, pl. 16, figs. 3-5, pl. 17, figs. 1-6, pl. 18, figs. 1-3, pl. 19, figs, 1-5, pl. 20, figs. 1-5; pl. 21, figs. 1-3 (with complete synonymy).

Material: Two internal moulds (MSC 895 - MSC 896).

Dimension:	D	Wb	Wh	U
MSC 895	51	16	27(53)	13(25)
MSC 896	48			

Description: Shell involute, with umbilicus comprising 25 % of the diameter, whorls compressed, with flattened convergent, narrowly rounded

Fig. 5. a-b. *Vascoceras proprium* (REYMENT) (MSC 894). Section C, Abu Qada Formation. Lower Turonian. **c-d.** *Choffaticeras segne* (SOLGER). **c.** (MSC 897). **d.** (MSC 898). Section A & C, Abu Qada Formation. Lower Turonian. **e.** *Metatissotia fourneli* (BAYLE) (MSC 903). Section B. Matulla Formation. Middle Coniacian. All x 0.8.

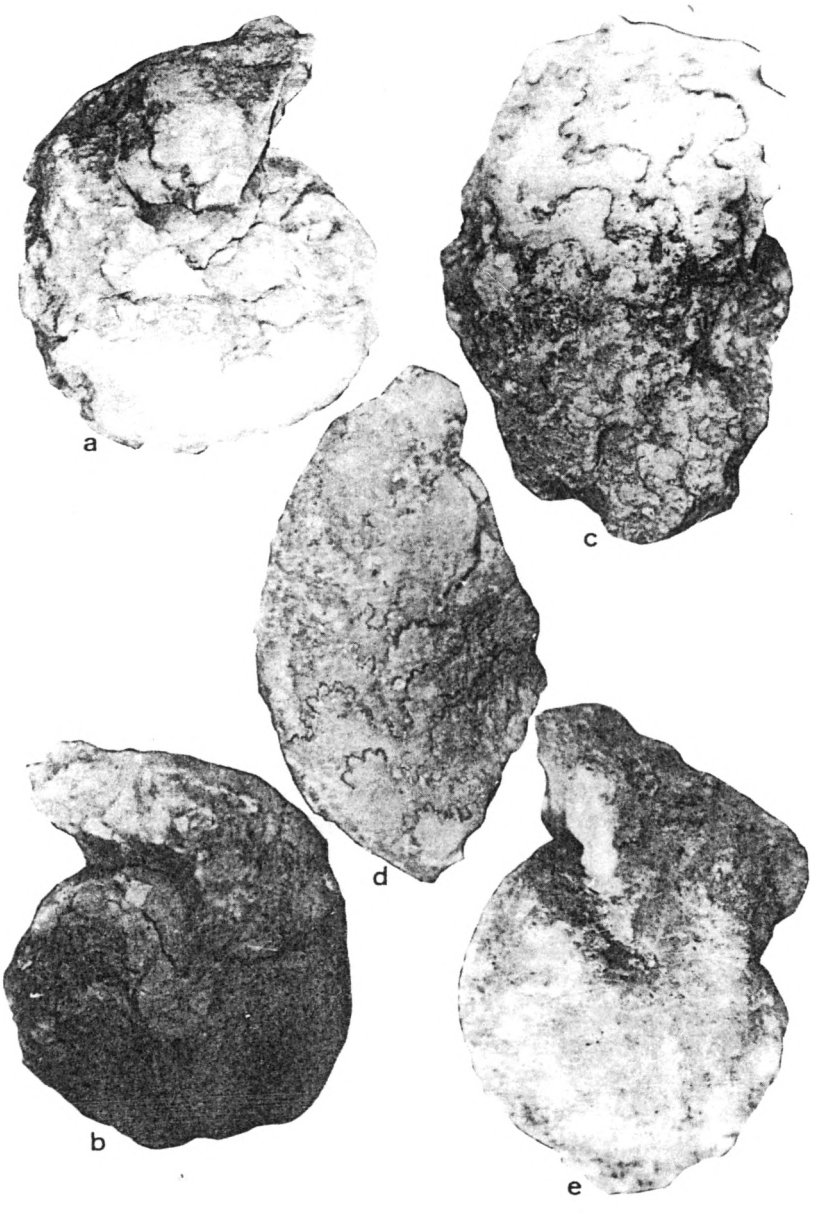

Fig. 5 (Legend see p. 408)

ventro-lateral shoulder and broad tricarinate - bisulcate venter. Only outer flank ornament is well preserved and consists of blunt prorsiradiate ribs that terminate in blunt ventral clavi on blunt ridges. These are separated by grooves from a blunt siphonal clavi.

Discussion: The present specimen closely resembles that of MEISTER (1989) who reviewed the synonymy and differences from other species of the genus.

Occurrence: Raha Formation, section C. upper Upper Cenomanian. *Thomasites gongilensis* first appears in the Upper Cenomanian and ranges into the lowest Turonian of Nigeria (WOODS, 1911). There are records from Spain and southern England (MEISTER, 1989).

Genus *Choffaticeras* HYATT, 1903

Type species: *Pseudotissotia meslei* PÉRON, 1896, pl. 1, fig. 1; pl, 2, figs. 1 & 2; pl. 3, fig. 2; pl. 17, fig. 1, by subsequent designation of ROMAN.

Choffaticeras segne (SOLGER, 1903) Fig. 5 (c-d), Fig. 8c

1903 *Pseudotissotia segnis*. – SOLGER, p. 77, pl. 4.
1914 *Pseudotissotia segnis* (SOLGER). – ECK, p. 204, pl. 15, fig. 3.
1915 *Pseudotissotia* (*Choffaticeras*) *segnis* (SOLGER). – GRECO, p. 213, pl. 19, fig. 1.
1985 *Choffaticeras segne* (SOLGER). – KASSAB, p. 87, pl. 16, figs. 6-11; pls. 17-20.
1987 *Choffaticeras segne* (SOLGER). – KORA & HAMAMA, pl. 1, fig. 7.
1992 *Choffaticeras segne* (SOLGER). – ABDEL GAWAD et al., p. 330, pl. 1, fig. 6.
1993 *Choffaticeras segne* (SOLGER). – KORA et al., pl. 3, fig. 8.

Material: Four internal moulds (MSC 897 - MSC 900).

Dimension:	D	Wb	Wh	U
MSC 899	75	18(24)	25(33)	12(16)

Description: Shell strongly involute, compressed whorls with broadly rounded inner flanks and convergent outer flanks, and a narrowly rounded venter. Umbilicus small with rounded walls. Suture line shown in Fig. 8c.

Discussion: The present specimens closely resemble *Eotissotia simplex* BARBER of the Lower Turonian of Nigeria, but all the sutural saddles except E/L are entire in BARBER's species (1957, p. 55). ABDEL GAWAD et al. (1992) figured a single specimen of poor preservation and based in their identification only on the nature and configuration of the suture line.

Occurrence: Abu Qada Formation, sections A & C. Lower Turonian. *Choffaticeras segne* is recorded in the Lower Turonian of Tunisia, Algeria and Egypt. According to KORA & HAMAMA (1987) this species is known from the Lower Turonian Wata Formation of Gebel Gunna, southeastern Sinai, Egypt.

Family Tissotiidae HYATT, 1900
Subfamily Tissotiinae HAYTT, 1900

Genus *Metatissotia* HYATT, 1903

Type species: *Ammonites fourneli* BAYLE, 1849, p. 360, pl. 17, figs. 1-5, by subsequent designation of ROMAN (1938).

Metatissotia fourneli (BAYLE, 1859)
Fig. 5 (e), Fig. 6 (a-b); Fig. 7 (a-c); Fig. 8d

1849 *Ammonites fourneli*. – BAYLE, p. 360, pl. 17, figs. 1-5.
1897 *Tissotia fourneli* BAYLE emend. – THOMAS & PÉRON - PÉRON, p. 59, pl. 10, figs. 1-8; pl. 17, figs. 9 & 10.
1897 *Tissotia grossouvrei*. – PÉRON, p. 70, pl. 16, figs. 1 & 2; pl. 18, fig. 17.
1903 *Metatissotia fourneli* (BAYLE). – HYATT, p. 45.
1903 *Paratissotia grossouvrei* (PÉRON). – HYATT, p. 45.
1907 *Tissotia fourneli* (BAYLE). – PERVINQUIÈRE, p. 372, pl. 26, fig. 5a-b.
1915 *Tissotia fourneli* (BAYLE). – GRECO, p. 225, pl. 21, fig. 6a-b.
1956 *Tissotia fourneli* (BAYLE). – BENAVIDES-CÁCERES, p. 480, pl. 62, figs. 3 & 4.
1989 *Metatissotia fourneli* (BAYLE). – LUGER & GRÖSCHKE, p. 383, pl. 45, figs. 2 & 3, text-fig. 10F-G.

Material: Six internal moulds (MSC 902 - MSC 907).

Dimension:	D	Wb	Wh	U
MSC 905	70	29(41)	28(40)	9(12)
MSC 902	75	30(40)	33(44)	10(13)
MSC 903	81	31(38)	34(42)	11(14)

Description: Shell involute, tightly coiled, oxycone, with tiny umbilicus comprising 12-14 % of the diameter. The whorl section varies in the degree of depression from compressed to slightly depressed. Well-developed keel that disappears gradually on body chamber. Umbilical shoulder rounded. Ornament in general not strongly developed, consists of widely spaced ribs beginning on umbilical node-like undulations and ending at the ventrolateral shoulder. Suture line shown in Fig. 8d.

Discussion: Generally, the present species shows great variability in the degree of depression of the shell. Whereas PÉRON (1896, pl. 10, figs. 1-8;

pl. 17, figs. 9 & 10) figured relatively compressed specimens, PERVINQUIÈRE (1907 p. 372, pl. 26, fig. 5) reported a more compressed form. According to PERVINQUIÈRE (1907, p. 374), *Tissotia grossouvrei* shows great similarity to *T. fourneli* especially in whorl section but they differ only in the slightly weaker ornamentation of the former, so that a differentiation of the two forms cannot be justified. The lacking of any umbilical sculptural elements in *Subtissotia africana* (PÉRON, 1897) differentiate it from the present species.

Occurrence: Matulla Formation. Sections B & D. Middle Coniacian. *M. fourneli* (BAYLE) is well known in Algeria and Tunisia as a characteristic species of the Lower Coniacian (PÉRON, 1897; PERVINQUIÈRE, 1907). Also, this species is recorded in the Coniacian of Peru (BENAVIDES-CÁCERES, 1956). LEWY (1975) and LEWY & RAAB (1968) considered that *M. fourneli* (BAYLE) is an Upper Coniacian species (Zone CA5) of the Middle East. Later, LEWY & HONIG (1985) recorded this zone in levels higher than previously recognized. *M. fourneli* is reported in the Middle or Upper Coniacian of Wadi Qena, Eastern Desert, Egypt (LUGER & GRÖSCHKE, 1989).

Metatissotia ewaldi (VON BUCH, 1848) Fig. 6 (c); Fig. 8f

1848 *Ammonites ewaldi*. – VON BUCH, p. 221, pl. 1, fig. 4.
1890 *Tissotia ewaldi* (VON BUCH). – PÉRON, p. 5, pl. 15, figs. 1 & 2 te 1-2.
1984 *Metatissotia ewaldi* (VON BUCH). – KENNEDY, p. 127, pl. 28, figs. 4-5; pl. 29, figs. 9-11; pl. 30, figs. 1-2, 2-5, 8-9, 12; pl. 32, figs. 1-3; text-fig. 40 B & E (with full synonymy).
1989 *Metatissotia* cf. *ewaldi* (VON BUCH). – LUGER & GRÖSCHKE, p. 384, pl. 44, figs. 1 & 2, text-fig. 10E.

Material: Three specimens of internal moulds (MSC 908 - MSC 910).

Dimension:	D	Wb	Wh	U
MSC 909	68	18(26)	29(43)	6(9)

Description: Shell involute, compressed with whorl breadth to height ratio 0.62, tightly coiled. Umbilicus very narrow, umbilical shoulder rounded with a steep wall, venter fastigiate. Weak ornaments of 18 relatively broad

Fig. 6. a-b. *Metatissotia fourneli* (BAYLE). **a.** (MSC 903). **b.** (MSC 906). Section B & D, Matulla Formation. Middle Coniacian. **c.** *Metatissotia ewaldi* (BUCH) (MSC 909). Section B & D, Matulla Formation. Middle Coniacian. **d-f.** *Coilopoceras requienianum* (D'ORBIGNY) (MSC 901). Section A, Wata Formation, uppermost Turonian. All x 0.8.

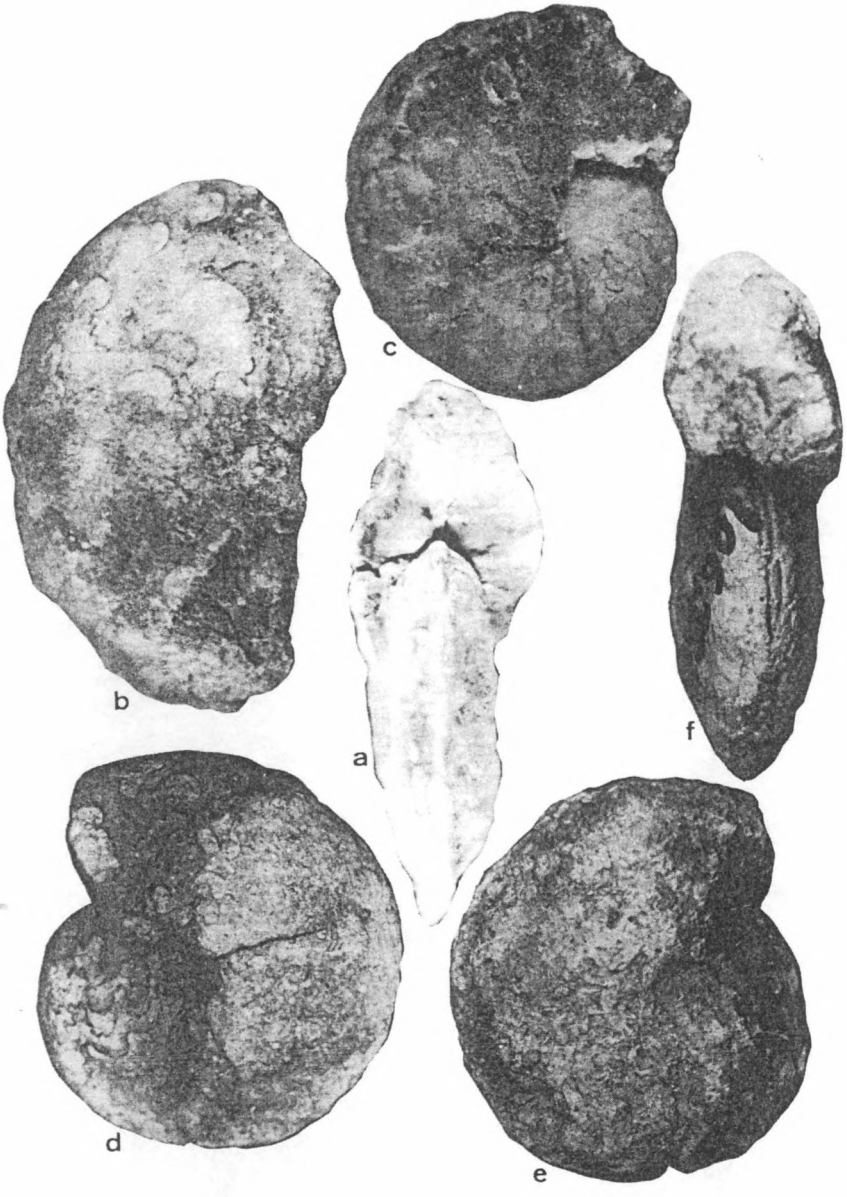

Fig. 6 (Legend see p. 412)

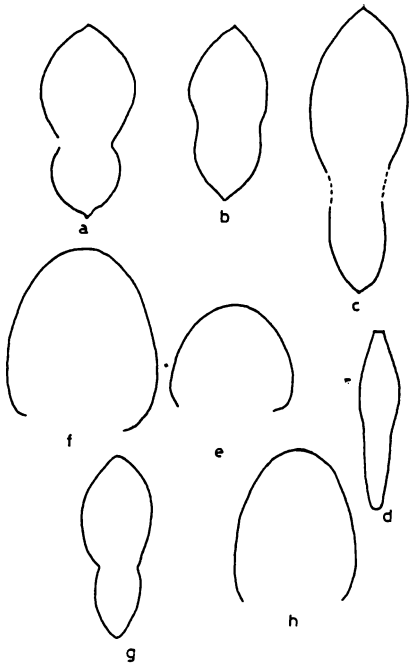

Fig: 7. Whorl sections of **a-c,** *Metatissotia fourneli* (BAYLE); **a,** MSC 906, **b,** MSC 905; **c,** MSC 907. **d.** *Neolobites vibrayeanus* (D'ORBIGNY). MSC 880. **e,** *Vascoceras proprium* (REYMENT) (MSC 894). **f,** *Vascoceras cauvini* CHUDEAU (MSC 893). **g,** *Coilopoceras requienianum* (D'ORBIGNY). MSC 901. **h,** *Thomasites gongilensis* (WOODS) (MSC 896). All 0.8.

Coilopoceras requienianum (D'ORBIGNY, 1841)
Fig. 6(d-f); Fig. 7g; Fig. 8b

1841 *Ammonites requienianum.* – D'ORBIGNY, p. 315, pl. 93, fig. 1-4.
1903 *Coilopoceras requienianum* (D'ORBIGNY). – HYATT, p. 99.
1984 *Coilopoceras requienianum* (D'ORBIGNY). – KENNEDY & WRIGHT, p. 282, pls. 35-36, text-figs. 1-5 (with complete synonymy).
1989 *Coilopoceras requienianum* (D'ORBIGNY). – LUGER & GRÖSCHKE, p. 88, pl. 46, figs. 1-3-, text-figs. 6a-e, 11, 12, 13a-c.

and widely spaced ribs start from the umbilicus and end at the ventrolateral shoulder. Suture line (Fig. 8f) composed of four saddles of which the first lateral is the largest of all the sutural elements. The first lateral saddle is divided by deep lobule into two nearly subequal parts; the internal is entire and subrounded while the external part is divided by deep lobule into two subequal parts. The other three saddles are entire and become smaller gradually towards the umbilical side. All lobes are almost regularly denticulated.

Discussion: GROSSOUVRE (1894) stated that some varieties of *Tissotia haplophylla* REDTENBACHER, particularly less thick varieties with less accentuated ornament are analogous to *T. robini* and *T. ewaldi*. However, PÉRON (1890, p. 8) stated that there is a great similarity between *T. ewaldi* and *T. robini* except the absence or weak appearance of ribs at the umbilicus that distinguish the former. GROSSOUVRE (1894) reported that the only difference between *T. robini* and *T. ewaldi* is that the external division of the first lateral saddle is rounded in *T. ewaldi* whereas it is indented in *T. robini* but PERVINQUIÈRE (1907, p. 376) was convinced that the two species are identical and the difference indicated by GROSSOUVRE is minute and may reflect ontogenetic variations. *M. ewaldi* (VON BUCH, 1848) sensu KENNEDY (1984) is much more compressed, has a fastigiate venter, and generally shows a weaker ornamentation than *M. fourneli*. He (1984) regards *M. robini* as a junior synonym of *M. ewaldi*. The present specimen closely resembles the one figured by LUGER & GRÖSCHKE (1989, pl. 44, figs. 1 & 2; text-fig. 10E) but the latter is much more inflated, has faint marginal ribs on phragmocone and no ornament on body chamber. The present species is more compressed than *Subtissotia africana* (PÉRON) described and figured by LUGER & GRÖSCHKE (1989).

Occurrence: Matulla Fomation, section B & D. Middle Coniacian. *M. ewaldi* occurs together with *Tissotioides haplophyllus* (REDTENBACHER) in the Lower Coniacian of N. Spain, Zone 1 (WIEDMANN, 1960, 1978 and WIEDMANN & KAUFFMAN, 1978). *M. ewaldi* is known from the Middle Coniacian of France and Austria (KENNEDY, 1984). It is recorded in the Upper Coniacian of Sinai and Israel (LEWY & RAAB, 1978). LUGER & GRÖSCHKE (1989) recorded *M.* cf. *ewaldi* from the Middle Coniacian of the Hawashya Formation of Wadi Qena, Eastern Desert, Egypt.

Family Coilopoceratida HYATT, 1903

Genus *Coilopoceras* HYATT, 1903

Type species: *Coilopoceras colleti* HYATT, 1903, p. 91, pl. 10, figs. 5-21; pl. 11, fig. 1, by original designation.

Description: Shell involute, oxycone. Whorl section lanceolate with a sharpened venter, maximum width closes to umbilicus. Umbilicus small, with rounded shoulders and almost vertical wall. No ornamentation observed. Suture line shown in Fig. 9b.

Discussion: COBBAN & HOOK (1980, p. 11) argued that species of the genus *Coilopoceras* display sexual dimorphism. This agrees with the redescription of the type-material of ORBIGNY (1841) by KENNEDY & WRIGHT (1984, p. 283) who suggested the existence of sexual dimorphism in *C. requienianum* which is shown by smooth oxycones and ribbed, less compressed forms. Therefore, the present specimen represents the unornamented oxycone form. Due to the great similarity between both *C. sinaiense* LEWY and *C. multicostatum* LEWY collected from the *requienianum* Zone of the Sinai and Israel (LEWY, 1975), these specimens can with doubt (due to the poor preservation) be considered as synonyms of the discussed species.

Occurrence: Wata Formation section A, upper Upper Turonian. The present species is recorded from the Upper Turonian of Madagascar (COLLIGNON, 1965), France and Germany (KENNEDY & WRIGHT 1984). In Egypt, *C. requienianum* occurs in the Upper Turonian of the northern Eastern Desert (KASSAB, 1991) and Sinai (LEWY, 1975 and KORA & HAMAMA, 1987). JELETZKY (1958, 1968) argued that *C. requienianum* Zone is not the latest Turonian ammonite biozone.

Biostratigraphical significance

The upper Cenomanian-Coniacian outcrops of the west central Sinai, Egypt yield a diverse and well preserved macro-fauna, particularly ammonites, oysters, gastropods and echinoids, in a addition to many significant microfaunas.

The chronostratigraphic importance of the ammonites allowed the subdivision of the Upper Cenomanian-Coniacian succession in the area studied into six biozones (biostratigraphic units). In an ascending order these zones are:

1 - *Neolobites vibrayeanus* Zone

This is the lowermost ammonite zone encountered in the area studied and characterizes the Upper Cenomanian. The upper boundary is marked by the appearance of *V. cauvini*. It is associated with abundant oysters like *Ilymatogyra* (*Afrogyra*) *africana* (LAMARCK), *Ceratostreon flabellatum* (GOLDFUSS), *Liostrea isidis* (FOURTAU).

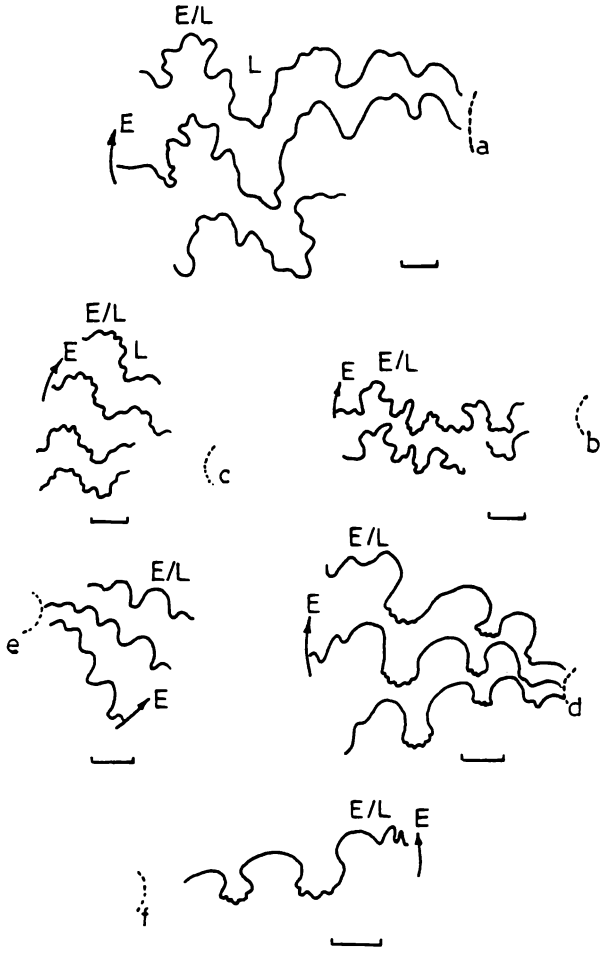

Fig. 8. External sutures of: **a,** *Nigericeras* sp. (MSC 888). **b,** *Coilopoceras requienianum* (D'ORBIGNY) (MSC 901). **c,** *Choffaticeras segne* (SOLGER). (MSC 898). **d,** *Metatissotia fourneli* (BAYLE) (MSC 906). **e,** *Neolobites vibrayeanus* (D'ORBIGNY) (MSC 880). **f,** *Metatissotia ewaldi* (BUCH). (MSC 909). Scale bar is 10 mm.

Material: A single specimen of mould (MSC 901).

Dimension:	D	Wb	Wh	U
MSC 901	110	34(31)	45(41)	4.9(0.4)

This zone is equivalent to the Egyptian Eastern Desert *vibrayeanus* Zone (KASSAB, 1991), the Portuguese *Calycoceras naviculare* Zone (BERTHOU, 1984), the Algerian *vibrayeanus* Zone (AMARD et al., 1981), the American *Calyoceras guerangeri* Zone (WRIGHT & KENNEDY, 1981; WRIGHT et al., 1984, COBBAN, 1984; TRÖGER & KENNEDY, 1996)), the Spanish *vibrayeanus-lotzei* Zone (WIEDMANN & KAUFFMAN, 1978), the *Neolobites vibrayeanus* Zone of Morocco (CHARRIÈRE et al., 1997), the Brazilian *Pseudocalyoceras harpax- Thomelites* aff. *sornayi* Zone (WALTER et al. in press), the western Europe *Metoicoceras geslinianum* Zone (TRÖGER & VOIGT, 1995; TRÖGER, 1996) and the Israeli *vibrayeanus* Zone (FREUND & RAAB, 1969; LEWY et al., 1984).

2 - *Vascoceras cauvini* Zone

The *cauvini* Zone defines the uppermost Cenomanian in the area studied. It has an upper boundary defined by the disappearance of *V. cauvini* and the appearance of *V. proprium*. This zone is characterized by the presence of *Thomasites gongilensis*. It also contains several oysters like *Exogyra* (*Costagyra*) *olisiponensis* SHARPE, *Curvostrea rouvillei* (COQUAND), *Ceratostreon flabellatum* (GOLDFUSS).

This zone is equivalent to the *cauvini & rumeaui* Zone of the Egyptian Eastern Desert (LUGER & GRÖSCHKE, 1989), the *cauvini & rumeaui* Zone (Zone V) of Algeria (AMARD et al., 1981), the *cauvini* Zone of Israel and the Middle East (FREUND & RAAB, 1969; LEWY et al., 1984), the *Fallotoites subconciliatum* Zone of N. Spain (WIEDMANN, 1978) the *juddii* Zone of Portugal (BERTHOU, 1984), the *cauvini* Zone of Morocco (CHARRIÈRE et al. 1997), the *Vascoceras harttii-Pseudaspidoceras footeanum* Zone of Brazil (WALTER et al. in press) and probably correlates with the *Neocardioceras juddii* Zone of Western Europe (TRÖGER & VOIGT, 1995; TRÖGER, 1996).

LEWY et al. (1984) showed that the stratigraphical occurrence of the *cauvini* Zone is restricted to the Cenomanian or extends to the Lower Turonian, but it is now restricted to the Upper Cenomanian (KENNEDY, 1985 and KENNEDY et al., 1987).

3 - *Vascoceras proprium* Zone

This zone defines the basal Turonian in the area studied. The *proprium* Zone is characterized by the presence of *Nigericeras* sp., in addition to a single oyster species *Curvostrea rouvillei* (COQUAND).

The *proprium* Zone is equivalent to the Egyptian Eastern Desert *flexuosum* Zone (KASSAB, 1991), the American *flexuosum* Zone (COBBAN,

1984, 1993), the Brazilian *Pseudotissotia* sp. Zone (WALTER et al., in press), and correlates with the boreal *Watinoceras coloradoense* Zone on the basis of the occurrence of *Pseudaspidoceras flexuosum* POWELL, *V. pioti* (PÉRON & FOURTAU) and *V. durandi* (THOMAS & PÉRON).

4 - *Choffaticeras segne* Zone

This zone is the second Lower Turonian biozone in the area studied. Its upper boundary is defined by the appearance of *Coilopoceras*. It yields *Mammites* cf. *nodosoides* (SCHLÜTER), *Plicatula reynesi* COQUAND and *Tylostoma* (*T.*) *gadensis* ABBASS.

This zone is equivalent to the *Mammites* sp. *Fagesia* cf. *superstes* Zone of the Egyptian Eastern Desert (LUGER & GRÖSCHKE, 1989), the *Mammites nodosoides* Zone of Morocco (CHARIÈRE et al. 1997), the *nodosoides* Zone of Western Europe (TRÖGER & VOIGT, 1995) the three *Choffaticeras* zones of LEWY et al. (1984) and in part correlates with the *Mammites nodosoides* Zone of WRIGHT & KENNEDY (1981), WRIGHT et al. (1984), COBBAN (1984, 1993) and BERTHOU (1984).

5 - *Coilopoceras requienianum* Zone

The *requienianum* Zone is the latest Turonian zone encountered in the studied area. Due to the presence of an erosive surface separating this zone from the succeeding zone, the upper boundary is marked by the appearance of the Coniacian macrofossils.

This zone is equivalent to the *deverianum* and *neptuni* zones of France (DEVALQUE et al., 1982), the *neptuni* Zone of the Uchaux Massif (KENNEDY & WRIGHT, 1984), the *requienianum* Zone of Israel (LEWY, 1975; LEWY et al., 1984) and can be correlated with the European *Romaniceras deverianum* Zone on the basis of the common occurrence of *Coilopoceras requienianum* (D'ORBIGNY).

6 - *Metatissotia fourneli* Zone

This zone is the only Coniacian zone encountered in the area studied. It is characterized by the presence of *M. fourneli* (BAYLE) and *M. ewaldi* (VON BUCH); the former is very common in this zone. This zone is attributed to the Middle Coniacian. It is associated with the oyster *Nicaisolopha lyonsi* (BULLEN-NEWTON) and *Plicatula ferryi* (COQUAND).

This zone is equivalent to the *tridorsatum* Zone of Europe (KENNEDY, 1984), the *Tissotioides haplophyllus* (REDTENBACHER) Zone (Zone 1) of N. Spain (WIEDMANN, 1960, 1978; WIEDMANN & KAUFFMAN, 1978), the

Scaphites whitfieldi Zone of the Western Interior of United States (COBBAN, 1993) and the *ewaldi-fourneli* Zone (Zone 5) of the Middle East (LEWY & RAAB, 1978).

References

ABDEL GAWAD, G. I., ABOUL ELA, N. M. & GAMEIL, M. (1992): Molluscan Biostratigraphy of the Cenomanian-Turonian strata of Gebel Nezzazat area, west central Sinai, Egypt. – Geo. Arab. World, **2**: 321-332.

AMARD, B., COLLIGNON, M. & ROMAN, J. (1981): Etude stratigraphique et paléontologique du Crétace supérieur et Paléocène du Tinhert-W et Tademait-E (Sahara algérien). - Docum. Lab. Géol. Lyon, (Hors serie) **6**: 15-173, pls. 1-17.

BANDEL, K. & KUSS, J. (1987): Depositional environment of the pre-rift sediments of Heights (Gulf of Suez, Egypt). – B. Geol. Abh., (A), **78**: 1-48, 11 figs., 6 pls.

BARBER, W. (1957): Lower Turonian ammonites from northeastern Nigeria. – Bull. Geol. Surv. Nigeria, **26**: 1-67.

BARTHEL, K. W. & HERMANN-DEGEN, W. (1981): Late Cretaceous and Early Tertiary stratigraphy in the Great Sand Sea and its SE margins (Farafra and Dakhla Oasis), SW Desert, Egypt. – Mitt. bayer. Staatsslg. Paläont. hist. Geol., **21**: 141-182.

BARTOV, Y. & STEINITZ, G. (1977): The Judea and Mount Scopus groups in the Negev and Sinai with trend surface analysis of the thickness data. – Israel J. Earth Sci., **26**: 119-148.

BAYLE, E. (1849): Sur quelques fossiles de la Province de Constantine. In: FOURNEL, H. (Ed.): Richesse minérale d'Algérie accompagnée d'Eclaircissements historiques et géographiques sur cette partie de l'Afrique Septentrionale. – Imp. Nationale, Paris, **1**: 359-379, pls. 17-18.

BENAVIDES-CÁCERES, V. E. (1956): Cretaceous system in northern Peru. – Bull. Amer. Mus. natur. Hist., **108** (4) 353-493, pls. 31-66.

BERTHOU, P. Y. (1984): Albian-Turonian stage boundaries and subdivision in the western Portuguese Basin, with special emphasis on the Cenomanian -Turonian boundary in the ammonite facies and rudist facies. – Bull. geol. Soc. Denm., **33**: 41-55.

BUCH, L. VON (1848-1850): Über Ceratiten. – Phys. Math. Abh. Kgl. Akad. Wiss., 1848: 1-30 (issued in parts in 1848, volume published 1850).

CHARRIÈRE, A., ANDREU, B., CISZAK, R., KENNEDY, W. J., ROSSI, A. & VILA, J.-M. (1997): La transgression du Cénomanien supérieur dans la Haute Moulouya et le Moyen Atlas méridional, Maroc. – Géobios, **31**, 5: 351-569

CHERIF, O. H., AL RIFAIY, I. A., AL AFIFI, F. I. & ORABI, H. O. (1989): Planktonic Foraminifera and chronostratigraphy of Senonian exposures in west central Sinai, Egypt. – Rev. Micropal., **32** (3): 167-184.

CHOFFAT, P. (1898): Recueil d'études paléontologiques sur la fauna crétacique de Portugal. 1, espéces nouvelles ou peu connues. Deuxiéme série, Les Ammonées du Bellasien, des couches à *Neolobites Vibrayeanus*, du Turonien et du Sénonien. – Trav. géol. Portugal: 41-86, (céphalopodes) 3-22; Lisbon.

CHUDEAU, R. (1909): Ammonites du Damergou (Sahara meridional). – Bull. Soc. géol. France, (4) 9: 67-71, 3 pls.
– (1921): Ammonites turoniennes du Soudan. – Bull. Mus. Hist. natur. Paris, **6** (27): 463-470, 1 pl.
COBBAN, W. A. (1984): Mid-Cretaceous ammonite zones, Western Interior, United States. – Bull. geol. Soc. Denm., **33**: 71-89.
– (1993): Diversity and distribution of Late Cretaceous ammonites, Western Interior, United States. – In: CALDWELL, W. G. E. & KAUFFMAN, E. G. (Eds.): Evolution of the Western Interior Basin: Geol. Ass. Canada. Spec.. Pap., **39**: 435-451.
COBBAN, W. A. & HOOK, S. C. (1980): The Upper Cretaceous (Turonian) Ammonite Family Coilopocceratidae HYATT in the Western Interior of the United States. – Prof. Pap. U.S. geol. Surv., **1192**: 1-28, 21 pls.
COLLIGNON, M. (1965): Atlas des fossiles caractéristiques de Madagascar (Ammonites), **12** (Turonien): 1-82, 37 pls.
– (1957): Céphalopodes néocrétacées du Tinrhert (Fezzan). – Ann. Paléont., **43**: 113-136, 3 pls.
COOPER, M. R. (1979): Ammonite evolution and its bearing on the Cenomanian-Turonian boundary problem. – Paläont. Z., **53**: 120-128.
DEVALQUE, CH., AMEDRO, F., PHILIP, J. & ROBASZYNSKI, F. (1982): Etat des corrélations litho- et biostratigraphiques dans le Turonien supérieur des massifs d'Uchaux et de la Cèze. Les zones d'ammonitcs et de rudistes. – Mém. Mus. nat. Hist. natur., **49**: 57-69.
DOMINIK, W. (1985): Stratigraphie und Sedimentologie (Geochemie, Schwermineralanalyse) der Oberkreide von Bahariya und ihre Korrelation zum Dakhla-Becken (Western Desert, Ägypten). – Ber. Geowiss. Abh. A **62**: 1-173, 53 figs., 22 tab., 18 pls.
ECK, O. (1914): Die Cephalopoden der Schweinfurthschen Sammlung aus der oberen Kreide Ägyptens. – Z. dtsch. geol. Ges., **66**: 179-216. pls. 9-19.
EL-SHINNAWI, M. A. & SULTAN, I. Z. (1973): Lithostratigraphy of some subsurface Upper Cretaceous sections in the Gulf of Suez area, Egypt. – Acta Geol. Acad. Sci., **17**: 469-491.
FISHER, P. (1880-1887): Manuel de Conchyliologie et de Paléontologie Conchyliologieque, 1369 pp. 23 pls. Masson, Paris.
FREUND, R. & RAAB, M. (1969): Lower Turonian ammonites from Israel. – Spec. Pap. Palaeont., **4**: 1-83, 10 pls.
FURON, R. (1933): Faunes et extension du Crétacé au sud de l'Ahaggar (Cénomanien, Turonien, Sénonien). – Bull. Soc. géol. France, (**5**) 3: 259-280, 1 Pl.
– (1935): Le Crétacé et le Tertiaire du Sahara soudanais (Soudan, Nigar, Tchad). – Arch. Mus. nat. Hist. natur., (Paris), (6) **13**: 1-96, 7 pls.
GHORAB, M. A. (1961): Abnormal stratigraphic features in Ras Gharib oil Field. – 3 ed., Arab. Petr. Congr: 1-10.
GRECO, B. (1915): Fauna cretacea dell'Egitto racolta da Figari Bey. Part 1. Cephalopoda. Palaeontogr. Ital., **21**: 189-231, pls. 17-22.

GROSSOUVRE, A. DE. (1894): Recherches sur la craie supérieure. 2: Paléontologie les ammonites de la craié supérieure. – Mém. Serv. Carte géol. dét. France, 1-264, 39 pls. (misdated 1893).

HYATT, A. (1903): Pseudoceratitids of the Cretaceous. – Monogr. U.S. geol. Surv. **44**: 1-351, 47 pls.

ISSAWI, B., EL-HINNAWI, M., EL-KHAWAGA, L., LABIB, S. & ANANI, N. (1981): Contribution to the Geology of Wadi Feiran area, Sinai, Egypt. – Geol. Surv. Egypt: 1-43 (unpubl. internal report).

JELETZKY, J. A. (1958): Die Jüngere Oberkreide (Oberconiac bis Maastricht) Südwestrusslands und ihr Vergleich mit Nordwest- und Westeuropa. 1. Dnjepr-Donez-Senke und Nordwestrand des Donezbecken sowie einige Vergleichs-und Gliederungs-Probleme der russischen borealen Oberkreide. – Beih. Geol. Jb., **33**: 1-157.

– (1968): Macrofossil zones of the marine Cretaceous of the western interior of Canada and their correlation with the zones and stages of Europe and the western interior of the United States. – Geol. Surv. Can. Pap., **67-72**: 1-66.

KASSAB, A. (1985): Paleontological and stratigraphical studies of Cretaceous sections in Wadi Qena and Wadi Tarfa, Eastern Desert Egypt. – Unpubl. Ph.D. Thesis. Assiut Univ., Egypt: 1-221.

– (1991): Cenomanian-Coniacian biostratigraphy of the northern Eastern Desert of Egypt, based on ammonites. – Newsl. Stratigr., **25** (1): 25-35.

– (1996): Turonian sequence in the Egyptian Eastern Desert: Bioevents and interregional correlation. – Geol. Soc. Egypt (abstract).

KAUFFMAN, A. G., KENNEDY, W. J. & WOOD, CH. J. (1996): The Coniacian stage and substage boundaries. – Bull. Inst. Royal Sci. natur. Belgique, **66**: 81-94

KENNEDY, W. J. (1984): Systematic palaeontology and stratigraphic distribution of the ammonite faunas of the French Coniacian. – Spec. Pap. Palaeont., **31**: 1-160, 33 pls.

– (1985): Integrated macrobiostratigraphy of the Albian to basal Santonian. In: REYMENT, R. A. & BENGTSON, P. (Compilers): Mid-Cretaceous Events. – Publ. Palaeont. Inst. Univ. Uppsala. Spec., **5**: 1-132.

KENNEDY, W. J. & HANCOCK, J. M. (1978): The mid-Cretaceous of the United Kingdom. – Ann. Mus. Hist. natur. Nice, **4**: 1-72.

KENNEDY, W. J. & JUIGNET, P. (1981): Upper Cenomanian Ammonites from the Environs of Saumur, and the Provenance of the Types of *Ammonites vibrayeanus* and *Ammonites geslinianus*. – Cret. Res., **2**: 19-49.

KENNEDY, W. J. & SIMMONS, M. D. (1991): Mid-Cretaceous ammonites and associated microfossils from the Central Oman Mountains. – Newsl. Stratigr., **25** (3): 127-154, 7 pls.

KENNEDY, W. J. & WRIGHT, C. W. (1984): The Cretaceous ammonite *Ammonites requienianus* D'ORBIGNY, 1841. – Palaeontol., **27** (2): 281-293, pls. 35-37.

KENNEDY, W. J., WRIGHT, C. W. & HANCOCK, J. M. (1987): Basal Turonian ammonites from west Texas. – Palaeontol., **30**: 27-74.

KLITZSCH, E. (1978): Geologische Bearbeitung Südwest Ägyptens. – Geol. Rundsch., **67**: 507-520.

KORA, M. & HAMAMA, H. (1987): Biostratigraphy of the Cenomanian-Turonian succession of Gebel Gunna, Southeastern Sinai, Egypt. – Mans. Sci. Bull., **14** (2): 289-301.

KORA, M., SHAHIN, A. & SEMIET, A. (1993): Stratigraphy and macrofauna of the Cenomanian exposures in west central Sinai, Egypt. – Mans. Sci. Bull., **20** (2): 227-260.

KULLMANN, J. & WIEDMANN, J. (1970): Significance of sutures in phylogeny of Ammonoidea. – Paleont. Contr. Univ. Kansas, **47**: 1-32.

LEWY, Z. (1975): The geological history of southern Israel and Sinai during the Coniacian. – Israel J. Earth Sci., **24**: 19-43.

LEWY, Z. & HONIG, G. (1985): A Late Coniacian ammonite from the lower part of the Sayyarim Formation near Elat (southern Israel). – Israel J. Earth Sci., **34**: 205-210.

LEWY, Z. & RAAB, M. (1978): Mid-Cretaceous stratigraphy of the Middle East. – Ann. Mus. Hist. natur. Nice, **4**: 1-20.

LEWY, Z., KENNEDY, W. J. & CHANCELLOR, G. R. (1984): Co-occurrence of *Metoicoceras geslinianum* (D'ORBIGNY) and *Vascoceras cauvini* CHUDEAU (Cretaceous ammonites) in the southern Negev (Israel) and its stratigraphic implications. – Newsl. Stratigr., **13** (2): 67-76.

LUGER, P. (1985): Stratigraphie der marinen Oberkreide und des Alttertiärs im südwestlichen Obernil-Becken (SW Ägypten). – Berliner geowiss. Abh., (A), **63**: 1-51, 1-24.

LUGER, P. & GRÖSCHKE, M. (1989): Late Cretaceous ammonites from the Wadi Qena in the Egyptian Eastern Desert. – Paleontology **32**, (2): 355-407.

MATSUMOTO, T. (1973): Late Cretaceous Ammonoidea. – In: HALLAM, A. (Ed.): Atlas of Paleobiogeography. Elsevier Scientific Publishing Comp.: 421-429.

MEISTER, C. (1989): Les ammonites du Crétacé supérieur d'Ashaka. – Bull. Centres Rech. Explor. Prod. Elf-Aquitaine, **13** (supplement): 1-84.

ORBIGNY, A. D. (1840-1842): Paléontologie française. Terrains crétacés. 1. Céphalopodes. – 1-120 (1840), 121-430 (1841), 431-622 (1842), pls. 151.

PÉRON, A. (1890-1893): Description des mollusques fossils des terrains Crétacés de la région sud de Hauts-Plateaux de la Tunisie recueillis en 1885 et 1886 par M. Philippe Thomas.– Explor. sci. Tunisie: 1-405, pls. 35, 1-103 (1890): 104-327 (1891: 328-405 (1893).

– (1896-1897): Les ammonites du Crétacé supérieur de l'Algérie. I. + II. Mém. Soc. Géol. France, (Paléont), **17**: 1-88 pls. 1-18, 6: 1-24, pls. 14-19 (1-6) (1896), 7: 25-88, pls. 1-12 (7-18) (1897).

PERVINQUIÈRE, C. (1907): Etudes de paléontologie tunisienne. 1. Céphalopodes des terrains secondaires. – Carte géol. Tunisie: 1-438, s. 27.

RENZ, O. (1982): The Cretaceous ammonites of Venezuela. – 1-132; Birkhäuser, Basel.

REYMENT, R. A. (1954): Some new Upper Cretaccous ammonites from Nigeria. – Colon. geol. Surv. Min. Resour. Div.: **4**: 248-270, pls. 5.

REYMENT, R. A. (1955): The Cretaceous Ammonoidea of southern Nigeria and the southern Cameroon. – Bull. geol. Surv. Nigeria, **25**: 1-112, pls. 4.

– (1979): Variation and ontogeny in *Bauchioceras* and *Gombeoceras*. - Bull. geol. Inst. Univ. Uppsala, (n.s.), **8**: 89-111.

ROMAN, F. (1938): Les ammonites jurassiques et crétacées. Essai de genera: 1-554, pls. 53.

SAID, R. (1962): The geology of Egypt. – Elsevier Amsterdam-New York: 1-377.

SCHLÜTER, C. (1871): Die Cephalopoden der oberen deutschen Kreide. – Palaeontogr., **21**: 1-24.

SCHNEEGANS, D. (1943): Invertebrés du crétacé supérieur du Damergou (Territoire du Niger). – Bull. Div. Mines Afr. occid. fr., **7**: 87-150, pls. 8.

SCHÖBEL, J. (1975): Ammoniten der Familie Vascoceratidae aus dem Unterturon des Damergou-Gebietes, République du Niger. – Publ. Palaeont. Inst. Univ. Uppsala, **3**: 116, pls. 6.

SOLGER, F. (1903): Über die Jugendentwicklung von *Sphenodisicus lenticularis* OWEN und seine Beziehungen zur Gruppe der Tissotien. – Z. dt. Geol. Ges., **55**: 69-84.

STOLICZKA, F. (1863-1866): The fossil Cephalopoda of the Cretaceous rocks of southern India. – Mem. geol. Surv. India, Palaeontologia Ind., **3**, (1): 41-56, pls. 26-31 (1863); (2-5): 57-106, pls. 32-54 (1864); (6-9): 107-154, pls. 55-80 (1865); (10-13): 155-216, pls. 81-94 (1866).

TRÖGER, K.-A. (1996): Comparison of the Cenomanian through Middle Turonian faunas and facies between central and eastern Europe. – Acta Geol. Polon., **46** (1-2): 81-88.

TRÖGER, K.-A. & KENNEDY, W. J. (1996): The Cenomanian stage. – Bull. Inst. Royal Sci. natur. Belgique, **66**: 57-68.

WALTER, S., HERRMANN, A. & BENGTSON, P. (in press): Stratigraphy and facies analysis of the Cenomanian-Turonian boundary succession in the Japaratuba area, Sergipe Basin, Brazil. – J. South Amer. Earth Sci.

WEDEKIND, R. (1916): Über Lobus, Suturallobus und Inzision. – Cbl. Miner. Geol. Paläont. **1916**: 185-195.

WIEDMANN, J. (1960): Le Crétacé supérieur de l'Espagne et du Portugal et ses céphalopodes. – 84e Congr. Soc. Sav., Dijon, 1959: 709-764, pls. 8.

– (1978): Die Ammoniten der NW-deutschen, Regensburger und Ostalpinen Oberkreide im Vergleich mit den Oberkreidefaunen des westlichen Mediterrangebietes. – In: WIEDMANN, J. (Ed.): Aspekte der Kreide Europas: Intern. Union Geol. Sci., **6**, (A): 335-350.

WIEDMANN, J. & KAUFFMAN, E. G. (1978): Mid-Cretaceous biostratigraphy of northern Spain. – Ann. Mus. Hist. Natur., Nice, **4**: 1-34.

WOODS, H. (1911): The palaeontology of the Upper Cretaceous deposits of northern Nigeria. – In: FALCONER, J. D. (Ed.): The geology of northern Nigeria: 273-286.

WRIGHT, C. W. & KENNEDY, W. J. (1981): The Ammonoidea of the Plenus Marls and the Middle Chalk. – Palaeontogr. Soc. (monogr.): 1-148, pls. 32.

WRIGHT, C. W., KENNEDY, W. J. & HANCOCK, J. M. (1984): Introduction. – In: WRIGHT, C.W., KENNEDY, W. J. (Eds.): A monograph of the Ammonoidea of the Lower Chalk, part 1: Palaeontogr. Soc. (monogr.): 1-37.

ZABORSKI, P. M. P. (1987): Lower Turonian (Cretaceous) ammonites from south-east Nigeria. – Bull. Brit. Mus. natur. Hist. (Geol.), **41**: 31-66.

– (1990): Some Upper Cretaceous ammonites from southern Nigeria. – J. Afr. Earth. Sci., **10** (3): 565-581.

Revised manuscript received: February 6, 2001.
Accepted by the Tübingen editors: March 28, 2001.

Address of the author:

Dr. M. M. A. EL-HEDENY, Geology Department Faculty of Science, Alexandria University, Alexandria, Egypt.
E-mail: m_elhedeny@Yahoo.com