

Aptian ammonites of Abu Dhabi (United Arab Emirates)

[Ammonites aptiennes d'Abou Dabi (Émirats Arabes Unis)]

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Abstract: The identification of some twenty ammonite fragments from oil wells drilled in offshore Abu Dhabi revealed the presence of six Aptian genera: *Chelonicer*, *Epicheloniceras*, *Gargasicer*, *Colombicer*, *Pseudohaploceras*, and *Macroscaphites*. These ammonites indicate the Furcata Zone and the succeeding Martini Zone. The Gargasian age of the upper part (HST) of the Shu'aiba as well as that of the whole of the Bab are thus firmly established.

Key Words: Ammonites; middle Aptian; Upper Aptian; Gargasian; United Arab Emirates; Abu Dhabi.

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Résumé : La détermination d'une vingtaine de fragments d'ammonites extraites de forages pétroliers effectués au large de l'émirat d'Abou Dhabi fait apparaître la présence de six genres aptiens : *Chelonicer*, *Epicheloniceras*, *Gargasicer*, *Colombicer*, *Pseudohaploceras* et *Macroscaphites*. Ils sont attribués au Gargasien (Zone à Furcata et Zone à Martini). Ils fixent ainsi, respectivement pour partie et en totalité, l'âge des séries traversées, le Shu'aiba (plus précisément son HST) et le Bab.

Mots-Clefs : Ammonites ; Aptien moyen ; Aptien supérieur ; Gargasien ; Émirats Arabes Unis ; Abou Dabi.

English version

1-Introduction

Recent publications (GRANIER, 2000, 2008; GRANIER *et alii*, 2003, 2011; GRANIER & PITTET, 2010) collected, clarified, re-aligned and dated the infra-Cretaceous formations (Kahmah regional Series, Thamama Group) of the United Arab Emirates and neighboring countries (Oman, Qatar, ...). Ammonites had been reported in the oil wells of offshore Abu Dhabi, namely in the Umm Shaif field (BANNER & WOOD, 1964; HASSAN *et alii*, 1975; AZER & TOLAND, 1993; GRANIER, 2000). In well Umm Shaif N° 2, C.W. WRIGHT (1959, unpublished, *in* GRANIER, 2000) reported the presence of "*Chelonicer* (*Epicheloniceras*)

sp. indet." and of "*Colombicer* cf. *causicum* LUPPOW", respectively at well-depths of 5802' and 5820' near the base of the Bab Formation. M. HOWARTH (1992, unpublished, *in* GRANIER, 2000) mentioned in Well N° 3 near the upper limit of the Shu'aiba Formation, respectively at well depths of 5864' and 5866', the presence of "cf. *Pseudohaploceras* sp. indet." and of "*Diadochoceras* sp.". These ammonites are indicative of Gargasian (middle Aptian *sensu gallico*, lower Upper Aptian *sensu anglico*: see MOULLADE, 1965; SORNAY, 1968-2010; MOULLADE *et alii*, 2011). We were not able to review the material studied by C.W. WRIGHT and M. HOWARTH (Natural History Museum, London) but we were able to study the material housed at the Faculty of Sciences in Lyons (FSL), most of it from field "A" (GRANIER *et alii*, 2000). The singularity of

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these collections (it is most unusual to find ammonites in well cores) and their site - far from traditional areas - merit the brief paleontologic notes below.

2. Material and method

The material is from wells in offshore Abu Dhabi, specifically from 7 wells in the field "A" (5 other wells in that field did not furnish material good enough in either quality or quantity to make identifications) and one from the "B" field. These wells yielded numerous small ammonites that with considerable difficulty were extracted from fragmented cores. The specimens are broken, sectioned, fragmented, so it is hard to visualize their complete morphology. These thin and fragile shells, often broken, are frequently associated with the debris of gastropods and bivalve molluscs. Among the latter there are a great number of *Astartes* (*Astarte obovata* SOWERBY) from the Mediterranean Aptian (GILLET, 1924). This form abounds in the Upper Barremian and from the base of the Bedoulian (Lower Aptian) in the stratotype of La Bédoule (near Cassis). Two photographs by GRANIER *et alii* (2003: Figs. 13 - 14) show quite clearly the appearance and abundance of these small fossils along with the association of ammonites - bivalves - foraminifers in this environment of fine-grade mud. Of interest is the strict and precise distribution of the cephalo-

pods in association with planktonic foraminifera (GRANIER *et alii*, 2003: Fig. 7).

It is very difficult to extract these small, fragile-tested ammonites from this fine-grained homogeneous limestone, for they are almost inseparable from the sedimentary matrix. We tried using pure acetic acid to produce differential solution, but probably because the sediment was too calcified it did not work. Neither did the method of using rapid changes in temperature (cold-hot). Finally, the fossiliferous fragments were extracted using a more or less directionally-oriented crushing of each piece of core. As a result, the shells were always incomplete in a mass of pulverized sediment.

3. Paleontologic descriptions

The examination of some twenty fragments of limestone from well cores revealed the existence of six genera of ammonites that are well-known elsewhere. On the other hand, determination of their species remains difficult either because of the poor condition of the material, or because they are new. As a first tentative evaluation (GRANIER *et alii*, 2003), the following genera have been recognized: *Chelonicerases*, *Epicheloniceras*, *Valdedorsella*, *Colombiceras* et *Gargasicerases*. Similarity in ornamentation has led to confusion in the recognition of the genus *Valdedorsella* often misidentified as *Pseudohaploceras*.

List of samples studied:

Well Field	Interval	Taxa	FSL Number	Picture (Pl. 1)
3X3I	Shu'aiba HST	<i>Chelonicerases</i> sp.	105 435	
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 432	Fig. 1
		<i>Pseudohaploceras</i> sp.	105 434	Fig. 3 & 9
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 433	Fig. 2a, 2b
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 436	Fig. 5a, 5b
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 437	
		<i>Gargasicerases</i> sp.	105 438	Fig. 6a, 6b
3X6I	Bab LST1	<i>Colombiceras</i> sp.	105 443	
14	Bab TST	<i>Gargasicerases</i> sp.	105 445	
		<i>Epicheloniceras</i> sp.	105 446	Fig. 7a, 7b
		<i>Epicheloniceras</i> sp.	105 450	
18	Shu'aiba HST	<i>Chelonicerases</i> sp.	105 439	Fig. 10
19	Shu'aiba HST	<i>Macroscaphites</i> sp.	105 440	
		<i>Macroscaphites</i> sp.	105 441	
20	Shu'aiba HST	<i>Pseudohaploceras</i> sp.	105 442	
	Bab TST	<i>Epicheloniceras</i> sp.	105 447	Fig. 11
		? <i>Chelonicerases</i> sp.		
21	Bab LST2	Cheloniceratidae	105 449	
0X2I	?Shu'aiba HST	<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 448	Fig. 4
4	B Shu'aiba HST	<i>Colombiceras</i> sp.	105 444	Fig. 8a, 8b

The material is housed at the Faculty of Sciences of Lyons (FSL).

The age of these ammonites was determined after an examination of several sections in southeastern France, together with special

consideration of the results obtained by DUTOUR (2005) and also of the personal experience of the first author (RB). The accompanying table (Fig. 1) lists the ranges of the principal species of the ammonites present near the Bedoulian-

Gargasian boundary. So the genera *Chelonicer* and *Gargasiceras* belong to the Furcata Zone (the first zone of the Gargasian). The genus *Epicheloniceras* characterizes the Martini Zone (the second of the Gargasian). The genera *Pseudohaploceras* and *Colombiceras* evolve

over a longer range.

The letters D, E, H and O stand respectively for maximum diameter, width of the whorl, height of the whorl, and diameter of the umbilicus (mm).

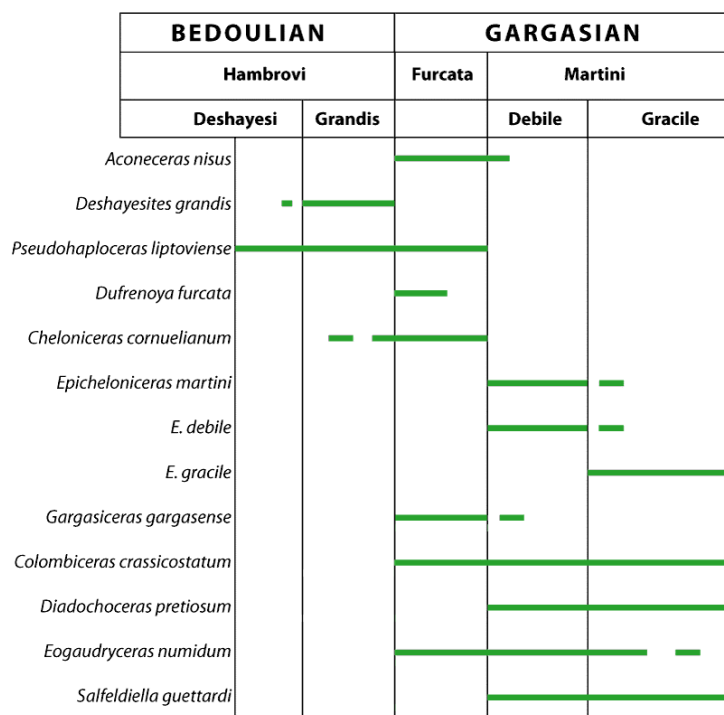


Figure 1: Ranges of the main Aptian ammonites in the vicinity of the Bedoulian-Gargasian boundary, modified from DUTOUR (2005).

Family Desmoceratidae
ZITTEL, 1895
Genus *Pseudohaploceras*
HYATT, 1900

Type species: *Ammonites liptoviensis* ZEUSCHNER, 1856

The species *A. liptoviensis* named by ZEUSCHNER (1856, p. 137) was subsequently fully described and admirably illustrated by UHLIG (1883) under the name *Haploceras liptoviense* (p. 229, Pl. XVII, figs. 9 & 16-18; Pl. XVIII, figs. 1, 3 & 5-6). It is specimen XVIII - 1 that was taken as the type species of the genus *Pseudohaploceras* (see C.W. WRIGHT, 1996, p. 73, Fig. 52, 3a-b). We reissue here a copy of that illustration (Pl. XVIII, fig. 1) together with that of Pl. XVII, fig. 18, that shows the inner whorls very well. Using them together makes possible a better appreciation of the comparisons with the Abu Dhabi specimens. This Silesian fauna, studied by UHLIG and viewed again by VASICEK (1972), is of Late Barremian-Early Aptian age without greater precision. Note that the genus *Pseudohaploceras* has a long range, which is unusual among Cretaceous ammonites. It probably represents several evolutionary lineages, for example the Gargasian forms from Blioux (FALLOT, 1920; THOMEL, 1980) do not have the same aspect as those from Silesia.

Both involution and costulation vary greatly from one species to another. Currently, some twenty species are assigned this genus. Generic differentiation is sometimes difficult to ascertain in closely related genera such as *Valdedorsella*, *Puzosia*, *Melchiorites*, *Zuercherella*, etc. Sometimes it is advisable to determine age using associated ammonites in order to avoid diachronism.

Pseudohaploceras liptoviense
(ZEUSCHNER, 1856)

References (partial):

- 1856 - *Ammonites liptoviensis* ZEUSCHNER, p. 181, Pl. II, figs. 1a-c, 2a-b & 3a-b
- 1883 - *Haploceras liptoviensis* (ZEUSCHNER).- UHLIG, p. 229, Pl. XVII, figs. 9 et 16-18; Pl. XVIII, figs. 1, 3 & 5-6
- 1920 - *Puzosia liptoviensis* (ZEUSCHNER).- FALLOT, p. 259, Fig. 21, Pl. 1, figs. 5-6
- 1972 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- VASICEK, p. 78, Pl. XIV, fig. 4
- 1980 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- THOMEL, p. 121, fig. 242
- 1994 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- GONZALES-ARREOLA, p. 38, Pl. 4
- 1996 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- WRIGHT, p. 73, Fig. 52, 3a-b
- 2004 - *Pseudohaploceras*.- BOGDANOVA & HOEDEMAEKER, p. 223
- 2005 - *Pseudohaploceras liptoviensis* (ZEUSCHNER).- DUTOUR, p. 126, Pl. 13, figs. 1-5

Material:

FSL 105432 - Pl. 1, fig. 1: A grayish beige limestone block enclosing a calcified somewhat broken half ammonite. D=21, H=9, E=12. Section rounded. Umbilicus rather closed. Four strong, irregularly spaced, rectilinear ribs cross the flanks; they weaken only slightly on the siphonal zone. Between the ribs fine costulae appear high up on the flanks.

FSL 105 433 - Pl. 1, figs. 2a-b: Free ammonite comprising slightly more than one whorl. D=28, E=10, H=11. Section a little higher than wide, with flanks almost flat. Costulation very strong with straight, very heavy ribs crossing the flanks and weakening a little on the siphonal area. On this half whorl there are nine main ribs, between which, and on the outer side only, 2 to 3 fine costules are intercalated. This specimen is certainly the best representative of the Abu Dhabi fauna. Unfortunately, it is but a fragment, not enough to permit the creation of a new species. In particular the adult portion is unknown.

FSL 105 434 - Pl. 1, figs. 3 and 9: Fragment of a third of a whorl of a well-exposed small ammonite. D=21, E=11.5, H=9.2. Costulation is quite isomorphic, but on the flanks some rare ribs are stronger. No differentiation on the siphonal area. Section rounded a little lowered.

FSL 105 436 - Pl. 1, figs. 5a-b. About half of a calcified ammonite and its impression (Pl. 1, fig. 5a). D=27, E=9, H=11. Section rounded, slightly higher than wide. Inner whorl visible from D= about 5 mm with 5 à 6 strong ribs. Ribs spaced irregularly and weakly sinuous. The last half whorl has 8 main ribs. No intermediate ribs at the beginning of the whorls but 4 to 6 fine intermediate costules appear high on the flanks. Costulation crosses the siphonal area without noticeable weakening. This type of ornamentation is found in the *P. liptoviense* figured by UHLIG, Pl. XVII, fig. 18, that we reproduce here (Fig. 2.B) for comparison. This affinity allows us or the time being to relate, if not to identify, the Abu Dhabi (U.A.E.) speci-

mens with those of UHLIG (Silesia, SW Poland).

FSL 105 437 - Small fragment representing a quarter of an ammonite whorl E=8.2, H=8. Section rounded. Some irregular main ribs and 5 to 6 intermediate costules high on the flanks. Although it is very fragmentary the ornamentation of this ammonite corresponds to that of the *Pseudohaploceras*.

FSL 105 442 - Gray micritic limestone. Traces of small bivalves and one calcified ammonite. Section rounded. Ornamentation like that of *Pseudohaploceras*.

FSL 105 448 - Pl. 1, fig. 4 - This is the largest ammonite of the lot. D=49, H=21, E ? - Calcified ammonite, very worn, showing only a part of the ornamentation. On the inner whorl heavy ribs like those on sample N° 105 436 are discernible. Then the main irregularly spaced ribs and the intermediate costules characteristics of the genus are seen again. In the final portion the costulation begins at the edge of the umbilicus then become flexuous with troughs developed between the costae. It is probable that this advanced expression of the costulation is not seen on the preceding examples because they are too young. The *P. liptoviensis* of FALLOT (Gargasian of Blieux, 1920) seem different to us. Their costulation is weak, almost erased: the constrictions are gentle and sinuous. Is it a species truly different from the one at Abu Dhabi? It seems probable but would require a larger-scale revision of more ample material to arrive at a decision. The same for the faunas described in detail by FALLOT (1920), and by DUTOUR (2005), as well as those collected and described by GONZALES-ARREOLA in Mexico (1994). These faunas are of Late Bedoulian-Early Gargasian age. BOGDANOVA & HOEDEMAEKER (2004) present several very well illustrated species from Colombia. And one sees clearly how difficult it is to separate them. Note that the ornamentation of *Zuercherella latecostata* is to some extent like that of the costulation of our sample N° 105 433 (Pl. 1, figs. 2a-b) with its ribs strong, rigid and straight.

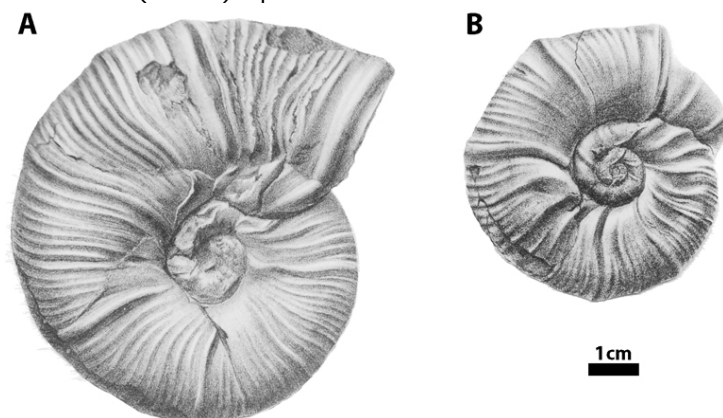


Figure 2: A and B: *Pseudohaploceras liptoviense* (ZEUSCHNER, 1856), A - type species of the genus according to UHLIG, 1883, Pl. XVIII, fig. 1; B - from UHLIG, 1883, Pl. XVII, fig. 18, see the inner costulation and compare it with that of Pl. 1, figs. 5a-b.

In summary:

The ornamentation of the 7 specimens discussed above corresponds rather well to that of the genus *Pseudohaploceras*: an alternation of main ribs and troughs and fine secondary costules that are more or less flexuous. Sample N° 105 436 shows the internal costulation (heavy ribs only) that may be likened to UHLIG's form (Pl. XVII, fig. 18, reproduced here: Fig. 2.B).

Sample N° 105 433 resembles the intermediate stage with strong, closely-spaced ribs and N° 105 448.

Sample N° 105 433 resembles the intermediate stage with strong, closely-spaced ribs and the first of the intermediate costules. The stage of ornamentation in N° 105 448 may represent the beginning of adult costulation. In the later stage the main ribs are replaced by true constrictions (or troughs) almost always bounded by a bourrelet. In the Abu Dhabi region most of the *P. liptoviensis* come from well 3X31, more precisely from the condensed level (about a half-meter thick) that represents the systems tract (ST) of the relatively high sea-level (HST) of the Shu'aiba. There, they are associated with *Chelonicerases* sp. and *Gargasicerases* sp., which confer on them an early Gargasian age. Their attribution to the species *P. liptoviensis* remains approximate: it may reflect a climatic differentiation, for the Arabian and Silesian faunas have a more pronounced Tethyan facies.

Family Douvilleiceratidae

PARONA & BONARELLI, 1897

Genus *Chelonicerases*

HYATT, 1903

Type species: *Ammonites cornuelianus* d'ORBIGNY, 1841

References (partial):

- 1841 - *Ammonites cornuelianus* d'ORBIGNY, p. 364, Pl. 112, figs. 1-2
- 1961 - *Chelonicerases cornuelianum* (d'ORBIGNY).- CASEY, p. 198-208, Figs. 60a-c, 61-62 & 67e-f, Pl. 33, figs. 7a-b; Pl. 34, figs. 1a-b; Pl. 35, figs. 1a-b & 2-3
- 1996 - *Chelonicerases*.- HYATT in WRIGHT, p. 269, Fig. 208, 4a-b
- 2004 - *Chelonicerases cornuelianum* (d'ORBIGNY).- SHARIKADZE *et alii*, p. 320-321, Pl. 11; Pl. 13; Pl. 14, fig. 1; Pl. 15, fig. 1
- 2005 - *Chelonicerases cornuelianum* (d'ORBIGNY).- DUTOUR, p. 152-156, Pl. 19, figs. 1-6
- 2006 - *Chelonicerases cornuelianum* (d'ORBIGNY).- BUSNARDO in GAUTHIER *et alii*, p. 132-133, Pl. 28, figs. 2a-c
- 2008 - *Chelonicerases cornuelianum* (d'ORBIGNY).- ROPOLO *et alii*, p. 15-16, Fig. 9b-d, Pl. 14, figs. 2.a-b; Pl. 15, figs. 1-3; Pl. 16, fig. 1

Chelonicerases sp.

This genus of ammonite is particularly interesting, as much for its richness and variety of ornament as for its abundance in the field,

particularly among the collections of hematized ammonites. CASEY shows us forms that are quite large. SHARIKADZE *et alii* (2004) present forms of moderate size but well preserved and DUTOUR (2005) adds the small hematized ammonites of which the micro-evolution is easy to see.

Among the fragmentary ammonites extracted from the Emirian wells four specimens resemble *Chelonicerases*, another one shows only some ribs too fragmentary to be determinable (FSL 105 449). The matrix is a blackish limestone.

FSL 105 435 - A half ammonite with D=21, O=5.5, H=9, E=1. Section slightly wider than high. Ornamentation poorly preserved. Nevertheless, a small section remains in which the costulation is still visible: some thickened ribs alternate with one or two fine costules.

A second fragment, 15 mm long, shows a clearly marked costulation. The section is distinctly wider than high (E=9, H=5) as it is in most of the *Chelonicerases*. The ribs of the rounded section are almost of the same size. One of them, a little stronger, is emphasized by a small trough. Near the edge of the umbilicus two small nodules appear. At this stage of evolution, a specific determination does not seem reasonable so we leave the two individuals in open nomenclature.

FSL 105 439 - Pl. 1, fig. 10. Fragment 21 mm long. Section depressed with E=11, H=8. Strong ribs without intermediaries cross the siphonal area without weakening. The ribs begin at the periphery of the umbilicus, strengthened by a crest. Here too a specific determination is hardly possible. A second fragment is a half-whorl about 19 mm in diameter. The costulation is poorly preserved, but some strong ribs and periumbilical nodules are discernible.

Genus *Epicheloniceras*

CASEY, 1954

Type species: *Douvilleicerases tschernyschewi* SINZOW, 1906

This is a particularly interesting genus, easy to recognize owing to the presence of trituberculate ribs alternating with only one or two plain intermediaries. The strong ribs and their perisiphonal tubercles stop at the edge of the siphonal area creating the illusion of a longitudinal trough. This feature makes it easy to recognize the genus. Nevertheless, note that there is a certain resemblance to the genus *Diadochoceras* that lived at the same time.

Epicheloniceras sp.

FSL 105 446 - *Epicheloniceras* sp. juv. (Pl. 1, figs. 7a-b): Half whorl of a small ammonite with a depressed section (D=19, E=10, H=8) appearing polygonal. Inner whorls visible showing strong quite closely spaced ribs. They spread apart on the last whorl and have 3 small

tubercles of varied heights. The perisiphonal tubercles, so characteristic of the *Epicheloniceras*, are quite visible. There are 2 to 5 plain intermediate ribs. This specimen is certainly the best preserved as regards ornamentation.

FSL 105 447 - *Epicheloniceras* sp. (Pl. 1, fig. 11): Fragment of whorl (E=11.5, H=8.5) with a depressed section. Main ribs with 2 tubercles, the outer one stronger. One intermediate rib.

Family Parahoplitidae

SPATH, 1922

Genus *Gargasiceras*

CASEY, 1954

Type species: *Ammonites gargasense* d'ORBIGNY, 1841

Forms with large umbilicus, section almost quadrilateral. Fine costulation with the main ribs not much stronger than the intermediaries. Slight rise at rib ends. Rare.

Gargasiceras sp.

FSL 105 438 - Pl. 1, figs. 6a-b. Small ammonite, but almost complete, in part calcified (D=26, E=13, H=11, E/H=1.18). Section rounded, slightly depressed. Enrollment nearly evolute. Costulation made up of main ribs that cross the siphonal area with the base having a tendency toward the presence of tubercles; there are 12 to 13 ribs on the last whorl. Intermediate costulation fine with 1 to 3 costules beginning near the umbilicus. No conspicuous tubercle as in the *Cheloniceras*.

FSL 105 445 - *Gargasiceras*?: A third of a calcified ammonite with a rounded section (D=17, H=6). Costulation rather fine, straight and regular. Main ribs absent. Probably a young representative of the genus *Gargasiceras*.

FSL 105 443 - *Gargasiceras* sp. Half of an ammonite whorl with its ornamentation rather well preserved. D=23, O=9, E=8?, H=9. Section subquadrate; costulation dense, almost uniform with straight ribs; no nodules.

Genus *Colombiceras*

SPATH, 1923

Type species: *Ammonites crassicostatus* d'ORBIGNY, 1841

This genus is common at the base of the Gargasian. The coarse ribs with a square section and its rather uniform costulation make it easy to recognize.

Colombiceras crassicostatum

(d'ORBIGNY, 1841)

FSL 105 444 - Pl. 1, figs. 8a-b. Two almost identical specimens. D=44, O=19, H=13, E=13. Section quadratic with a slight depression on the siphonal area. Strong costulation of poorly preserved simple, straight ribs. No nodu-

les with the exception of some points at the border of the siphonal area.

Family Macroscaphitidae

HYATT, 1900

Genus *Macroscaphites*

MEEK, 1876

Type species: *Scaphites yvani* Puzos, 1832

Macroscaphites sp.

[juvenile specimen]

FSL 105 441 - A small ammonite, 12 mm in diameter with open enrollment, a rounded section and fine radial ornamentation like that of the early whorls of *Macroscaphites*, often found at this stage of development in pyritized Gargasian faunas.

4. Discussion

BUCHEM *et alii* (2010a, p. 11) state that "the sediments of the Bab Basin are only known from sporadic core material, and the biostratigraphic control is here less precise" than those of the "outcrops of the intra-shelf basinal sediments of the Kazhdumi Basin in southwest Iran". In the same volume, BUCHEM *et alii* (2010b, p. 541) specify that "Only a few ammonites from the Bab Member have been reported in the literature, which have been interpreted of early Late ("mid") Aptian age (HASSAN *et al.*, 1975; GRANIER *et al.*, 2003), but their exact stratigraphic position is not known".

These statements reflect a very incomplete reading of our 2003 publication (GRANIER *et alii*, 2003). Indeed, although GRANIER *et alii* (2003, and before that GRANIER, 2000) did recall earlier findings (BANNER & WOOD, 1964; HASSAN *et alii*, 1975; AZER & TOLAND, 1993), they also reported the discovery of new specimens (presented here) not only in the Bab but also in the upper portion of the Shu'aiba, and in addition showed that these associations are characteristic only of the Gargasian (middle Aptian *sensu gallico*, upper Aptian *sensu anglico* -see MOULLADE, 1965; SORNAY, 1968-2010-; for MOULLADE *et alii*, 2011, Gargasian is a later synonym of the Aptian *sensu stricto*).

*: BUCHEM *et alii* (2010a, p. 20) do list GRANIER *et alii* (2003) in their bibliographic references. But the only quoted sentence concerns an accessory point of the contribution: "In core material from the UAE and Qatar this sequence boundary is placed on a bored hardground surface with evidence for clay penetration in the underlying carbonates and marking a distinct facies change to an argillaceous environment characterized by oysters (GRANIER *et al.*, 2003; van BUCHEM, personal observation)" (BUCHEM *et alii*, 2010a, p. 20, then bring up the lower limit of the "Arabian Plate Barremian 1 Sequence" of authors). In addition to the fact that the word "oyster" does not appear in our publication

(GRANIER *et alii*, 2003), from a scientific viewpoint it would perhaps have been more interesting to discuss other facts, more significant as regards repercussions, pointed out in this publication: for example the identification and placement of sequences and their limits; the location of the Barremian-Bedoulian boundary,... but BUCHEM *et alii* (2010a, 2010b) preferred the easy way out by neglecting or deliberately omitting scientific debate.

Still in the same "Special Publication" of *GeoArabia*, figure 18 of SCHROEDER *et alii* (2010**) is a striking example of fakery or worse for it indicates that GRANIER *et alii* (2003) restrict to the Bedoulian a succession of strata that includes the Hawar, the Shu'aiba and a

portion of the Bab, although already in 2000 GRANIER had assigned to the Gargasian a part of the Shu'aiba and the Bab, a position he has maintained ever since without let up (GRANIER, 2000, 2008; GRANIER *et alii*, 2003, 2011; GRANIER & PITTET, 2010). We strongly deplore erroneous use of our findings.

** : The second author (BG) reports that "Alas" he is listed among the 6 coauthors of this SCHROEDER *et alii* (2010) contribution. Rereading of work versions, errors in evaluation, inattention,... today he can but regret what may be considered "complacency". Although the publication otherwise is not entirely without interest we cannot guarantee that all the subjects treated are sound scientifically.

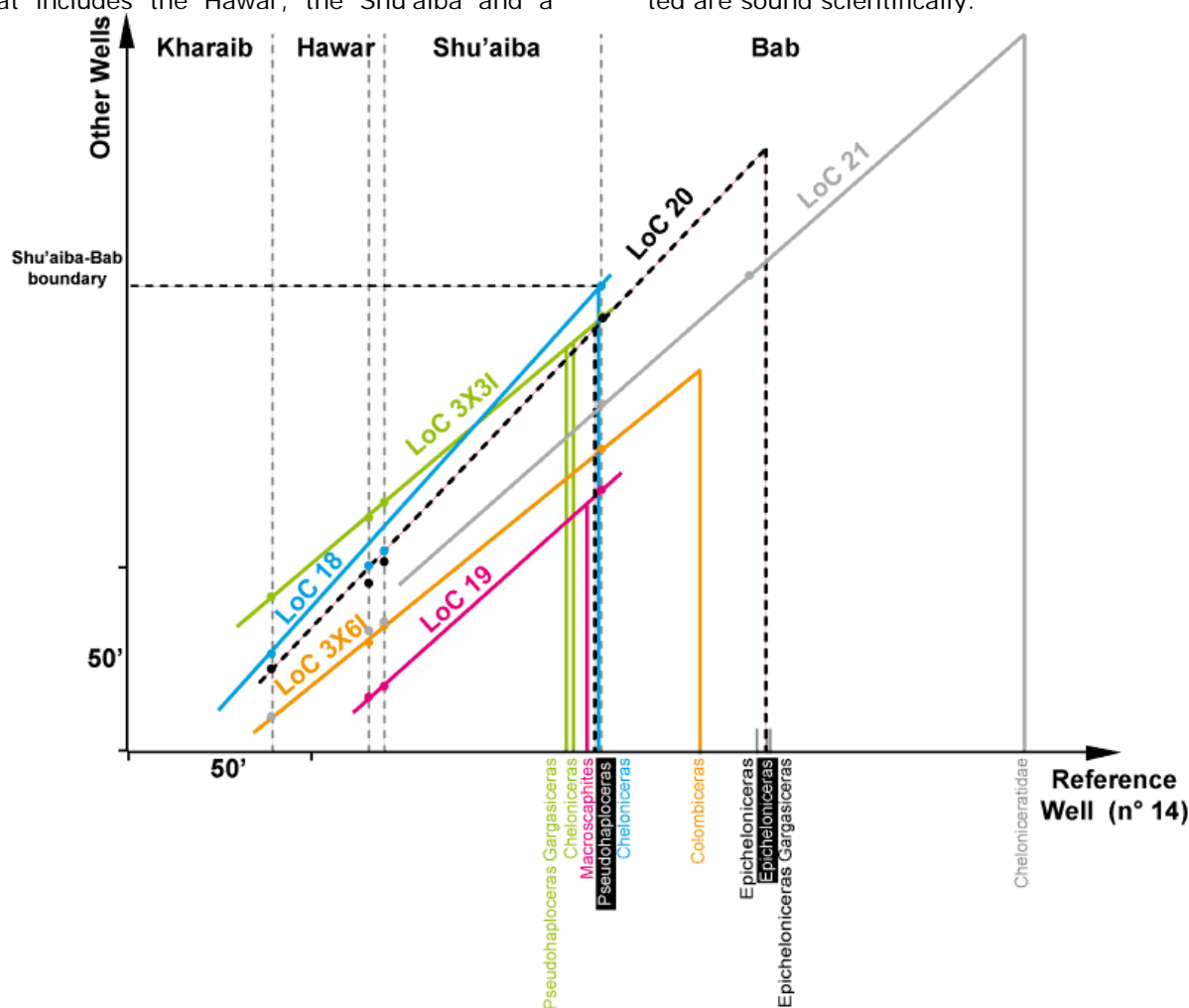


Figure 3: Lines of correlation. See text for details.

Using data from the 7 (12 in all) wells of the field "A" (N° 14 -the reference well-, 18, 19, 20, 21, 3x3i and 3x6i) in which determinable ammonites were found we can reconstitute the succession of these faunas using "Lines of Correlation": Fig. 3. The wells cross the formations (reservoirs or not) at a constant angle, different for each well, but that difference has no effect on the reconstitution. At one time the well depths of cores were converted to corresponding depths on electric logs (an adjustment of up to a few feet). Later, the well depth

of markers (limits of stratigraphic units) of one well (N° 14) chosen as a reference were plotted on the zero line of the X axis of an XY base and those of other wells were placed on the Y axis. For each well a line of correlation was drawn either passing through or as close as possible from the point of the XY projection of each well to those of the reference well. Finally, the Y axis depth of each identified ammonite is projected to the line of correlation of the corresponding well and from there along the X axis thus giving its relative position in the succession of faunas.

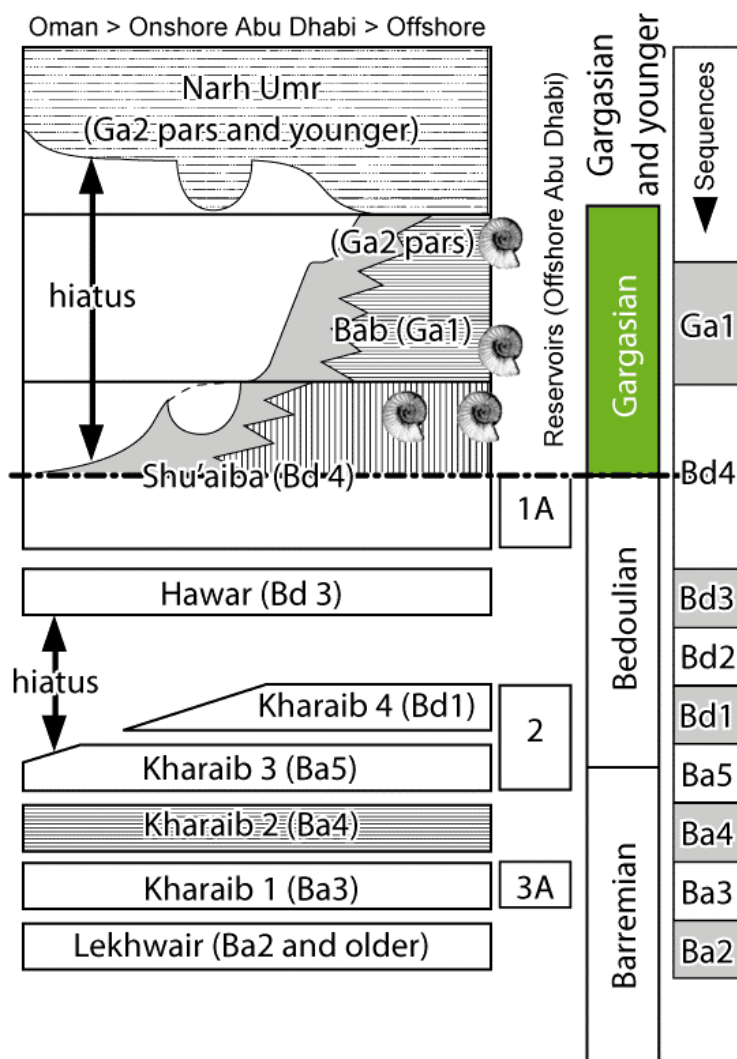


Figure 4: The regional stratigraphic framework modified from GRANIER *et alii*, 2003 (here the Hawar is measured from the top - not the bottom- and is henceforth attributed to cycle Bd3, not to Bd2). The numerations 1A, 2 and 3A are the appellations of Abu Dhabi oil-bearing levels. The next column lists "global" stages and substages; Kharaiib(-ian), Hawar(-ian), Shu'aiba(-ian) and Bab(-ian) are "regional" stage names (GRANIER *et alii*, 2011). The right-hand column gives the designations of the Urganian cycles of CLAVEL *et alii*, 2011, supplemented by some supra-Urganian cycles.

5. Conclusions

Of the ammonites presented here a part come from the lowest portion of the Bab Formation (Babian regional stage) and from its uppermost levels. The remainder are from the condensation level that represents the deposits of the HST (relative high sea level) of the Shu'aiba Formation (Shu'aibaian regional level). The new material completes previous discoveries (BANNER & WOOD, 1964; HASSAN *et alii*, 1975; AZER & TOLAND, 1993) and validates GRANIER's biostratigraphic conclusions (2000, 2008; GRANIER *et alii*, 2003, 2011): the HST of the Shu'aiba (the Bd4 HST) and that of the Bab (Ga1 and the LST of Ga2) are both Gargasian (Zone à Furcata et Zone à Martini). Neither the Bedoulian (Lower Aptian: see SORNAY, 1968-2010; MOULLADE *et alii*, 2011), nor the Clansayesian (upper Aptian *sensu gallico*, uppermost Aptian *sensu anglico*: see FABRE-TAXY *et alii*, 1965; SORNAY, 1968-2010; MOULLADE *et alii*,

2011) were recognized in the ammonite fauna. This publication with its material figured, along with a graphic calibration of their occurrences, should put an end to speculation about the age of the Bab and of a part of the Shu'aiba.

Acknowledgments

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Version française

1. Introduction

De récentes publications (GRANIER, 2000, 2008 ; GRANIER *et alii*, 2003, 2011 ; GRANIER & PITTET, 2010) ont rassemblé, éclairci et daté les formations infra-crétacées (Série régionale du Kahmah, Groupe du Thamama) des Émirats Arabes Unis et des pays voisins (Oman, Qatar, ...). Des ammonites avaient été signalées dans des forages pétroliers du domaine maritime d'Abou Dabi et nommément du champ d'Umm Shaif (BANNER & WOOD, 1964 ; HASSAN *et alii*, 1975 ; AZER & TOLAND, 1993 ; GRANIER, 2000). Ainsi, dans le puits Umm Shaif N° 2, C.W. WRIGHT (1959, inédit, *in* GRANIER, 2000) rapportait à la base de la Formation Bab la présence de "*Chelonicer* (*Epicheloniceras*) sp. indet." et celle de "*Colombiceras cf. caucasicum* LUPPOW", respectivement aux cotes -5802' et -

5820', et, dans le puits N° 3, M. HOWARTH (1992, inédit, *in* GRANIER, 2000) mentionnait au toit de la Formation Shu'aiba la présence de "cf. *Pseudohaploceras* sp. indet." et celle de "*Diadochoceras* sp." respectivement aux cotes -5864' et -5866'. Ces ammonites indiquent le Gargasien (Aptien moyen *sensu gallico* ; partie inférieure de l'Aptien supérieur *sensu anglico* : voir MOULLADE, 1965 ; SORNAY, 1968-2010 ; MOULLADE *et alii*, 2011). Nous n'avons pu réviser le matériel étudié par C.W. WRIGHT et M. HOWARTH (Natural History Museum de Londres), mais nous avons pu étudier du matériel déposé à la Faculté des Sciences de Lyon (FSL) et provenant pour l'essentiel du champ "A" (GRANIER *et alii*, 2000). L'originalité des récoltes (il est exceptionnel de trouver des ammonites issues de carottes de forage) et leur éloignement par rapport aux sites traditionnels méritaient les quelques notes paléontologiques qui suivent.

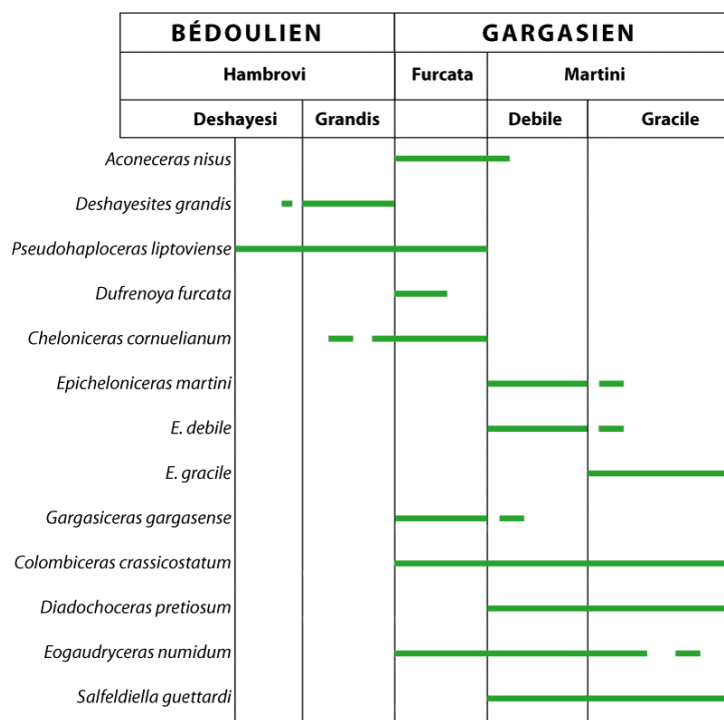


Figure 1 : Distribution des principales ammonites aptiennes à la limite des sous-étages Bédoulien-Gargasien d'après DUTOUR (2005), modifiée.

2. Matériel et méthode

Le matériel provient de forages du domaine maritime d'Abou Dabi : 7 forages du champ "A" (5 autres forages du même champ n'ont pas fourni du matériel de qualité et en quantité suffisantes pour permettre une identification) et un du champ "B" ont livré de nombreuses petites ammonites. Elles ont été difficilement extraites de fragments de carottes: elles sont cassées, tronçonnées, morcelées et donc difficile à visualiser dans leur morphologie complète. Ces coquilles minces et fragiles, souvent brisées, sont fréquemment associées à des débris de gastéropodes et de mollusques bivalves. Parmi ces derniers on notera de multiples

Astartes (Astarte obovata SOWERBY) de l'Aptien méditerranéen (GILLET, 1924). Cette forme abonde dans les couches du Barrémien supérieur et de la base du Bédoulien (Aptien inférieur) du stratotype de La Bédoule (près de Cassis). Deux photographies de GRANIER *et alii* (2003 : Figs. 13 - 14) montrent bien l'aspect et l'abondance de ces petits fossiles ainsi que l'association ammonites – bivalves – foraminifères dans ce milieu de vase fine. Il est intéressant de noter la répartition stricte et précise des céphalopodes associés à des foraminifères planctoniques (GRANIER *et alii*, 2003 : Fig. 7).

De ce calcaire homogène et fin, il est très difficile d'extraire ces petites ammonites au test fragile, presque indissociable de la matrice sédimentaire. Nous avons essayé la méthode de

dissolution différentielle à l'acide acétique pur. Mais, probablement en raison d'un sédiment trop calcifié, cette méthode n'a pas fonctionné. Pas plus d'ailleurs que la méthode des brusques variations de température (froid-chaud). Finalement, les fragments fossilifères ont été extraits par écrasement plus ou moins orienté de chaque morceau de carotte. Il en résulte des coquilles toujours incomplètes au sein d'un sédiment pulvérisé.

3. Description paléontologique

L'examen d'une vingtaine de fragments calcaires extraits de carottes de forages a permis de mettre en évidence six genres d'ammonites qui sont par ailleurs bien connus. Par contre, la détermination spécifique restait délicate soit en raison du mauvais état du matériel, soit en raison de sa nouveauté. En première approximation (GRANIER *et alii*, 2003), les genres suivants avaient été reconnus : *Chelonicerases*, *Epicheloniceras*, *Valdedorsella*, *Colombiceras* et *Gargasicerases*. Le genre *Valdedorsella* avait été confondu avec le genre *Pseudohaploceras*, confusion fréquente par l'ornementation.

Liste des échantillons étudiés :

Puits Champ	Intervalle	Taxons	N° FSL	Illustration (Pl. 1)
3X3I	HST du Shu'aiba	<i>Chelonicerases</i> sp.	105 435	
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 432	Fig. 1
		<i>Pseudohaploceras</i> sp.	105 434	Fig. 3 & 9
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 433	Fig. 2a, 2b
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 436	Fig. 5a, 5b
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 437	
3X6I	LST1 du Bab	<i>Gargasicerases</i> sp.	105 438	Fig. 6a, 6b
14	TST du Bab	<i>Colombiceras</i> sp.	105 443	
		<i>Gargasicerases</i> sp.	105 445	
		<i>Epicheloniceras</i> sp.	105 446	Fig. 7a, 7b
18	HST du Shu'aiba	<i>Epicheloniceras</i> sp.	105 450	
		<i>Chelonicerases</i> sp.	105 439	Fig. 10
19	HST du Shu'aiba	<i>Macroscaphites</i> sp.	105 440	
		<i>Macroscaphites</i> sp.	105 441	
20	HST du Shu'aiba	<i>Pseudohaploceras</i> sp.	105 442	
		<i>Epicheloniceras</i> sp.	105 447	Fig. 11
		? <i>Chelonicerases</i> sp.		
21	LST2 du Bab	Cheloniceratidae	105 449	
		<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 448	Fig. 4
0X2I	?HST du Shu'aiba	<i>Pseudohaploceras</i> <i>liptoviensis</i>	105 448	Fig. 4
4	B HST du Shu'aiba	<i>Colombiceras</i> sp.	105 444	Fig. 8a, 8b

Le matériel est déposé à la Faculté des Sciences de Lyon (FSL).

L'âge de ces ammonites est apporté après l'examen de diverses coupes du Sud-Est français, tout particulièrement d'après les résultats obtenus par DUTOUR (2005) et aussi d'après l'expérience personnelle du premier auteur (RB). Le tableau ci-joint (Fig. 1) rassemble les durées de vie des principales espèces d'ammonites à la limite Bédoulien-Gargasien. Les genres *Chelonicerases* et les *Gargasicerases* appartiennent à la Zone à *Furcata* (la première du Gargasien) ; le genre *Epicheloniceras* caractérise la Zone à *Martini* (la seconde du Gargasien). Quant aux genres *Pseudohaploceras* et *Colombiceras*, ils évoluent sur une plus grande longévité.

Les dimensions D, E, H et O correspondent respectivement au diamètre maximal, à l'épaisseur du tour, à la hauteur du tour et au diamètre de l'ombilic (en mm).

Famille des Desmoceratidae

ZITTEL, 1895

Genre *Pseudohaploceras*

HYATT, 1900

Espèce type: *Ammonites liptoviensis* ZEUSCHNER, 1856

L'espèce *A. liptoviensis* nommée par ZEUSCHNER (1856, p. 137) a été ultérieurement abondamment décrite et admirablement illustrée par UHLIG (1883) sous le nom de *Haploceras liptoviense* (p. 229, Pl. XVII, figs. 9 et 16-18 ; Pl. XVIII, figs. 1, 3 et 5-6). C'est l'exemplaire XVIII - 1 qui a été diffusé en tant que espèce-type du genre *Pseudohaploceras* (voir C.W. WRIGHT, 1996, p. 73, Fig. 52, 3a-b). Nous redonnons ici la copie de cette illustration (Pl. XVIII, fig. 1) associée à celle de la Pl. XVII, fig. 18, laquelle montre bien les tours internes. On pourra ainsi mieux apprécier les comparaisons avec les individus d'Abou Dabi. Cette faune de Silésie (SW

de la Pologne), étudiée par UHLIG, revue par VASICEK (1972), est d'âge Barrémien supérieur - Aptien inférieur, sans plus de précision. On notera que le genre *Pseudohaploceras* est d'une grande longévité, inhabituelle parmi les ammonites crétacées. Elle recouvre vraisemblablement plusieurs lignées évolutives, par exemple les formes du Gargasien de Blieux (FALLOT, 1920 ; THOMEL, 1980) n'ont pas le même aspect que les formes de Silésie. Involution et costulation varient également beaucoup d'une espèce à l'autre. On dénombre actuellement une vingtaine d'espèces rapportées à ce genre. La différenciation générique reste parfois délicate avec les genres proches tels que *Valdedorsella*, *Puzosia*, *Melchiorites*, *Zuercherella*, etc. Dans certains cas, il est important de connaître l'âge à l'aide des ammonites associées afin d'éviter les diachronismes.

Pseudohaploceras liptoviense (ZEUSCHNER, 1856)

Références (partielles) :

- 1856 - *Ammonites liptoviensis* ZEUSCHNER, p. 181, Pl. II, figs. 1a-c, 2a-b et 3a-b
- 1883 - *Haploceras liptoviensis* (ZEUSCHNER).- UHLIG, p. 229, Pl. XVII, figs. 9 et 16-18 ; Pl. XVIII, figs. 1, 3 et 5-6
- 1920 - *Puzosia liptoviensis* (ZEUSCHNER).- FALLOT, p. 259, Fig. 21, Pl. 1, figs. 5-6
- 1972 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- VASICEK, p. 78, Pl. XIV, fig. 4
- 1980 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- THOMEL, p. 121, fig. 242
- 1994 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- GONZALES-ARREOLA, p. 38, Pl. 4
- 1996 - *Pseudohaploceras liptoviense* (ZEUSCHNER).- WRIGHT, p. 73, Fig. 52, 3a-b
- 2004 - *Pseudohaploceras*.- BOGDANOVA & HOEDEMAEKER, p. 223
- 2005 - *Pseudohaploceras liptoviensis* (ZEUSCHNER).- DUTOUR, p. 126, Pl. 13, figs. 1-5

Matériel :

FSL 105 432 - Pl. 1, fig. 1 : Bloc calcaire gris beige incluant une demie ammonite calcitisée, quelque peu brisée. D=21, H=9, E=12. Section arrondie. Ombilic assez fermé. Quatre fortes côtes, irrégulièrement espacées, rectilignes, traversent les flancs ; elles s'affaiblissent à peine sur la zone siphonale. Entre les côtes, de fines costules apparaissent sur le haut des flancs.

FSL 105 433 - Pl. 1, figs. 2a-b : Ammonite dégagée comportant un peu plus d'un tour. D=28, E=10, H=11. Section un peu plus haute que large, avec des flancs presque aplatis. Costulation très vigoureuse avec de fortes côtes rectilignes traversant les flancs et s'affaiblissant un peu sur l'aire siphonale. Sur ce demi tour, on compte 9 côtes principales entre lesquelles, et du côté externe seulement, s'intercalent 2 à 3 fines costules. Cet échantillon est certainement le meilleur représentant de la faune d'Abou Dabi. Malheureusement il s'agit d'un fragment insuffisant pour permettre la création

d'une nouvelle espèce. En particulier on ne connaît pas la partie adulte.

FSL 105 434 - Pl. 1, figs. 3 et 9 : Fragment d'un tiers de tour d'une petite ammonite bien dégagée D=21, E=11,5, H=9,2. La costulation est assez isomorphe, laissant cependant apparaître quelques rares côtes plus fortes sur les flancs. Pas de différenciation sur l'aire siphonale. Section arrondie, un peu surbaissée.

FSL 105 436 - Pl. 1, figs. 5a-b. Environ une moitié d'ammonite calcitisée et son empreinte (Pl. 1, fig. 5a). D=27, E=9, H=11. Section arrondie, à peine plus haute que large. Tour interne visible depuis D=environ 5 mm avec 5 à 6 fortes côtes irrégulièrement espacées et faiblement sinueuses. Le dernier demi tour comporte 8 côtes principales. Pas de côtes intermédiaires au début des tours, mais 4 à 6 fines costules intermédiaires apparaissent ensuite sur le haut des flancs. La costulation traverse l'aire siphonale sans affaiblissement notable. On trouve ce type d'ornementation chez l'espèce *P. liptoviense* figurée par UHLIG, Pl. XVII, fig. 18, que nous avons reproduite ici (Fig. 2.B) à titre de comparaison. Cette affinité nous autorise, pour le moment, à rapprocher, voire à identifier, les échantillons d'Abou Dabi (É.A.U.) avec ceux de UHLIG (Silésie, SW de la Pologne).

FSL 105 437 - Petit fragment représentant un quart de tour d'ammonite E=8,2, H=8. Section arrondie. Quelques côtes principales irrégulières et 5 à 6 costules intermédiaires sur le haut des flancs. Bien que très fragmentaire l'ornementation de cette ammonite correspond à celle des *Pseudohaploceras*.

FSL 105 442 - Calcaire gris micritique. Traces de petits bivalves et d'une ammonite calcitisée. Section arrondie, ornementation de *Pseudohaploceras*.

FSL 105 448 - Pl. 1, fig. 4 - C'est la plus grande ammonite du lot. D=49, H=21, E ? - Ammonite calcitisée, très abîmée, ne montrant qu'une partie de l'ornementation. Sur le tour interne, on discerne les grosses côtes déjà observées sur l'échantillon N° 105 436. Ensuite, on retrouve les côtes principales irrégulièrement espacées et les costules intermédiaires caractéristiques du genre. Sur la partie terminale la costulation débute dès le rebord ombilical puis elle devient flexueuse avec présence de sillons. Il est vraisemblable que cette partie de la costulation n'était guère visible sur les échantillons précédents car ceux-ci sont trop juvéniles. Les *P. liptoviensis* de FALLOT (Gargasien de Blieux, 1920) nous semblent différents. Leur costulation est faible, presque effacée : les constrictiones sont peu prononcées et sinueuses. S'agit-il d'une espèce vraiment différente par rapport à celle d'Abou Dabi ? Cela nous semble probable mais nécessiterait une révision de plus grande ampleur avec un matériel plus étoffé pour en décider. Il en est de même des faunes longuement décrites par FALLOT (1920), et par DUTOUR (2005), ainsi que celles récoltées et dé-

