Early Jurassic (Sinemurian to Toarcian) ammonites from the central High Atlas (Morocco) between Er-Rachidia and Rich

Markus WILMSEN¹, Joachim BLAU², Christian MEISTER³, Mohammed MEHDI⁴ & Fritz NEUWEILER⁵

Abstract
This paper presents new biostratigraphic data based on a Sinemurian to Toarcian ammonite succession from the central High Atlas (Morocco) between Er-Rachidia and Rich. The ammonite fauna consists of 20 taxa belonging to the families Lytoceratidae NEUMAYR, 1875, Arietitidae HYATT, 1874, Oxynoticeratidae HYATT, 1875, Echioceratidae BUCKMAN, 1913, Eoderoceratidae SPATH, 1929, and Hildoceratidae HYATT, 1867. Within the Liasic succession, the ammonites preferentially occur at levels which indicate deepening episodes (e.g., Obtusum Zone, late Raricostatum to Jamesoni zones, Margaritatus Zone, late Domerian/early Toarcian). In the range of some uncertainties, most of these levels can be correlated with the NW European standard zonation. The ammonite data serve for discussion of the extent of diachronism of boundaries of lithostratigraphic units, which may vary chronostratigraphically at the scale of a substage on relatively short distances (10-20 km). Furthermore, the ammonite data now allow to precisely correlate sections in order to elucidate the tectono-eustatic and sedimentary evolution in the studied basin transect.

Key words
Jurassic, Liassic, central High Atlas, Morocco, ammonites, systematic palaeontology, biochronologic correlation.

Résumé
De nouvelles données biostratigraphiques reposant sur une faune d’ammonites d’âge Sinémurien à Toarcien du Haut-Atlas central entre Errachidia et Rich (Maroc) sont présentées ici. Cette faune est composée de 20 taxons appartenant à plusieurs familles : les Lytoceratidae NEUMAYR, 1875, Arietitidae HYATT, 1874, Oxynoticeratidae HYATT, 1875, Echioceratidae BUCKMAN, 1913, Eoderoceratidae SPATH, 1929, et Hildoceratidae HYATT, 1867. Ces ammonites proviennent préférentiellement des niveaux d’approfondissement qui correspondent par exemple à la Zone à Obtusum, à la partie supérieure de la Zone à Raricostatum jusqu’à la Zone à Jamesoni, à la Zone à Margaritatus et au Domérian supérieur/Toarcien inférieur. Ces niveaux à ammonites sont corrélables, à quelques incertitudes près, avec la zonation standard du Nord-Ouest de l’Europe et offrent une bonne base de discussion sur le degré du diachronisme des limites entre les différentes unités lithostratigraphiques. En effet, ces limites peuvent varier chronostratigraphiquement à l’échelle parfois d’un sous-étage et sur des distances relativement courtes (10 à 20 km). De plus, les corrélations entre les différentes coupes permettent, grâce aux ammonites, une compréhension de l’évolution tectono-eustatique et sédimentaire de la région étudiée.

Mots-clés
Jurassique, Liassique, Haut-Atlas central, Maroc, ammonites, systématique, corrélation biochronologique.

1 Institut für Paläontologie der Universität, Pleichervall 1, D - 97070 Würzburg, Germany. e-mail: m.wilmsen@mail.uni-wuerzburg.de
2 Institut für Paläontologie, Loewenichstrasse 28, D - 91054 Erlangen, Germany. e-mail: joachim.blau@geol.uni-erlangen.de
3 Muséum d’Histoire Naturelle de Gènève, Département de Géologie et de Paléontologie, 1 Rte de Malagnou, cp 6434, CH - 1211 Gènève, Switzerland. e-mail: christian.meister@nhm.ville-ge.ch
4 Université Ibn Tofail, Faculté des Sciences, Département de Géologie, B.P. 133, Kénitra, Maroc.
5 Göttinger Zentrum für Geowissenschaften (GZG), Abteilung Geobiologie, Georg-August-Universität Göttingen, Goldschmiedstr. 3, D - 37077 Göttingen, Germany.
1. INTRODUCTION

Lower to Middle Jurassic strata are widespread and superbly exposed in the central High Atlas, Morocco. Easy access to the rocks is provided in the eastern part between Midelt and Er-Rachidia (Fig. 1), where National road P21 crosses the mountain chain. In addition, between Rich and Er-Rachidia, the Ziz river (Oued Ziz) cuts into the succession, exposing expanded sections in deeply entrenched gorges. For such reasons, the area was repeatedly investigated by several workers (e.g., EVANS & KENDALL, 1977; DU DRESNAY et al., 1978; BERNASCONI, 1983; BREDE & HEINITZ, 1986; NEUWEILER et al., 2001), mainly focusing on features such as deep water limestones, sponge “reefs”, or structural geology. WARME (1989) and LACHKAR (2000) presented tectono-sedimentary models to explain the complex facies development of the Jurassic of the studied transect. However, biostratigraphic data are still scarce and the static application of lithostratigraphic subdivisions elaborated in neighbouring areas repeatedly led to miscorrelations. For example, the Aberdouz Formation at Tunnel de la Légion (section 2 in Figs 1 and 2) was assigned to the Upper Sinemurian by LACHKAR (2000) based on correlation with its stratotype; however, it is of latest Sinemurian to Early Carixian age as shown by ammonite data presented herein.

This study refers to four sections (Fig. 1), namely Foum Tillicht (no. 4), Foum Zidet (no. 3), Tunnel de la Légion (no. 2) and between Ait-Athmane and Amzouj (no. 1). All sections were measured bed-by-bed and ammonites

Fig. 1: Locality map of the southern part of the central High Atlas between Midelt and Er-Rachidia. Investigated sections are numbered from 1 to 4 (see text).
were mostly collected in situ; where found loose, they usually can be referred to certain thin intervals of strata. Due to the enormous thickness of the succession (in part more than 1,000 m of Sinemurian to Pliensbachian strata) and rapid lateral facies changes, ammonite data are crucial for the establishment of a chronostratigraphic framework and correlation of sections. However, ammonites are rare and only a few papers were published so far dealing with the ammonite fauna of the Liassic succession between Er-Rachidia and Midelt (e.g., DUBAR, 1961; DUBAR & MOUTERDE, 1978; RAKUS, 1991, 1994; LACHKAR et al., 1998). The aim of the present contribution is the documentation of an Early Jurassic (Sinemurian to Toarcian) ammonite fauna collected from the area between Rich and Er-Rachidia in order to precise the dating of changes of facies along a proximal/distant transect and to increase our understanding of the sedimentary dynamics and basin evolution.

2. GEOLOGICAL SETTING

The central High Atlas area forms part of an inverted rift basin filled with Triassic to Jurassic sediments (e.g., JACOBSHAGEN, 1988). The basin developed in response to widespread Triassic/Jurassic intra-continental rifting related to the opening of the Atlantic system and westward-proceeding enlargement of the Tethyan Realm (e.g., MANSPEIZER et al., 1978; GUIRAUD, 1998). The approximately E/W-trending central High Atlas Rift developed between the stable Sahara Craton in the south and the rifted blocks of the Oran Meseta and the Moroccan Meseta in the north. Balanced cross-sections (BEAUCHAMP et al., 1999) suggest an original basin width of ca. 110 km for the central High Atlas Seaway. The basin fill records a complete transgressive-regressive megacycle bounded by continental red beds of Late Triassic and Late Mid-Jurassic (Bathonian?) age, embracing in between a succession of marine, predominantly calcareous sediments ranging from the Hettangian to the Bajocian or Bathonian. The Hettangian to Toarcian succession documents the retrogradational (transgressive) hemicyclic deposition during crustal extension and rapid thermo-tectonic subsidence, whereas the Middle Jurassic (Aalenian to Bathonian) succession indicates the infilling (progradational) part after the cessation of extension, culminating in the deposition of continental sediments. The complete basin fill can attain an enormous thickness of up to 7,000 to 12,000 m (e.g., STUDER & DU DRESNAY, 1980; BEAUCHAMP et al., 1999). Basin inversion during the Tertiary (e.g., POISSON et al., 1998) mainly via compression led to the formation of an intra-continental mountain belt. Lateral shortening by ca. 30% (BEAUCHAMP et al., 1999) generated a sub-parallelly orientated structural pattern of narrow anticlinal ridges/reverse fault zones and broad intervening synclinal areas. The anticlinal ridges usually comprise the best exposures of the Lower Jurassic succession.

3. LITHOSTRATIGRAPHY

In the central High Atlas, the Lower Jurassic succession overlying the continental Triassic to (?)Hettangian red beds and dolerites ("dry-rift" sediments of WARME, 1989) are commonly subdivided using the lithostratigraphy of STUDER (1987), erected for the Tournif-Tirhist area, several tens of kilometers to the west of the investigated transect. This lithostratigraphy was also applied by LACHKAR et al. (1998) and LACHKAR (2000) for the succession in the study area albeit the authors mentioned serious problems in separating individual formations. This is in part caused by the very inconsistent approach of STUDER’S (1987) lithostratigraphy: on one hand, he combined lithologically completely different units in one formation (i.e., the Idikel Formation). On the other hand, he gave very narrow definitions for other formations (e.g., the Abergou Formation), making it very difficult to include lateral lithostratigraphic equivalents characterized by only moderate facies changes. Therefore, a revised lithostratigraphy is proposed by MEHDI et al. (submitted) which is followed here (Fig. 2).

Restricted marine sedimentation commenced with the deposition of massive to thickly bedded dolomites and limestones of the Idikel Formation ("dolomies et calcaires massifs d'Idikel" of STUDER, 1987), generally assigned to the Sinemurian (see Fig. 2). The facies of the Idikel Formation (primary dolomites and dark-coloured mudstones, fenestral fabrics, impoverished fauna) indicates a restricted, marginal marine environment and it can attain a thickness of up to 300 m. In the central part of the basin, the Idikel Formation is followed by the Foum Zidet Formation (MEHDI et al., subm.), characterized by dark coloured, bioclastic limestones rich in brachiopods and crinoids and the development of extensive sponge mounds (NEUWEILER et al., 2001). The formation records open, in part even deeper marine conditions and can attain a thickness of up to 300 m. Formerly, it was included by STUDER (1987) in the upper part of the Idikel Formation. However, it is a laterally extensive, mappable and lithologically clearly distinct unit. The Foum Zidet Formation, defined at the stratotype at Foum Zidet (Fig. 1, section 3) ranges from the upper part of the Lower Sinemurian up into the Carixian and is characterized by a highly diachronous upper boundary over very short distances (Fig. 2). Therefore, in the anticlinal ridge of Foum Tillicht, ammonites collected
from the base of the Ouchbis Formation give ages of middle Late Sinemurian (Oxynotum Zone) to Early Carixian (Jamesoni Zone) on a transect of a few hundreds of metres. Mapping of the ridge showed the highly irregular upper boundary of the Foum Zidet Formation; depressions were filled with Upper Sinemurian rhythmites of the Ouchbis Formation, whereas laterally, sponge mounds of the Foum Zidet Formation continued to grow into the Carixian (see NEUWEILER et al., 2001; Fig. 2). The Foum Zidet Formation is laterally replaced or overlain by the Aberdouz Formation in the more proximal areas, and the Ouchbis Formation in the central parts of the basin (Fig. 2). The Aberdouz Formation ("calcaires lites de l’Aberdouz" of STUDER, 1987) is characterized by bedded, fine-grained limestones yielding scarce macrofossils (ammonites, brachiopods, bivalves), some foraminifera and calcareous algae, indicating an open marine environment. Locally, slumps, debrites and oolitic intercalations may occur and chert is common. The age of the Aberdouz Formation is commonly given as Late Sinemurian (Lotharingian) and it may range into the Carixian. Its thickness is between 50 and 200 m but it may pinch out completely towards the basin centre. It is overlain or laterally replaced by the well-bedded, rhythmic succession of the Ouchbis Formation ("alternance calcaéo-marnése de l’Ouchbis" of STUDER, 1987). This unit consists of a monotonous succession of decimetric limestones (usually dark grey to black mudstones) with thin (1-10 cm) intercalations of marl or marly limestone indicating a hemipelagic, basinal setting. Locally, calcareous turbidites and debris flow

Fig. 2: Synoptic chrono-lithostratigraphic scheme for the Lower Jurassic succession in the studied area (cf. MEHDI et al., submitted). Numbered ammonite symbols indicate ammonite levels which are referred to in the systematic description.

![Diagram](image-url)
Early Jurassic (Sinemurian to Toarcian) ammonites from the central High Atlas (Morocco) 153

deposits may be present. Apart from rare ammonites, it is poorly fossiliferous. The formation can attain a maximum thickness of 1.000 m (e.g., near Tunnel de la Légion; LACHKAR, 2000) and it can range from the Upper Sinemurian to the uppermost Pliensbachian/Lower Toarcian. The Ouchhis Formation is overlain by a marly unit with thin limestones regarded as a lateral equivalent of the Tagoudite Formation (“gres calcaires et marnes gréseux de Tagoudite” of STUDER, 1987). This unit is often poorly exposed and relatively thin (usually a few tens of metres). It records an increased input of siliciclastic material into the basin, probably related to tectonic instability around the Domerian/Toarcian boundary (POISSON et al., 1998; ETTAKI et al., 2000). The Tagoudite Formation is Early Toarcian in age and overlain by well-bedded marly limestones and marls of the Agoudim Formation (“marnes et marno-calcaires d’Agoudim” of STUDER, 1987). This unit reflects deposition in a hemipelagic setting and may contain thin intercalated siliciclastic turbidites. It starts in the Middle Toarcian and straddles the Mid-Jurassic boundary. Its thickness can be in the order of several hundreds of metres up to a few kilometers (4500-5000 m at the type locality; STUDER, 1987: 82).

At the southern margin of the basin (area between Ain-Athmane and Amzouj, see Figs 1 and 2), a different succession is developed. There, a >220 m thick succession of thinly bedded limestones rich in lithiotid and megalodontid bivalves with thin intercalations of continental red beds is developed, characterized by stacked peritidal shallowing-upward cycles. These rocks represent the lagoonal part of a carbonate platform fringing the southern margin of the central High Atlas Seaway. This lithostratigraphic unit is not formally described in the working area (“calcaires à grands lamellibranches” of LACHKAR, 2000) and may be referred to as the “Chouch/Aganane Formations” (SEPTFONTAINE, 1986), defined in the western part of the High Atlas near Béni Méllal. However, in this paper it is (informally) called “Lithiotid Limestone Formation”. It appears to be of Late Sinemurian to Pliensbachian age and is overlain by a marly unit (informally) referred to as “formation de Ain-Athmane” and placed in the Early Toarcian by LACHKAR (2000). Ammonite data presented herein assign the base of this unit to the uppermost Domerian/lowestmost Toarcian. It is considered here to be a lateral equivalent of the Tagoudite and Agoudim formations.

Since, in the context of this paper, no detailed stratigraphic logs of the sections can be provided, the ammonite finds are referred to their stratigraphic positions relative the formation boundaries at the individual localities. The approximate stratigraphic horizon can be inferred from Fig. 2, where the ammonite occurrences in the lithologic successions of the four sections are indicated by the sections prefix plus the ammonite level number, counted from base to top (e.g., the section at Ain-Athmane/Amzouj has the number 1 and there is only one ammonite level; it is referred to as “ammonite level 1.1”).

4. SYSTEMATIC PALAEONTOLOGY

This chapter is only a brief palaeontological note. Therefore we do not include complete lists of synonymies but refer only to the type specimens. Taxa which where already discussed in the literature from the central High Atlas are listed in the synonymy. The material will be stored at the Muséum d’Histoire naturelle de Genève, Switzerland. The ammonite specimens were treated with black ink and magnesium oxide prior to photography.

Suborder Lytoceratina HYATT, 1889
Superfamily Lytoceratoidea NEUMAYR, 1875
Family Lytoceratidae NEUMAYR, 1875
Genus Lytoceras SUESS, 1866

Type species: Ammonites fimbriatus SOWERBY, 1817.

Lytoceras ovimollata HYATT, 1893
Pl. I, fig. 1a-c

* 1893. Lytoceras ovimollata. - GEYER, pl. 8, fig. 1a-c.
1996. Lytoceras ovimollata GEYER.- EL HARIRI, DOMMERGUES, MEISTER, SOUHEL & CHAFIKI, p. 548, pl. 67, fig. 15.

Remarks: One fragment of a Lytoceras shows a suboval whorl section. The ribs are crenulated and start to subdivide irregularly from the middle part of the flanks.

Local occurrence: The specimen was collected from the Ouchhis Formation at Foum Tillich (ammonite level 4.4). Additional ammonite occurrences (Fucinitceras sp.) indicate a Domerian age. EL HARIRI et al. indicated an early Domerian age for L. ovimollata from the High Atlas of Béni Méllal, ca. 150 km west of the working area.

Suborder Ammonitina HYATT, 1889
Superfamily Psiloceratoidea HYATT, 1867
Family Arietitidae HYATT, 1875
Subfamily Asteroceratinae SPATH, 1946
Genus Asteroceras HYATT, 1867

Type species: Ammonites stellaris SOWERBY, 1815 by secondary definition (BUCKMAN, 1911).
**Asteroceras aff. acceleratum HYATT, 1889**
*Pl. I, fig. 2a, b; Pl. II, fig. 1a, b*

aff. * 1889. *Asteroceras acceleratum.* HYATT, pl. 9, fig. 4, pl. 10, fig. 3.


**Remarks:** These large *Asteroceras* present higher than broad whorl sections. The flanks are weakly convex (nearly flat) and converge towards the venter. The keel is broad and accompanied by two sulci which persist until the adult stage. The ribs are straight and developed strongest near the middle of the flanks. On the ventrolateral part of the flanks the ribbing becomes weak to smooth, thereby bending towards the aperture. This habitus shows affinities to the *acceleratum* group, especially to the specimen figured by CASSEL (1997). However, since our specimens are ribbed throughout, they cannot be assigned to true *A. acceleratum* (see HYATT, 1889; GUERIN-FRANIAITTE, 1966) and might represent a new species.

*Asteroceras aff. acceleratum* differs from *Asteroceras confusum* by a whorl section that is clearly higher than broad and the nearly flat flanks. In *Asteroceras aff. acceleratum*, the sulci persist until the adult stage. This distinguishes the species from *Asteroceras* sp. nov. described in LACHKAR et al. (1998, figs. 5.18-19) and the specimens figured by EL HARIRI et al. (1996, pl. 67, figs. 16-18, pl. 68, figs. 1-2).

**Local occurrence:** Five specimens of *Asteroceras aff. acceleratum* were collected from the top of the *Ouchhis* Formation at Foun Tillicht (ammonite level 4.1). All *Parasteroceras* described by EL HARIRI et al. (1996) and by LACHKAR et al. (1998) are ascribed to an interval from the top of the *Obtusum* Zone up to the top of the *Oxynotum* Zone. In the present paper we follow this opinion.

**Family Oxynoticeratidae HYATT, 1875**

**Genus Gleviceras BUCKMAN, 1918**

**Type species:** *Gleviceras glevense* BUCKMAN, 1918 by original definition.

*Gleviceras* sp.

*Pl. II, fig. 3a, b*

**Remarks:** One eroded specimen is placed in *Gleviceras* because of the keeled, subectiform external area. It distinguishes from *Oxynoticeras* by the less compressed whorl section. A specific determination is not possible due to the poor preservation.

**Local occurrence:** The specimen comes from the lowermost part of the *Aberdouz* Formation (ammonite level 2.1a) at the Tunnel de la Légion (called "Foum Zabel" by some other authors), directly overlying the massive carbonates of the *Idikel* Formation at the northern tunnel mouth. The specimen was collected together with *Paltechioceras* sp. L, inferred to indicate the *Macdonelli* Subzone of the *Raricostatum* Zone (see discussion below).

**Genus Radstockiceras BUCKMAN, 1918**

**Type species:** *Radstockiceras complicatum* BUCKMAN, 1918 by original definition.

*Radstockiceras* cf. *complanosum* (SIMPSON, 1855)

*Pl. III, fig. 1*


cf. 1962. *Oxynoticeras complanosum* (SIMPSON).- HOWARTH, pl. 15, fig. 4 (= holotype).
Remarks: This *Radstockiceras* shows a strong ornamentation of subprovers, prominent ribs typical for *R. complanatum*. However, since the outer thirds of the flanks are somewhat eroded, our specimen is placed with reservation in the species.

Local occurrence: The single, wholly septate fragment was found in the lower part of the Ouchbis Formation at Foun Tlilchett (ammonite level 4.2a) associated with *Paltechioceras* cf. *tardecrescens*, indicating a *Raricostatum* Zone age (see below). *Radstockiceras* sp. was also recorded by LACHKAR et al. (1998) from Jebel Bou Hamid near Rich where it occurs mainly in the *Raricostatum* Zone.

Further records of large *Radstockiceras* sp. are from a bedding plane crowded with giant ammonites (Pl. IV, fig. 5). There, *Radstockiceras* is associated with *Paramicroderoceras* sp., inferred to indicate either the uppermost Sinemurian or already the base of the Carixian (see below).

Family Echioceratidae BUCKMAN, 1913
Genus *Paltechioceras* BUCKMAN, 1924

Type species: *Paltechioceras elictum* BUCKMAN (1924) by original definition.

*Paltechioceras* cf. *tardecrescens* (VON HAUER, 1856)
Pl. III, figs 2-5


Description: Several small, densely ribbed inner whorls (maximum diameter: 20 mm). The ribs are rursiradrate, sinuous to straight and sometimes projected on the venter. We attribute these specimens to *P. cf. tardecrescens* according to similar finds by LACHKAR et al. (1998) in a nearby section.

Local occurrence: The specimens of *Paltechioceras* cf. *tardecrescens* were collected from the lower part of the Ouchbis Formation at Foun Tlilchett (ammonite level 4.2a). The species *tardecrescens* indicates the topmost Sinemurian (e.g., BLAU & MEISTER, 2000).

*Paltechioceras* sp. 1
Pl. III, figs 6, 7

Remarks: *Paltechioceras* characterized by straight radiate ribs in the early ontogenetic stage which become prostriatate in later ontogenetic stages. The ribs are not or only weakly projected. The ventral area is rounded with only weakly developed sulci. This habitus is comparable to the morphology of earlier *Paltechioceras*, e.g., *Paltechioceras meisteri* BLAU, 1998 which occur in the Macdonnelli Subzone.

Local occurrence: Two specimens of *Paltechioceras* sp. 1 were collected from the lower part of the Ouchbis Formation at Foun Tlilchett (ammonite level 4.2a) and the lowermost part Aberdouz Formation at Tunnel de la Légiun (ammonite level 2.1a, directly overlying the *Idikel* Formation). According to the phylogenetic trend in *Paltechioceras*, a Macdonnelli Subzone age is inferred (BLAU, 1998), assigning a late Late Sinemurian age to the base of the Aberdouz Formation at Tunnel de la Légiun.

Superfamily Eoderocerataceae SPATH, 1929
Family Eoderoceratidae SPATH, 1929
Genus *Paramicroderoceras* DOMMERGUES, FERRETTI & MEISTER, 1994

Type species: *Microderoceras birchiales* ROSENBERG, 1909.

Remarks: The morphological disparity in *Paramicroderoceras* is very high and the ontogeny is only poorly known. Therefore, only a typologic treatment of the group is possible (e.g., DOMMERGUES et al., 2000). The situation is further complicated by the fact that the stratigraphic ranges are not well documented. The genus first appears in the *Raricostatum* Zone (DOMMERGUES, FERRETTI & MEISTER, 1994). In the uppermost Sinemurian, it co-occurs together with *Paltechioceras* of the Aplanatum Subzone. Since the family Echioceratidae disappears then, this group, in the Tethyan Realm, is the only element remaining and might indicate either the latest Sinemurian or earliest Pliensbachian.

*Paramicroderoceras aff. birchiales* (ROSENBERG, 1909)
Pl. III, fig. 8a, b

* aff. 1909. *Microderoceras birchiales* - ROSENBERG, pl. 13, fig. 5.

Remarks: In the literature *Paramicroderoceras* with well expressed primary and covering secondary ribs as well as two rows of tubercles are commonly attributed to *P. birchiales*. Since our single specimen has a more compressed whorl section than the type specimen, it is placed with doubt in the species.

Local occurrence: *Paramicroderoceras aff. birchiales* was collected from the Lower Ouchbis Formation at Foun Tlilchett (ammonite level 4.2b) and is inferred to characterize an interval around the Sinemurian/Pliensbachian boundary.
**Paramicroderoceras aff. nothum** (sensu FUCINI, 1898 non MENEGHINI, 1875)

Pl. III, fig. 9a, b

*aff. 1898. Microderoceras nothum MENEGHINI-FUCINI, pl. 3, fig. 1.

**Remarks:** A single fragment of a large body chamber with a subrectangular whorl section shows only prominent bituberculate primary ribs is therefore attributed with reservation to *P. nothum* (sensu FUCINI).

**Local occurrence:** The specimen was collected from the lower part of the Aberdouz Formation at the Tunnel de la Légion, ca. 15 m above the basal beds of this formation (ammonite level 2.2b) which have yielded *Pallechioceras* sp. 1. Therefore, a latest Sinemurian age cannot be ruled out since *P. aff. nothum* was recorded with *Pallechioceras* aff. *tarderecrescens* in the Apennines (DOMMERGUES et al., 1994).

Paramicroderoceras sp. type 5 sensu DOMMERGUES et al., 2000

Pl. III, fig. 10a, b

2000. Paramicroderoceras type 5.- DOMMERGUES, MEISTER, BONNEAU, CADET & FILI, fig. 8.1.

**Remarks:** The type of ornamentation of the single poorly preserved specimen is similar to that of *Paramicroderoceras* sp. type 5 sensu DOMMERGUES et al. (2000). The ornamentation differs from *P. aff. birchiiades* in being more coarse with broad, flat primary ribs. The whorl section is wider with a broadly rounded venter.

**Local occurrence:** The specimen was collected from the transition of the Foum Zidet Formation to the Ouchbis Formation at Foum Tillicht (ammonite level 4.2b). Additional specimens of *Paramicroderoceras* sp. occur on the bedding plane figured in Pl. IV, figs 2-4 associated with representatives of the genus *Radstockoceras*. *Paramicroderoceras* sp. type 5 is inferred to characterize an interval around the Sinemurian/Pliensbachian boundary.

**Genus Milloceras** WIEDENMAYER, 1980

**Type species:** *Aegoceras sellae* GEMMELLARO, 1884.

*Milloceras deficiens* (WIEDENMAYER, 1980)

Pl. V, fig. 4

1963. Coeloderceras sp.- DU DRESNAY, p. 149, pl. 2, fig. 5.

*aff. 1963. Coeloderceras sp.- DU DRESNAY, p. 149, pl. 2, fig. 5.

1963. Coeloderceras sp.- DU DRESNAY, p. 149, pl. 2, fig. 5.


**Remarks:** The quite coarse ornamentation of this evolute *Milloceras* allows an attribution to *M. deficiens* which shows an intermediate morphology between the very coarse *M. wiedenmayeri HILLEBRANDT* and the fine ornamented *M. sellae* (GEMMELLARO).

**Local occurrence:** The single specimen comes from the lower part of the Ouchbis Formation at Tunnel de la Légion, ca. 50 m above the top of the underlying Aberdouz Formation (ammonite level 2.2). *M. deficiens* was also collected by EL HARIRI et al. (1996) from the High Atlas of Béni Méllal where it occurs in the middle part of the Jamesoni Zone.

**Genus Metaderoceras**

**Type species:** *Ammonites muticus* D’ORBIGNY, 1844.

*M. muticus*? Metaderoceras sp.

Pl. V, figs 2, 3a, b

**Remarks:** Two fragments of evolute ammonites are doubtfully attributed to *Metaderoceras*. Both bear lateral straight prorsiradiate ribs which become weakened, slightly convex and more broad across the venter like in *Uptonia*, a genus sometimes confused with *Metaderoceras* in the literature.

Only one specimen (Pl. V, fig. 2) shows a row of very weak ventrolateral tubercles. The second specimen (Pl. V, fig. 3) is close to *M. meneghiniti* (FUCINI) which looses the tubercles on the body chamber.

**Local occurrence:** One specimen comes from the lower part of the Ouchbis Formation at Tunnel de la Légion, ca. 50 m above the underlying Aberdouz Formation (ammonite level 2.2). This specimen co-occurs with *M. deficiens* (see above). The second one occurred in the lower part of the Ouchbis Formation at Foum Tillicht (ammonite level 4.2b).
Superfamily Hildocerataceae HYATT, 1867
Family Hildoceratidae HYATT, 1867
Subfamily Harpoceratinae NEUMAYR, 1875
Genus Protogrammoceras SPATH, 1913

Type species: Grammoceras bassanii FUCINI, 1900.

Protogrammoceras gr. costiciliatum (FUCINI, 1900)
Pl. V, fig. 5

* 1900. Grammoceras normanianum (D’ORBIGNY) var. costiciliata.- FUCINI, pl. 7, fig. 10; pl. 8, fig. 1.
1996. Protogrammoceras gr. costiciliatum (FUCINI) - detractum (FUCINI).- EL HARI RI, DOMMERGUES, MEISTER, SOUHEL & CHAFI KI, pl. 70, figs. 20-27.

Remarks: A Protogrammoceras with moderate degree of evolution characterized by regular sinuous ribs weakly bending in the lower part of the flanc. The ventral part is pinched with two narrow keel bands. These features allow an attribution to P. gr. costiciliatum.

Local occurrence: The single specimen comes from the Ouchbis Formation at Foum Tillet (ammonite level 4.3) and indicates the late Carixian (Davoei Zone, e.g., MEISTER, 1995). The Protogrammoceras gr. costiciliatum - detractum recorded by EL HARI RI et al. (1996) from the High Atlas of Béni Mellal were likewise assigned to the late Carixian.

Genus Fuciniceras HAAS, 1913

Type species: Harpoceras lavinianum MENEGHINI in FUCINI, 1900.

Fuciniceras gr. ambiguum (FUCINI, 1900) - portisi (FUCINI, 1900)
Pl. V, fig. 6; Pl. VI, figs 1-4

* 1900. Harpoceras ? ambiguum.- FUCINI, pl. 7, fig. 6.
1900. Grammoceras portisi.- FUCINI, pl. 9, figs. 1-3.
1904. Hildoceras ambiguum FUCINI.- FUCINI, pl. 42, figs. 10-12.
1904. Hildoceras portisi FUCINI.- FUCINI, pl. 41, fig. 7-11, pl. 42, fig. 18.

Remarks: These moderately evolute specimens show a subrectangular whorl section and a tricarinate venter. The sinuous ribs are rursiradiate orientated and some of them are bifurcated near the first bend. In the adult stage the ribs become bundled, a typical feature of the genus Fuciniceras. F. portisi (FUCINI) represents the morphologic pole with less sinuous ribs which are less projected near the venter.

Local occurrence: Several specimens of Fuciniceras ambiguum - portisi were collected from the Ouchbis Formation at Foum Zidet (ammonite level 3.2). They indicate the early Domerian (Stokesi Subzone) (see GECZY & MEISTER, 1998).

Genus Neolioceratoides CANTALUPPI, 1970

Type species: Hildoceras (Lillia) hoffmanni GEMMELLARO, 1885.

Neolioceratoides gr. hoffmanni (GEMMELLARO, 1885)
Pl. VI, figs 5, 7

* pars 1885. Hildoceras (Lillia) hoffmanni.- GEMMELLARO, pl. 2, figs. 11, 13, 15 (non fig. 12).”

Remarks: The conch is evolute with a subrectangular whorl section with flanks converging towards the tricarinate venter. The strongly sinuous ribs are orientated rursiradiate and have a short basal segment giving a nearly falciform trace. The following hook is strongly bent backwards, broader and more prominent than the basal part and characterizes the species.

Local occurrence: Several specimens of N. gr. hoffmanni were collected from the base of the informal Ait-Athmane formation LACHKAR (2000) (ammonite level 1.1) in the section between Ait-Athmane and Amzouz. According to BRAGA (1983), these finds indicate a latest Domerian to earliest Toarcian age. ETTAKI et al. (2000) recorded N. gr. hoffmanni from the Domerian-Toarcian boundary of the central High Atlas of Todra-Dadès.

Neolioceratoides sp. 1
Pl. VI, figs 6a, b, 8a-c; Fig. 3


Remarks: These forms show a particularly more subrectangular whorl section and a relatively broad tricarinate venter. This habitus is quite similar to Neolioceratoides sp. described by FARAONI et al. (1994, pl. 12, fig. 3, 5) for the Central Apennines. Indeed our specimens have in common the opening of the umbilicus, the broad whorl section, the rib density and the similar plotting of the ribs. Murleyiceras ? gr. hoffmanni, as described by DUBAR & MOUTERDE (1978) from the upper Domerian northeast of d’Amellago (High Atlas, ca. 50 km WSW of the
working area), is more involute than the Neolioceratoides gr. hoffmanni (GEMMELLARIO) described herein and is placed with doubt in Neolioceratoides sp. 1.

Local occurrence: Our specimens are recorded from the base of the informal Ait-Athmane formation (ammonite level 1.1) in the section between Ait-Athmane and Amzouj. By comparison with the Italian material, our fauna indicates an Early Toarcian age.

Neolioceratoides aff. perplexum (FUCINI, 1923)
Pl. VII, figs 1a, b, 2, 3a, b, 4

* 1923. Ovaticeras perplexum.-FUCINI, pl. 14, fig. 15-18.

Remarks: Among the Neolioceratoides of level 1.1, some ex situ ammonites (Pl. VII, figs 1-4) are close to Neolioceratoides sp. 1 due to their whorl section and venter. They can be distinguished by the relatively open umbilicus and quite fine, closely spaced, and less falciform ribs. For the Southern Calcareous Alps, WIEDENMAYER (1980) described some N. perplexum (FUCINI) which differ by a wider umbilicus and a less dense ribbing.

Local occurrence: N. aff. perplexum (FUCINI) is collected from the base of the Tagoudite Formation (ammonite level 1.1) in the section between Ait-Athmane and Amzouj (informal Ait-Athmane formation of LACHKAR, 2000). They characterize most probably the Lower Toarcian as in the Alps.

Genus Harpoceras WAAGEN, 1869

Type species: Ammonites falcifer SOWERBY, 1820.

Harpoceras sp. 1
Pl. VII, figs 5-8

Remarks: Moderately involute Harpoceras with very dense, fine ornament of falcate ribs. The base of the ribs are radially orientated and strongly bent backwards at the beginning of the hook which starts at the lower third of the flanc.

Local occurrence: Several specimens of Harpoceras sp. 1 were collected from the transition of the Ouchbis Formation to the succeeding Tagoudite Formation at Foum Tillicht (ammonite level 4.5) and placed in the Early Toarcian. LACHKAR (2000) dated the transition between both formations in a section ca. 15 km to the north as Domerian-Toarcian boundary interval.

Subfamily Hildoceratinae HYATT, 1867
Genus Hildoceras HYATT, 1867

Type species: Ammonites bifrons BRUGUIÈRE, 1789 by secondary definition (BUCKMAN, 1889).

Hildoceras cf. bifrons (BRUGUIÈRE, 1789)
Pl. VII, fig. 9


Remarks: This Hildoceras is characterized by a well expressed lateral furrow separating the smooth lower
part of the flange from the relatively coarse and widely spaced ribbed upper part. The first feature distinguishes our specimen from the relatively primitive *Hildoceras* of the Sublevisoni Subzone, the latter from the more densely and finer ribbed *H. seniopolium* (BUCKMAN) which was recorded by BERNASCONI (1983) from the area of Rich. Because of the moderate preservation we place our specimen with reservation in *H. bifrons* (BRUGUIÈRE).

**Local occurrence:** The single specimen of *H. cf. bifrons* was derived from the Agoudim Formation south of the ridge of Foum Tillicht (ammonite level 4.6). It is inferred to indicate the upper part of the Middle Toarcian (Bifrons Subzone, e.g. ELMI et al., 1997).

### 5. BIOCHRONOLOGY AND CONCLUSIONS

In the range of some uncertainties, most of the ammonite levels shown in Fig. 2 can be correlated with the NW European standard zonation (Fig. 4). Based on regional comparison and data from NW Europe (e.g., GUERIN-FRANIATTE, 1966), the lowermost level characterized by *Asteroceras* aff. *acceleratum HYATT* can be correlated with the base of the Obtusum Zone of the Lower Sinemurian. The following find is that of *Parasteroceras* sp. 1 n. sp. The known total range of the genus is from the top of the Obtusum into the Raricostatum Zone. *Parasteroceras* sp. 1 n. sp. is inferred to characterize the middle part of the Upper Sinemurian (top Obtusum to top Oxynotum Zone) since all *Parasteroceras* recorded from the central High Atlas were recorded from the Oxynotum Zone.

The ammonite levels with *Paltechioceras* sp. 1 and *P. cf. tardoecrescens* (HAUER) characterize the upper part of the Upper Sinemurian (upper Raricostatum Zone). According to the phylogeny of the genus, *Paltechioceras* sp. 1 with its more "primitive" characters can be assigned to the Macdonnelli Subzone (BLAU, 1998), whereas *P. cf. tardoecrescens* clearly indicates the uppermost part of the Upper Sinemurian, i.e. the Aplanatum Subzone (BLAU & MEISTER, 2000).

The following ammonite level including common *Paramicroderoceras* is difficult to correlate with the standard zonation since the genus and its stratigraphic range are only poorly known (e.g., DOMMERMUES et al., 2000). However, it is inferred to indicate the uppermost Sinemurian to basal Carixian (Aplanatum Subzone to Taylori Subzone of the Jamesoni Zone). After its first appearance in the Aplanatum Subzone (DOMMERMUES et al., 1994), *Paramicroderoceras* characterizes the lowermost Piensbachian in the Tethyan Realm (FARAONI et al., 1996) after the disappearance of representatives of the family Echioceratidae BUCKMAN. Therefore, due to the absence of *Paltechioceras* on the bedding plane crowded with large ammonites at the top of the Foum Zidet Formation in Foum Tillicht shown in PI. IV (yielding representatives of *Paramicroderoceras* and *Radstockoceras*) this level might represent an interval including the topmost Sinemurian and the lower Carixian (Jaimesoni Zone). The occurrence of *Miloeceras deficiens* (WIEDEMAYER) can be referred to the middle and upper part of the Jaimesoni Zone (Fig. 4). The presence of this species in the lower Ouchlis Formation at Tunnel de la Légion dates the ca. 200 m thick Aberdouz Formation in this section as late Late Sinemurian (Macdonnelli Subzone) to early Early Carixian (lower to middle Jaimesoni Zone).

The next ammonite occurrences can be referred to the standard zonation with relative confidence. The first is that of *Protogrammoceras* gr. *costicillatum* (FUCINI). According to MEISTER (1995), it indicates the Upper Carixian Davoei Zone. The level with common *Fucinoceras* gr. *ambiguum* (FUCINI) – *portisi* (FUCINI) indicates the base of the Lower Domerian Margaritatus Zone, Stokesi Subzone. The level with *Neolioceratoides* gr. *hoffmanni* (GEMMELLARO) at the base of the *Ai Almame formation* indicates an interval from the uppermost Domerian (Hawkerense Subzone) into basal Toarcian (Paltus Subzone) (BRAGA, 1983). This inference coincides with records of this species from the Domerian/Toarcian boundary interval in the central High Atlas of Todra-Dadès (ETTAKI et al., 2000) if we take in account *N. gr. hoffmanni* (GEMMELLARO) only. But the presence of other *Neolioceratoides* like *Neolioceratoides* sp. 1 and *N. aff. perplexum* (FUCINI) more probably indicates an Early Toarcian age.

In the Toarcian, two ammonite occurrences are recognized. The level with *Harpoeceras* sp. 1 is broadly correlated with the Lower Toarcian Tenuicostatum Zone and the greater part of the Falciferum Zone. It dates the base of the Tagoufite Formation at Foum Tillicht as Lower Toarcian, and regional comparison indicates a position in the lower part of the substage. The single find of *Hildoceras* cf. *bifrons* (BRUGUIÈRE) from the Agoudim Formation is inferred to indicate the upper part of the Middle Toarcian (Bifrons Subzone of the Bifrons Zone).

The ammonites preferentially occur at levels which indicate deepening episodes (e.g., Obtusum Zone, late Raricostatum to Jamesoni zones, Margaritatus Zone, late Domerian/early Toarcian). The mass occurrences at the top of the Foum Zidet Formation (e.g., PI. IV) may indicate incipient condensation in the course of transgressive developments.

The new biostratigraphic data show the high degree of diachronism of lithostratigraphic units recognized in the study area (see Fig. 2). For example, the top of the Foum Zidet Formation is of early Late Sinemurian age at the type locality whereas it ranges into the Carixian at Foum Tillicht near the basin centre. Its deposition was
Fig. 4: Biochronologic correlation of the ammonite succession (* = Ragazzoni, Bertrandt, Accuratum, Meneghini and Levidorsatum subzones). The numbers indicate the ammonite levels provided in Figure 2.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TOARCIAN</td>
<td>Subzones</td>
<td>Subzones</td>
</tr>
<tr>
<td></td>
<td>Bifrons</td>
<td>Hildoceras cf. bifrons [4.6]</td>
</tr>
<tr>
<td></td>
<td>Sublevisoni</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Falciferum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elegantulatum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Semicelatum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paitus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hawkerense</td>
<td>Neolioceratoides gr. hoffmanni [1.1]</td>
</tr>
<tr>
<td></td>
<td>Apyrenum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gibbosus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subnodosus</td>
<td>Cornacaidense</td>
</tr>
<tr>
<td></td>
<td>Stokesi</td>
<td>Fucinicipas ambiguum-portisi [3.2]</td>
</tr>
<tr>
<td></td>
<td>Davoeil</td>
<td>Protogrammoceras gr. costicilliatum [4.3]</td>
</tr>
<tr>
<td></td>
<td>Capricornus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maculatum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luridum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valdani</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Masseanum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jamesoni</td>
<td>Miltoceras deficiens [2.2]</td>
</tr>
<tr>
<td></td>
<td>Brevispinapolyphorpus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taylori</td>
<td>Paramicroderoceras [2.1b/4.2b]</td>
</tr>
<tr>
<td></td>
<td>Aplanatum</td>
<td>Paltechioceras cf. tardecrencens</td>
</tr>
<tr>
<td></td>
<td>Macdonnellii</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Raricostatum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Densinodulum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxynotum</td>
<td>Parasteroceras sp. 1 n. sp. [4.1]</td>
</tr>
<tr>
<td></td>
<td>Simpsoni</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Denotatus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stellare</td>
<td>Asteroceas aff. acceleratum [3.1]</td>
</tr>
<tr>
<td></td>
<td>Obtusum</td>
<td></td>
</tr>
</tbody>
</table>
largely controlled by palaeoceanographic conditions related to the opening of the Central High Atlas Seaway (NEUWEILER et al., 2000). The most abrupt facies changes occurred in a S/N direction across synsedimentary faults, e.g. at Tunnel de la Légion, where movements of the Tizi N’Firest Fault controlled the position of the southern platform margin during the Late Sinemurian and Pliensbachian. Phases of pronounced tectonic activity were the Sinemurian/Carixian boundary interval and the latest Domerian/earliest Toarcian (see also ETITAKI et al., 2001). The latter event caused the submergence of the shallow southern platform areas followed by the deposition of widespread (hemi-)pelagic sediments in the studied transect.

ACKNOWLEDGEMENTS

Mrs. H. Schönig (Würzburg) carried out the photographic artwork and Stefanie Bullrich (Würzburg) developed the fossils - thanks to both. Francesco Macchioni (Perugia) is thanked for discussion during a stay in Geneva as well as Mohammed Etaki (Marakech), Thorsten Schäfer and Valentin Wöhling (Göttingen) for joint fieldwork. M.W., M.M. and F.N. acknowledge financial support by the German Research Foundation (DFG grant No 652/3-1).

REFERENCES


FUCINI, A. (1900) - Ammoniti del Lia medio dell’Appennino centrale esistenti nel Museo di Pisa. Paleontogr. It., 6: 17-78.


MENEGHINI, G. (1867-1881) - Monographie des fossiles du

Plate I

Fig. 1: Lystoceras ovimontanum GEYER, 1893 from the Ouchbis Formation at Foum Tillich (ammonite level 4.4); a: ventral view; b: c: lateral view.

Fig. 2: Asterocheras aff. acceleratum HYATT, 1889 from the top of the Foum Zidet Formation at Foum Zidet (ammonite level 3.1); a: lateral view; b: ventral view.

All figures in natural size.


SIMPSON, M. (1855) - The fossils of the Yorkshire Lias; described from nature. 1st edition; London and Whitby (Whittaker).

SOWERBY, J. (1812-1822) - Mineral conchology of Great Britain; or coloured figures and descriptions of those remains of testaceous animals or shells, which have been preserved at various times and depths in the earth. 1-4: 383 pls; London (Meredith).


Accepté mars 2002

Plate II

Fig. 1: Asteroceras aff. acceleratum HYATT, 1889 from the lower Ouchbis Formation at Foum Zidit (ammonite level 3.1); a: lateral view; b: ventral view.

Fig. 2: Parasteroceras sp. 1 n. sp. from the lower part of the Ouchbis Formation at Foum Tillicht (ammonite level 4.1); a: lateral view; b: ventral view.

Fig. 3: Gleviceeras sp. from the lowermost part of the Aberdouz Formation (ammonite level 2.1a) at the Tunnel de la Légion; a: ventral view; b: lateral view.

All figures in natural size.
Plate III

Fig. 1: *Radstockiceras cf. complanosum* (SIMPSON, 1855) from the lower part of the Ouchbis Formation at Fourn Tillich (ammonite level 4.2a).

Fig. 2-5: *Paltechioceras cf. tardicrescens* (VON HAUER, 1856) from the lower part of the Ouchbis Formation at Fourn Tillich (ammonite level 4.2a) (all figures x 2.0)

Fig. 6: *Paltechioceras* sp. 1 from the lower part of the Ouchbis Formation at Fourn Tillich (ammonite level 4.2a).

Fig. 7: *Paltechioceras* sp. 1 from the lowermost part of the Aberdouz Formation (ammonite level 2.1a) at the Tunnel de la Légion.

Fig. 8: *Paramicroderoceras aff. birchiades* (ROSENBERG, 1909) from the Lower Ouchbis Formation at Fourn Tillich (ammonite level 4.2b); a: lateral view; b: ventral view.

Fig. 9: *Paramicroderoceras aff. oothum* (*sensu* FUCINI, 1898 *non* MENEGHINI, 1875) from the lower part of the Aberdouz Formation at the Tunnel de la Légion (ammonite level 2.1b); a: lateral view; b: ventral view.

Fig. 10: *Paramicroderoceras* sp. type 5 *sensu* DOMMERGUES *et al.*, 2000 from the transition of the Fourn Zidet Formation to the Ouchbis Formation at Fourn Tillich (ammonite level 4.2b); a: ventral view; b: lateral view.

All figures except figs 2-5 in natural size.
Fig. 1: Bedding plane crowded with large ammonites at the top of the Foum Zidet Formation at Foum Tillicht, probably earliest Carixian in age (hammer for scale).

Fig. 2: Large ammonite (Paramicroderoceras sp.) from the bedding plane shown in Pl. IV, fig. 1 (hammer for scale).

Fig. 3: Large ammonite (?Paramicroderoceras sp.) from the bedding plane shown in Pl. IV, fig. 1 (eraser for scale).

Fig. 4: Close-up of the outer whorls of the ?Paramicroderoceras sp. of Pl. IV, fig. 3; note prominent ventro-lateral tubercles (width of picture is 10 cm).

Fig. 5: Large Radstociceras sp. from the bedding plane shown in Pl. IV, fig. 1 (coin for scale).
Plate V

Fig. 1: *Paramicroderoceras* sp. from the lower part of the Ouchbis Formation at Foum Tillicht (ammonite level 4.2b); a: ventral view; b: lateral view.

Fig. 2: ? *Metaderoceras* sp. from the lower part of the Ouchbis Formation at Tunnel de la Légion (ammonite level 2.2).

Fig. 3: ? *Metaderoceras* sp. from the lower part of the Ouchbis Formation at Foum Tillicht (ammonite level 4.2b); a: lateral view; b: ventral view.

Fig. 4: *Miltoceras deficiens* (WIEDENMAYER, 1980) from the lower part of the Ouchbis Formation at Tunnel de la Légion (ammonite level 2.2).

Fig. 5: *Protiomoceras* gr. *coticilliatum* (FUCINI, 1900) from the Ouchbis Formation at Foum Tillicht (ammonite level 4.3).

Fig. 6: *Fuciniceras* gr. *ambiguum* (FUCINI, 1900) – *portisi* (FUCINI, 1900) from the Ouchbis Formation at Foum Zidet (ammonite level 3.2) (latex cast).

All figures in natural size.
Plate VI

Fig. 1-4: *Fuciniceras gr. ambiguam* (FUCINI, 1900) – *portisi* (FUCINI, 1900) from the Ouchbis Formation at Foum Zidet (ammonite level 3.2) (Fig. 2 is a latex cast).

Fig. 5, 7: *Neolioceroides gr. hoffmanni* (GEMMELLARO, 1885) from the base of the Tagoudite Formation (ammonite level 1.1) in the section between Ait-Athmane and Amzouj (informal Ait-Athmane formation of LACHKAR, 2000) (latex cast).

Fig. 6, 8: *Neolioceroides* sp. 1 from the base of the informal *Ait-Athmane formation* (ammonite level 1.1) in the section between Ait-Athmane and Amzouj.

All figures in natural size.
Plate VII

Fig. 1-4: *Neolioceratoides aff. perplexum* (FUCINI, 1923) from the base of the Tagoudite Formation (ammonite level 1.1) in the section between Ait-Athmane and Amzouj (informal *Ait-Athmane formation* of LACHKAR, 2000).

Fig. 5-8: *Harpoceras* sp. 1 from the transition of the Ouchbis Formation to the succeeding Tagoudite Formation at Foum Tillicht (ammonite level 4.5) (Fig. 6 is x 2.0).

Fig. 9: *Hildoceras cf. bifrons* (BRUGUIÈRE, 1789) from the Agoudim Formation south of Foum Tillicht (ammonite level 4.6).

All figures except Fig. 6 (x 2.0) in natural size.