

**CONTRIBUTION TO THE GEOLOGY
AND PALEONTOLOGY OF MADAGASCAR**

The middle and upper Campanian in the Menabe and its fauna

**(Ampolipoly-Antirasira-Behamotra, Ankilizato,
Andimaka and Trangahy sections)***

BY

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SUMMARY

The present note gives the collection of results of the stratigraphic and paleontological study of the fundamental sections of the Menabe for the middle and upper Campanian. The middle Campanian comprises a lower zone with *Pachydiscus grossouvrei* with two sub-zones with *Eupachydiscus lamberti* and *Pachydiscus basseae* and an upper zone with *Delawarella subdelawarensis* and *Australiella australis*, within which several levels can be separated, in particular that of the sphenodiscid *Manambolites*. The upper Campanian, largely masked, belongs to the *Hoplitoplacenticeras marroti* (= *H. vari*) zone.

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In 1966 and 1969 I gave the complete description of some large sections produced by my work in the Menabe (Madagascar): Ampolipoly-Antirasira-Behamotra, Ampamba-Antirasira section of Bevaho, Berere I and II sections, and, additionally, other less important sections (Ampamba-Andimaka and Andimaka-Dabolava), and I provided a table bringing together the stratigraphy of the Lower Cretaceous in the Menabe.

* Original citation: Collignon, M. 1970. Contribution à la géologie et à la paléontologie de Madagasikara. Le Campanien moyen et supérieur dans le Menabe et sa faune (coupe Ampolipoly-Antirasira-Behamotra, Ankilizato, Andimaka et Trangahy). *Comptes Rendus des Semaines Géologiques de Madagascar* 1970:31-37. Translated by Matthew Carrano, Department of Anatomical Sciences, SUNY-Stony Brook, October, 2001.

NB—The table of zones, sub-zones and levels appended to the present memoir must be continually consulted for a perfect comprehension of the different sections.

These descriptions were published in the *C. R. des Semaines Géologiques de Madagasikara* in 1966 and 1969: they involved the Santonian and lower Campanian exclusively. Furthermore, in 1967 I began again the study of the Mitraiky section (North Menabe) that shows a succession of levels going from the lower Santonian to the middle Campanian.

Today, with the progression of my researches on the fossil faunas I recovered in the Menabe in 1953, 1954, and 1957, I am able to perfect my stratigraphic and paleontological studies. In particular, I can define—at least provisionally—the stratigraphy of the middle Campanian (very developed) and additionally that of the upper Campanian (restricted).

The study of the middle Campanian was made particularly in the extension of the Ampolipoly-Antirasira-Behamotra section, and principally in the Ankilizato region where this portion of the stage shows an exceptional development and a great richness of fossils. For the upper Campanian, masked to the west of Ankilizato by the sandy covering, I am led to study the rare outcrops to the north of Manambolo (North Menabe) formed by the hillocks north of Trangahy.

MIDDLE CAMPANIAN

I. The faunas

Four great families of ammonites, Desmoceratidae, Pachydiscidae, Texanitidae and Baculitidae, which exist in the Santonian and lower Campanian, persist into the middle Campanian, exceeding it and sometimes passing up into the Maastrichtian

Others play only a local role, although sometimes still very important (for example the genus *Manambolites* HOURCQ, 1949).

But also, a very particular fact, the subfamily Pseudoschloenbachiinae, which has furnished nearly 10,000 specimens in the lower Campanian, declines and then becomes extinct almost immediately at the upper limit of this sub-stage above which it is not represented any more. It is replaced in abundance by the Pachydiscidae initially which exist in great number, then by the Texanitidae and finally, in all levels, by the Baculitidae.

A. DESMOCERATIDAE

The Desmoceratidae are in decline. Only these subsist:

– some Desmoceratinae, however rare: *Desmophyllites* SPATH, 1929, which passes into the Maastrichtian; *Damesites* MATSUM., 1942, having furnished only very rare specimens entirely at the summit of the sub-stage (*Damesites* aff. *rabei* COLL.);

– in contrast, the Hauericeratinae, although much less abundant than in the lower Campanian, still have fairly numerous representatives. The type-species *Hauericeras* (*Gardeniceras*) *gardeni* BAILY is found at all levels, but it undergoes a remarkable reduction in size, sometimes important, while keeping all its other specific characters; but one never finds the very large specimens of certain lower Campanian localities. Above all, one can admit that the middle Campanian in its ensemble is still characterized by *Hauericeras gardeni* BAILY.

Here this is in lieu of citing the genus *Grandidiericeras* COLL., 1960, from the top of the middle Campanian, which has produced only two complete specimens.

B. PACHYDISCIDAE

Very abundant in the lower Campanian, with some individuals frequently of large size, the Pachydiscidae have furnished only three genera in total, *Anapachydiscus* YABE and SHIM., 1926, *Pachydiscus* ZITT., 1884 and *Eupachydiscus* SPATH, 1922.

In the middle Campanian, *Anapachydiscus* no longer exists whereas *Pachydiscus* and *Eupachydiscus* remain very abundant: in particular, at the base of the sub-stage, *Eupachydiscus lamberti* COLL. develops into beautiful specimens; at the same time *Eupachydiscus grossouvrei* KOSSM., quite as abundant, survives for a long time and is associated above with *Pachydiscus bassae* COLL.

With *E. lamberti* COLL. are also found *E. haradai* JIMBO, *Pachydiscus obermülleri* COLL., then other species that, less abundant, persist for a long time: *Eupachydiscus levyi* GROSS. arrives at the upper part of the sub-stage; *P. spissus* COLL., *P. praecolligatus* COLL., *P. praeegertoni* COLL. make a timid appearance and only become abundant later, at the top. Another species, *P. bühneri* COLL., is associated later with *Delawarella* and *Australiella* of the upper zone.

But, regarding the family Pachydiscidae, the principal fact is the appearance and development of the genus *Canadoceras* SPATH, 1922, whose specimens are found at all levels; the genus becomes very rare and disappears before the upper Campanian.

Finally, a unique specimen of *Patagosites* SPATH, 1954 must be noted; it is *P. coxi* COLL. And *Hoepenites* COLLIGNON, 1952, which is perhaps synonymous with the preceding (*H. roedereri* COLL.). These two species have not been found in the Mitraiky section.

C. TEXANITIDAE

The representatives of this family are still abundant in the middle Campanian.

It is known that *Texanites* sensu stricto has disappeared at the top of the Santonian, and that *Bevahites* (issuing from *Parabevahites* COLL. of the Santonian) has disappeared in the *Karapadites karapadensis* zone. It was replaced by *Submortonicerases* SPATH, 1921 and by *Menabites* COLL., 1948.

Submortonicerases is never abundant, but still gives very beautiful, varied specimens: among them some lose the very excavated and so elegant partition that distinguishes certain species, such as *S. spathi* COLL. and *S. franiattae* COLL., and acquires, on the contrary, massive lobes that tend to connect them to *Delawarella* and *Australiella*, subgenera strictly limited to the upper part of the sub-stage where they develop and dominate without contest. Among these ammonites with a massive first lateral lobe I preserved in *Submortonicerases*, *S. behamotrense* COLL. and *S. johanniludovici* COLL. (Pl. DCXXXIV, Fig. 2321) (Pl. DCXXVII, Fig. 2318 to 2320), which it will probably be necessary, once they are better known, to incorporate into a new subgenus.

In 1949 I created *Delawareella* and *Australiella*, considered as subgenera of *Menabites* COLL.; they were recovered in number in the formation of the Gulf Coast described by K. YOUNG in 1963.

Besides these subgenera and preceding them a little in time, I created the new subgenus *Ankilizatella*, characterized by its considerable flattening, the width of its umbilicus, the multiplication of the external tubercles becoming extremely fine and small, and by a partition with a particularly massive lateral lobe. The subgenus *Ankilizatella* then characterizes a particular level at the base of the zone with *Delawareella subdelawarensis* and *Australiella australis*.

D. BACULITIDAE

In reality, it is the family Baculitidae that, through the profusion of its representatives in all levels, has replaced the disappeared Pseudoschloenbachidae.

Baculites LAMK., 1799 was already abundant in the Santonian where I have found *Baculites capensis* WOODS and, in important numbers, its variety *tuberculata* COLL. With them, *Baculites malagasyensis* COLL., a rare species, but which will give thereafter a whole series of thick *Baculites* with a flat, wide external region.

Thus the thin *Baculites* with a narrow external region, such as *B. menabensis* COLL., *B. antsirasiraensis* COLL., *B. subtilis* COLL., and *B. cf. tanakae* MATSUM. and the thick *Baculites* with a flat external region, *B. falcatus* COLL., *B. ventroplanus* COLL. and *B. sparsinodosus* COLL., were distinguished in the lower Campanian.

These two groups of *Baculites* return in the middle Campanian, in very great numbers, and the complete study of the family will be the object of a new part of my "Neocretaceous Ammonites of the Menabe". The first group includes *B. tanakaeformis* nov. sp. and *B. androtsyensis* nov. sp. And the second: *B. increscens* nov. sp., *B. mamillatus* nov. sp., *B. coagmentatus* nov. sp., *B. leopoliensis* NOWAK, *B. rectangulatus* nov. sp., *B. ankilizatensis* nov. sp. and *B. cf. taylorensis* ADK. This second group contains the most abundant species. All are distributed in several levels more or less clearly defined for the moment. Unfortunately many of these *Baculites* are not always very well preserved.

E. OTHER GROUPS OF AMMONITES

Much less abundant forms are also found in the middle Campanian of the Menabe:

Some "unrolled" forms: it must be noted initially the persistence of *Bostrychoceras saxonicum* SCHLUT. and *B. indicum* STOL., known in the Menabe since the Coniacian. But they have become extremely rare. It seems that they disappear definitively at the top of the middle Campanian.

Then a new *Neoglyptoxoceras* appearing until now unique to northern Germany: it is *N. certa* MULL. and WOLL. *Nostoceras* is represented by very rare specimens the same as *Scaphites*, which has furnished only a single specimen of *S. bemontensis* nov. sp. *Nostoceras* persists, less rare, into the Maastrichtian, and *Scaphites* seems to disappear definitively in Madagascar.

It must be noted very particularly the most abundant ammonite at the top of the sub-stage: it is *Manambolites* HOURCQ, 1949, the sole representative of the family Sphenodiscidae, and limited to a restricted and less thick level where it accompanies *Pachydiscus*, by then having become abundant, *P. praecolligatus* COLL. and *P. praegergertoni* COLL., which announce by their form and ornamentation the Pachydiscidae unique to the top of the Arrialoor of India.

F. LAMELLIBRANCHS

As in the lower Campanian, it is above all the inoceramids that still develop throughout the sub-stage. But they are less varied and include most often only species already known in the lower Campanian: thus *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY exists throughout the lower Campanian and appears in the middle Campanian up to the *Manambolites* level. *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY, noted as the most abundant of all the species (225 specimens studied), abounds in all localities. But *I.* (*Cordiceramus*) *antsirasiraensis* SORN. further provided only rare specimens.

G. CRUSTACEANS

It is in the middle Campanian of the Menabe that the crustaceans are both the most abundant and the most diverse. One finds there *Linuparus bererensis* SECR., and its subspecies *multispinosus* SECR., and above all *Schlüteria menabensis* SECR., as abundant as in the lower Campanian, and also the most abundant of all, *Ctenocheles madagascariensis* SECR. In contrast, *Notopocorystes* has become very rare, and *Carpiliopsis* furnishes only the single specimen known from Madagascar.

The other groups of fossils, except the gastropods, are rare (Serpulidae, Echinoidea).

II. The ammonite zones and sub-zones in the middle Campanian

The middle Campanian was divided into two zones:

- the *Pachydiscus grossouvrei* zone includes the lower two-thirds of the sub-stage with two sub-zones, with *Eupachydiscus lamberti* and *Pachydiscus bassae*;
- the *Delawarella subdelawarensis* and *Australiella australis* zone, relatively thinner, which I have not subdivided, but within which I could however recognize a series of levels bearing extremely localized ammonites.

1. — *PACHYDISCUS GROSSOUVREI* ZONE

It includes two sub-zones.

Eupachydiscus lamberti sub-zone.

On the Ampolipoly-Ansirasira-Behamotra section that is extended beyond the Androtsy River, it includes localities 329 to 329 beyond kilometer 17,000-18,000. The

chaotic nature of the terrain covered with woods and marshes where the progression is difficult prevented me from continuing the evaluation of distances and thicknesses.

In contrast, the Ankilizato section, above locality 182, permitted me, with successive localities 181, 180, 179 and 178-177, to establish a fairly rigorous parallel with the preceding section and to evaluate its thickness at around 40-50 meters. On the other hand, at Andimaka (6 km north of Ankilizato—localities 203-1 and 202) I recovered the same elements of the fauna.

a. The most abundant ammonite and that which I found nearly everywhere is *Eupachydiscus lamberti* COLL. It is accompanied by numerous other ammonites, in particular *Pachydiscus obermülleri* COLL., *Pachydiscus besairiei* BASSE, and already rare specimens of *P. bassae* COLL. and *Eupachydiscus levyi* GROSS.

b. At Andimaka the main level contains *Eupachydiscus haradai* JIMBO, and a little above, a thinner level with “unrolled” forms is the locality with *Neoglyptoxoceras certa* MULL. and WOLL., whose type comes from northern Germany.

c. And everywhere, if the Texanitidae becomes rare (except *Submortonicerases*), then the Baculitidae abound: their species, represented by numerous individuals, follow one another in “nests” that often are not mixed together.

At the base, *Baculites tabakaeformis* nov. sp. exists only in localities 180-181 and 326 in the two sections. In the Ankilizato section, this *Baculites* is accompanied by *B. increscens* nov. sp., and in the two sections *B. mamillatus* nov. sp. is found.

Above *B. androtsyensis* nov. sp. and *B. coagmentatus* nov. sp. succeed them.

Pachydiscus bassae sub-zone.

The *Pachydiscus bassae* sub-zone occupies a large surface discovered around 1 kilometer wide, south of the *piste* that travels from Behamotra to Ankilizato.

a. The principal ammonite, abundant in localities 176, 153, 154 and 155, is *Pachydiscus bassae* COLL., everywhere with the thick *Baculites* that are principally *B. leopoliensis* NOWAK.

At the base of this sub-zone I have collected moreover *Eupachydiscus levyi* GROSS, which is abundant up to 155, rare *Hauericeras* (*Gardeniceras*) *gardeni* BAILY, and rare *Submortonicerases*. And also a unique *Hercoglossa*: I note that this genus, relatively abundant in the lower Campanian, becomes extremely rare here, before again undergoing an important increase.

b. A level where gastropods, small debris of crustaceans (*Ctenochilus*), serpulids and cidarid radioles develop, continues over the entire length of the section.

c. Above *Canadoceras* appears in numbers that become relatively abundant up to the top of the sub-stage.

d. The end of this is marked by the profusion of *P. bassae*.

e. Here the Baculitidae are also abundant. The most frequent is *B. leopoliensis* NOWAK and, at the top, *B. ankilizatensis* nov. sp. Unfortunately many of these *Baculites* are most often represented only by fragments as innumerable as they are indeterminate.

2. — *DELAWARELLA SUBDELAWARENSIS* AND *AUSTRALIELLA AUSTRALIS* ZONE

This is the most interesting part of the middle Campanian, which constitutes upper third, between the Behamotra-Ankilizato *piste* and another *piste* that detaches from it 3 kilometers southwest of Ankilizato, and which goes to Andimaka.

The terrain, entirely uncovered, is formed by a succession of low hills each having elements of particular faunas. In fact localities 156, 157, 158, 159 and 183 are exceeded gradually and their thickness reaches about 50 meters. The last, on the border of the Andimaka *piste* to the west of Ankilizato, is the terminal level of *Manambolites*. Beyond, the sandy covering interrupts all investigation. As I have indicated previously, I did not judge it useful to create several sub-zones in this very collected ensemble.

a. In all the localities mentioned above, two special genera abound in this zone: *Delawarella* and *Australiella*; they exist in more or less great abundance, but are present everywhere; the last specimens are associated with *Manambolites*.

b. The clarity of the partial sections raised in the Ankilizato hills permit locating particular levels with special elements of the fauna:

— *Neoglyptoxoceras* level associated with the rare genus *Grandidiericeras* COLL.

— Several levels (between 155 and 158) contain *Ankilizatella*.

— *Pachydiscus bühneri* level with some special *Submorticeras*, *S. behamotrense* nov. sp., *S. johannis-ludovici* nov. sp. Here is the decline and end of *Submorticeras*, which is distinguished by the acquisition of a massive first lateral lobe.

— Finally, along and to the east of the Andimaka *piste* the *Manambolites* level discovered by V. HOURCQ in 1933 is widely spread out.

This good representation of the Sphenodiscidae is accompanied by rare Pachydiscidae and the last Texanitidae, *Delawarella* and *Australiella* which are represented there by specimens of great size.

UPPER CAMPANIAN

To the west of Ankilizato, the Campanian is limited by the Behamotra-Andimaka *piste*; beyond, the sandy covering impedes all investigation, and only fossiliferous terrains further to the west, in the Maastrichtian of Mount Ambohitsiombe will be examined.

To find the upper Campanian, it is necessary to cross the Manambolo and traverse the *piste* that climbs toward the North from Trangahy in the direction of Antokazo (Antsalova page): it is represented along and to the west of this *piste* by a suite of small hillocks saved by erosion and hardly dominating for some meters the sandy covering in the area.

More to the north, the good Mokotibe section (Antsalova page) includes the base of an upper Campanian level surmounted by a good development of the lower Maastrichtian with echinoids.

The fauna

It is very poor and remarkably uniform. But it has the advantage of having furnished a relatively considerable number of ammonites of the genus *Hoplitoplacenticeras* SPATH 1922, among which are found some well-known species such as *H. marreti* COQ. (= *H. vari* SCHLUTER which, according to HOWARTH, lies in

synonymy) and some species known only in northern Germany, or very nearby, such as *H. cf. coesfeldiense* SCHLUT., *H. cf. costulosum* SCHLUT., *H. sp. aff. lemfördense* SCHLUT., *H. dolbergense* SCHLUT., and other species also entirely new those described by PAULCKE in Patagonia. There are also several “unrolled” forms without importance here, but which go on to be very abundant in the Maastrichtian.

In contrast, there are abundant gastropods and above all lamellibranchs that pass, also, into the Maastrichtian (*Diploschiza chavani* COLL., *Cardium subtriangulare* COTTR.), serpulids, brachiopods (*Crania*), a beautiful fauna of echinoids, and still the crustaceans known since the base of the Campanian, *Ctenochilus madagascariensis* SECR.

The stratigraphy

With such a petty fauna it was not possible to make unspecified subdivisions, more especially because the sediments are much thinner (several meters).

The ensemble was referred to a unique *Hoplitoplacenticeras vari* zone.

NB—The bibliography is given with the references incorporated into the paleontological descriptions in Atlas volume XVI.

TABLE OF STRATIGRAPHY AND DISTRIBUTION OF AMMONITES
IN THE UPPER CRETACEOUS OF THE MENABE — MADAGASCAR

MIDDLE CAMPANIAN <i>Delawarella,</i> <i>Australiella,</i> <i>Manambolites</i> <i>Canadoceras</i>	ZONES and SUB-ZONES	Ankilizato section	Ampolipoly- Antsirrasira- Behamotra section (continuation and end)	Andimaka (201-203) Ambaravaranam y (200) Mitraiky (147-148)		distribution of <i>Baculites</i>
	<i>Delawarella</i> <i>subdelawarensis</i>	183				<i>Manambolites</i> level <i>piveteaui</i> with <i>Pachydiscus praeegertoni</i> and <i>Pachydiscus praecolligatus</i>
and	159			200	<i>Submortoniceras johannis-ludovici</i>	<i>B. ankilizatensis</i> (153-159)
<i>Australiella</i>	158			203-3	<i>Pachydiscus bühreri</i> level	
<i>australis</i>	157				<i>Ankilizatella</i> level	<i>B. rectangulatus</i> (156-157)
zone	156				<i>Neoglyptoxoceras</i> and <i>Grandidiericeras</i> level (155-159)	

MIDDLE CAMPANIAN	Hauerites and Submortonieras Eupachydiscus and Pachydiscus	Pachydiscus bassae sub-zone	155			principal <i>Pachydiscus bassae</i> level	<i>B. ankilizatensis</i> (beginning: 153-159)		
			154			appearance of <i>Canadoceras</i> (from 155 to 183)			
			153			level with gastropods, serpulids and crustaceans			
			176		147-148	<i>Patagosites</i> + <i>Hoepenites</i> + <i>Eupachydiscus levyi</i> (until 155)		<i>Baculites leopoliensis</i> (177-156)	
		Pachydiscus grossouvrei zone	177				<i>B. coagmentatus</i> (177-153)		
			178	329					
			Eupachydiscus lamberti sub-zone	179	328	203-1		<i>Neoglyptoxoceras sarta</i> M. and W. level	<i>B. androtsyensis</i> (180 + 327-328-329)
				180	327	202		<i>Eupachydiscus haradai</i> JIMBO	
				181	324				
					325				
	182		201						

top of LOWER CAMPANIAN (*Termiericeras lenticulare* sub-zone)

N.B. — *Submortonieras* extends throughout the stage.

Canadoceras goes from 153 to 183.

Australiella and *Delawarella* develop in all levels from 156 to 183.