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Campanian *Inoceramus* from the Menabe Area, Southwestern Madagascar* Part I

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Introduction

In this report, we describe and discuss inoceramid species from the Menabe area collected by the junior author (Y.K.) in 1973 as part of a paleontological reconnaissance survey in Madagascar carried out by the National Science Museum, Tokyo (ASAMA, 1977).

The Menabe area in southwestern Madagascar is a famous region where occur vast numbers of Cretaceous marine mollusks. COLLIGNON (1932, 1937, 1948, 1955a, b, 1956, 1961 etc.) described numerous ammonite species, whilst geological investigation were carried out at the same time (HOURCQ, 1956; Service Géologique de Madagascar, 1958). Inoceramid species co-occurring with ammonites from this area were described by SORNAY (1962, 1964, 1968, 1969, 1973, 1975, 1976).

We do appreciate the distinguished achievements made by Dr. SORNAY in the study of inoceramids from Madagascar, it is, however, our first experience to deal with specimens themselves from Madagascar. We attempted to sort them through our own procedures. Though this study we have noticed some questions about the extent of variation and relationships of species and also about the definition of subgenera, but our collection is not yet sufficient to discuss fully the problem. Therefore, we tentatively follow the taxonomy of SORNAY, so as to report the results of our sorting of the specimens collected.

In this study the basic field work was done by the junior author (Y.K.) and the laboratory work was primarily carried out by the senior author (M.N.).

The specimens examined in this study are registed as a part of the collections of the National Science Museum, though they will be returned to the Malagasy Republic.

We express our sincere gratitude to Dr. Ikuwo OBATA for his kind cooperation during field work in 1975, to Emeritus Professor Tatsuro MATSUMOTO of Kyushu

* Contribution to the Paleontology of Madagascar, VI

University for critical reading of the manuscript, and to Dr. William J. KENNEDY of Oxford University for kind rephrasing of the English. The field work was carried out with the facilities afforded by the Geological Survey, Department of Mines and Energy of the Malasy Republic. The study was supported by a Grant in Aid for Overseas Scientific Survey from the Ministry of Education, and Science and Culture.

Geological Notes

The paleontological reconnaissance survey of the Menabe area is concisely recorded in a "Preliminary Report of the First Paleontological Expedition to Madagascar in 1973" (1975) and "Preliminary Report of the Paleontological Survey of Madagascar by National Science Museum Party in 1975" (1975). From these preliminary reports, the Cretaceous sequence in this district may be summarized, in ascending order, as follows: Formation C_6 (Turonian, marine), Member C_7a (Turonian to Coniacian, continental deposits with intercalated basalt layers; marine in the upper part), Member C_7b (Santonian, marine), Member C_8a (Lower Campanian, marine), Member C_8b (Middle Campanian, marine), Member C_8c (Upper Campanian, continental?) and Formation C_9 (Maastrichtian, marine). The stratigraphic relationship between successive members is conformable, although between C_8c and C_9 was not seen.

In the northern part of the area investigated, inoceramids occur frequently, whereas

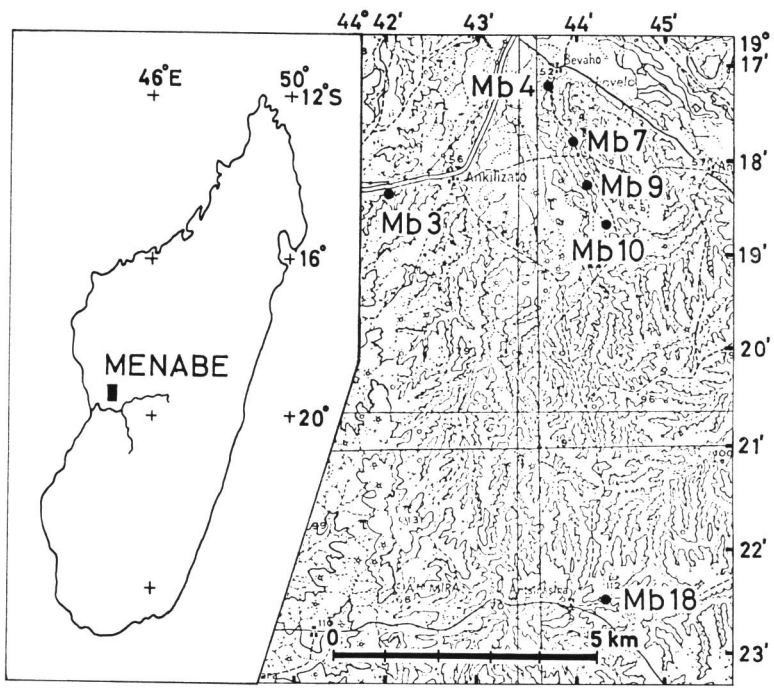


Fig. 1. Locations of inoceramid species in the Menabe area, southwestern Madagascar.

in the central and southern parts of basin compressed and smooth ammonites such as *Hauericeras* and *Pseudoschloenbachia* are abundant (Table 1).

Table 1. Faunal assemblages at each of six localities in the Menabe area, southwestern Madagascar. The figure is the number of collected specimens.

species	locality					
	Mb3	Mb4	Mb7	Mb9	Mb10	Mb18
I. (*Selenoc.*) *flexus*	6					
I. (*Cordic.*) *pseudoregularis*	1	2		1		3
I. (*Cordic.*) α aff. *pseudoregularis*	2					
I. (*Cordic.*) β aff. *pseudoregularis*						1
I. (*Cordic.*) cf. *heberti*	1					
I. (*Cordic.*) *paraheberti*	12					
I. (*Cordic.*) *ampambaensis*	8					2
I. (*Cordic.*) cf. *arculiferus*	1					1
I. (*Cordic.*) aff. *arculiferus*			1		1	
I. (*Cordic.*) *mitraikyensis*	1					
I. (*Endocostea*) *balticus*						2
I. regularis	1			1		1
I. aff. *bererensis*	2				1	
I. (*Trachoc.*) aff. *ianjoanensis*						1
Bostrychoceras sp.						1
Polyptychoceras sp.		1				
Baculites cf. *menabensis*	1					
Eupachydiscus spp.	2		1	1	2	3
Canadoceras hoepeni	1					
Hauericeras gardeni		1				2
Austinceras menabensis						
Desmoceras sp.		1				
Puzosiid gen. et sp. indet.				1		
Menabites sp.		3			1	
Pseudoschloenbachia spp.	3					
P. (*Bühreriella*) *bühreri*		1			1	12
P. (*Hourcquiella*) sp.				1		
Eutrephoceras spp.	2	1	1	1		2

Locality Guide

The following is the record of the localities where the inoceramid specimens of this report were obtained. Their locations are indicated in Text-fig. 1 and the faunal assemblage of each of the six localities is shown in Table 1.

Loc. Mb3. Location: Long. 44°42′00″E, Lat. 19°18′19″S. Roadside exposure about 1 km westwards from Ankirizato. Str. position: Upper part of Member C8a. Thick bedded siltstone and fine-grained sandstone. Inoceramids abundant in calcareous nodules.

Loc. Mb4. Location: Long. 44°43′39″S, Lat. 19°17′11″S. Beside mountain path

about 500 m southwards from Bevaho. Str. position: Lower part of Member C8a. Thick bedded siltstone and fine-grained sandstone. Inoceramids abundant in calcaleous nodules.

Loc. Mb7. Location: Long. 44°43′56″E, Lat. 19°17′47″S. Beside mountain path about 1 km southeastwards from loc. Mb4. Str. position: Lower part of Member C8a. Thick bedded siltstone and fine-grained sandstone, probably the same horizon as that of loc. Mb4. Inoceramids rare in calcaleous nodules.

Loc. Mb9. Location: Long. 44°44′07″E, Lat. 19°18′13″S. Beside mountain path about 900 m southeastwards from loc. Mb7. Str. position: Lower part of Member C8a. Thick bedded siltstone and fine-grained sandstone, probably the same horizon as that of Mb4. Inoceramids rare in calcaleous nodules.

Loc. Mb10. Location: Long. 44°44′20″E, Lat. 19°18′40″S. Beside mountain path about 800 m southeastwards from loc. Mb9. Str. position: Lower part of Member C8a. Thick bedded siltstone and fine-grained sandstone, probably the same horizon as that of Mb4. Inoceramids rare in calcaleous nodules.

Loc. Mb18. Location: Long. 44°44′20″E, Lat. 19°22′31″S. Beside mountain path from Antsirasira to Ampamba, about 800 m eastwards from Antsirasira. Str. position: Middle part of Member C8a. Thick bedded siltstone and fine-grained sandstone. Inoceramids common in calcaleous nodules.

Biometric Methods

In this paper we describe the characters of specimens, determine and discuss them following SORNAY's accounts (1962, 1964, 1968, 1969, 1973, 1975 and 1976). Comments on infrageneric taxa and the succession of species are limited at present, because we have been unable to study SORNAY's original specimens. Because of the limited number of specimens available the samples from each locality could not be examined at population level. The following characters, however, are statistically examined to some extent.

1. Antero-hinge angle (α): angle between antero-dorsal margin and hinge-line
2. Simple ratio l/h (l: shell length, h: shell height)
3. Simple ratio $l/h_{=60\ mm}$
4. Simple ratio h/l
5. Simple ratio $h_{=60\ mm}/l$
6. Simple ratio T/h (T: thickness)
7. Simple ratio HL/h (HL: length of hinge-line)
8. Rib density
9. Obliquity $\delta_{H=60\ mm}$: angle between hinge-line and H at the growth stage 60 mm in H (H: maximum dimension from umbo to ventral extremity), commonly expresses the less angle, the more oblique.

The relative growth of shell height and length and the ontogenetic change of obliquity in each species are shown in Text-figures 3–28 respectively.

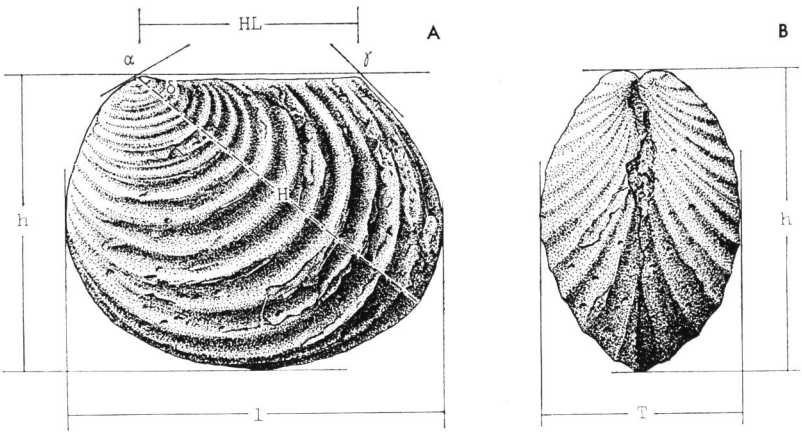


Fig. 2. Basic morphology for measurement of inoceramid specimen.

A calipers of JIS standard, 20 mm in measurable range and 1/20 mm in accuracy, and a contact goniometer were used for measurements of length and angle respectively. Measurements were made three times for the same part, and the mean value is shown. From the above numerical characters, the standard deviation and PEARSON's coefficient of variation were calculated. The formulae are as follows.

(1) Calculation of standard deviation

$$s=\sqrt{\frac{\sum (xi-\bar{x})^2}{N-1}} \qquad \bar{x}=\frac{1}{N}\sum xi$$

(2) Calculation of PEARSON's coefficient of variation

$$V=\frac{100s}{\bar{x}}$$

where
- s: standard deviation
- xi: variable
- $\bar{x}$: mean value of variable
- N: sample size
- V: PEARSON's coefficient of variation

The basic morphology for measurement is shown in Text-figure 2.

The results are shown in Text-figs. 3–28, which are incerted respectively in the description of species. The way of representation is much different from that attempted by SORNAY (1932, 1937, 1948, 1955a, b, 1956, 1961).

Systematic description

Order Pterioida NEWELL, 1965
Family Inoceramidae GIEBEL, 1852

Genus *Inoceramus* SOWERBY, 1814
Subgenus *Selenoceramus* HEINZ, 1932

Remarks.——For the definition of the subgenus, we follow tentatively SEITZ (1967, p. 93–94), with type-species *Inoc.* (*Selenoceramus*) *selenae* SEITZ, 1967.

Inoceramus (*Selenoceramus*) *flexus* SORNAY
Pl. 1, Figs. 1, 2; Pl. 4, Fig. 2; Pl. 5, Fig. 2

1975. *Inoceramus* (*Selenoceramus*) *flexus* SORNAY. *Ann. Paléont.*, vol. 61, p. 24–27, pl. 3, figs. 3, 4; pl. 5, fig. 1; pl. 6, figs. 2, 3.

Holotype.——See SORNAY 1975, p. 24.

Material.——Six specimens NSM. PM9301, 9302, 9305, 9306, 9307 and 9308 from loc. Mb3.

Description.——Shell medium or comparatively large in size; equivalve, oblique, moderately inflated along the growth axis and antero-posteriorly, anterior and antero-ventral parts steep to the valve plane, posterior and postero-dorsal areas more or less flattened. In some specimens, e.g. NSM.PM9302, 9308, abruptly bent down to the ventral border. Antero-dorsal margin convex passing to the moderately rounded antero-ventral one; ventral margin broadly curved, continuing with a narrowly bent postero-ventral extremity; posterior margin slightly convex forming an obtuse angle of 140° on average with the hinge-line, which is longer than a half of shell length. Umbo terminal or subterminal.

Surface ornamented with concentric ribs and striae; ribs commonly low, round-topped, fairly crowded in the umbonal region and gradually broadened with growth, sometimes bifurcate or inserted on the anterior part of flank. The ribs curved gently along the marginal outline. Numerous faint striae cover the major ribs. Many small pits irregularly scattered on the surface of the internal mould, where the concentric ornament is indiscernible but faint radial striae discernible. In two specimens, i.e. NSM.PM9302, 9303a broad and shallow depression along the growth axis is indistinctly visible.

A narrow and small anterior wing-like area is developed in few individuals.

Measurements.——

Table 2A. Measurement of *Inoceramus* (*Selenoceramus*) *flexus* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9301	129	66.5	81.1		47.2	16	1.22	1.13	0.82	0.88		0.71	0.24	47
9302	132	84.5	106.6	56.9	58.6	18	1.26	1.22	0.79	0.82	0.67	0.69	0.21	53
9305	123	75.2	92.9	54.2	61.4	24	1.24	1.17	0.81	0.85	0.72	0.82	0.32	48
9306	127	81.5	101.2	57.4	56.0	16	1.24	1.12	0.81	0.89	0.70	0.69	0.20	46
9307	136	76.3	95.1		50.3	16	1.25	1.21	0.80	0.83		0.66	0.21	46
9308	much incomplete preservation for measurement													

α: angle between antero-dorsal margin and hinge-line
h: shell height
l: shell length
T: thickness
HL: length of hinge-line
rib: number of rib
l/h: simple ratio of l to h
$l/h_{=60\ mm}$: simple ratio of l to h at the growth stage of 60 mm in h
h/l: simple ratio of h to l
$h_{=60\ mm}/l$: simple ratio of h to l at the growth stage of 60 mm in h
T/h: simple ratio of T to h
HL/h: simple ratio of HL to h
R. D.: rib density
$\delta_{H=60\ mm}$: angle between hinge-line and H at the growth stage of 60 mm in H
H: maximum length from umbo to ventral extremity

Table 2B. Numerical characters of *Inoceramus* (*Selenoceramus*) *flexus* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	5	5	5	5	5	3	5	5	5
m	129.4	1.242	1.170	0.806	0.854	0.679	0.714	0.236	48.0
s	4.93	0.0148	0.0453	0.0114	0.0305	0.0252	0.0619	0.0493	2.92
V	3.81	1.1916	3.8718	1.4144	3.5714	3.6155	8.6695	20.8898	6.08

N: sample size
m: mean value
s: standard deviation
V: PEARSON's coefficient of variation

Remarks.——The test of the specimens examined is completely worn, the details of surface ornamentation are unknown. Numerous pits scattered on the surface of the internal mould may be the traces of the pearl-like substance present on the interior of the shell. The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 3 and 4 respectively. The specific characters described above are in agreement with those of *Inoceramus* (*Selenoceramus*) *flexus* SORNAY, from the Lower to Middle Campanian to Mangoki Basin, southern Madagascar. As SORNAY (1975) mentioned, *I.* (*Selenoceramus*) *flexus* is akin to *I.* (*S.*) *inaequabilis* SEITZ (1967), from the Middle Santonian of northwestern Germany, but we agree with SORNAY in distinguishing the two species.

Subgens *Cordiceramus* HEINZ, 1932

Remarks.——For the definition of *Cordiceramus*, we follow tentatively SEITZ (1961, p.110) and SORNAY (1968, p. 25). We have some doubts for the subgeneric descrimination i.e. *Haenleinia*, *Cordiceramus*, *Endocostea* and *Cataceramus*, at population level.

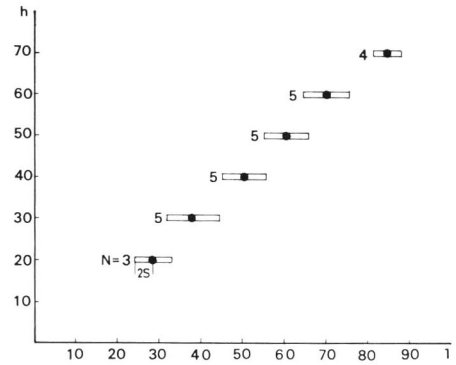


Fig. 3. Relative growth between shell height (h) and length (l) in *Inoceramus* (*Selenoceramus*) *flexus* SORNAY. N: sample size.

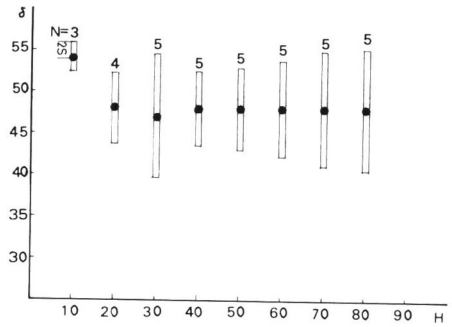


Fig. 4. Ontogenetic change of obliquity in *Inoceramus* (*Selenoceramus*) *flexus* SORNAY. N: sample size.

Inocermus (*Cordiceramus*) *pseudoregularis* SORNAY
Pl. 3, Fig. 1; Pl. 7, Fig. 3A, 3B; Pl. 8, Fig. 2

1962. *Inoceramus* (*Haenleinia*) *pseudoregularis* SORNAY. *Bull. Soc. Géol. France,* ser. 7 vol. 4, p. 118, 119, pl. 7, fig. 1, text-fig. 1A.
1968. *Inoceramus* (*Cordiceramus*) *pseudoregularis,* SORNAY. *Ann. Paléont.* vol. 54, p. 32–36, pl. D, figs. 1, 2, text-figs. 3–6.

Holotype.——See SORNAY 1968, p. 32.

Material.——Seven specimens NSM.PM9322 from loc. Mb3, NSM.PM9336 and 9337 from loc. Mb4, NSM.PM9344 from loc. Mb9 and NSM.PM9352, 9354 and 9355 from loc. Mb18.

Description.——Shell of medium size or attaining large size, equivalve, moderately convex along the growth axis and antero-posteriorly; umbonal region considerably inflated. Anterior part relatively thick; antero-dorsal marginal part steep to the valve plane, postero-dorsal part gradually compressed, but not forming a distinct wing-like area. Obliquity commonly constant throughout the growth. Marginal outline inequilateral, considerably oblique, longer than high. Antero-dorsal and anterior margins arcuate, passing to the broadly rounded ventral one, postero-ventral extremity narrowly bent, passing into the moderately arcuated posterior one. Hinge-line longer than a half of shell length, forming an obtuse angle of 122° on average with the postero-dorsal margin. Umbo subterminal, small and slightly prominent.

Surface sculptured with concentric ribs and rings. The ribs rather regular in strength and distance, showing some variation in density, symmetrically acute-topped in cross section, and separated from one another with somewhat wider interspaces. A shallow radial depression runs somewhat posteriorly along the growth axis. Many small pits are scattered irregularly on the surface of internal mould.

Measurements.——

Table 3A. Measurements of *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9322	120	83.7	104.3	46.0	58.2	12	1.25	1.19	0.80	0.84	0.55	0.70	0.14	44
9336	122	109.6	140.0		88.2	11	1.28		0.78			0.80	0.10	
9337	123	86.1	105.5		70.0	11	1.23	1.16	0.81	0.86		0.81	0.13	45
9344	130	76.0	91.1		56.4	10	1.20	1.21	0.83	0.83		0.74	0.13	43
9352	124	60.3	78.2		49.0	10	1.30	1.30	0.77	0.77		0.81	0.17	44
9354	125	62.7	88.2		50.0	11	1.41	1.28	0.71	0.78		0.80	0.18	45

Table 3B. Numerical characters of *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	H/h	R. D.	$\delta_{H=60\ mm}$
N	6	6	5	6	5		6	6	5
m	124.0	1.287	1.228	0.783	0.816		0.777	0.142	44.2
s	3.41	0.0736	0.0597	0.0418	0.0391		0.0459	0.0293	0.84
V	2.75	5.7590	4.8616	5.3384	4.7917		5.9073	20.6338	1.90

Inmeasurable character (e. g. destroyed, deformed and smaller than standard) is left as a blank.

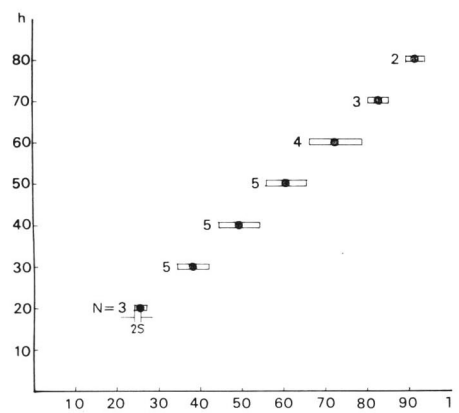


Fig. 5. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY. N: sample size.

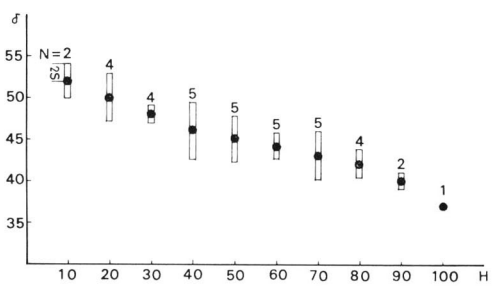


Fig. 6. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY. N: sample size.

Remarks.——All the specimens examined are internal moulds, and the surface ornamentation and hinge structure are unknown. The numerous pits may be the traces of pearl-like nodes on the interior of the shell. The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 5 and 6 respectively. The shell convexity, long hinge-line, subterminal and less prominent umbo, curvature of anterior margin and a radial depression along the growth axis closely resemble those of *Inoceramus* (*Cordiceramus*) *pseudoregularis* described by SORNAY from the Lower to lower Middle Campanian of the Menabe area, southwestern Madagascar. However, the concentric ribs are commonly much coarser than those

of the SORNAY's original specimens, but the rib density of the specimens examined shows considerable variation as shown in Table 3A and B. According to the description by SORNAY (1968), the obliquity is very variable from 40° to 50° for angle δ and it is commonly constant with growth, and the simple ratio h/l is 0.76 to 0.77 on average. The specimens examined show the same values in these characters regardless of a slightly greater h/l ration. The present specimens, therefore, are identified with *I.* (*C.*) *pseudoregularis* SORNAY.

Inoceramus (*Cordiceramus*) sp. α aff. *pseudoregularis* SORNAY

Pl. 6, Fig. 2A, 2B, 2C

Material.——Two specimens NSM.PM9326 and 9328 from loc. Mb3.

Description.——Shell medium in size, equivalve, gently inflated antero-posteriorly and also dorso-ventrally: umbonal region relatively convex, anterior part moderately inclined to the valve plane, postero-dorsal one gradually flattened, passing to a wing-like area. Marginal outline inequilateral, oblique, longer than high; antero-dorsal margin moderately arcuate, gradually passing into the broadly rounded anterior and then ventral ones, postero-ventral extremity narrowly bent, continuing to the gently convex posterior one. Hinge-line about a half of shell length, but may be variable. Umbo subterminal, small and slightly prominent beyond the hinge-line.

Surface ornamented with concentric ribs, which are acute-topped, separated by concave interspaces, regular in intensity, comparatively crowded in earlier growth stages and gradually coarsening with growth. Numerous concentric rings discernible on the major ornament, partially crossing obliquely the latter. A shallow radial depression runs from behind the umbo to the postero-ventral extremity.

Measurements.——

Table 4A. Measurements of *Inoceramus* (*Cordiceramus*) sp. α aff. *pseudoregularis* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9326	132	67.1	73.6	44.6	43.8	13	1.10	1.11	0.91	0.90	0.66	0.65	0.21	48
9328	147	52.3	56.4		26.5	16	1.08		0.93			0.51	0.31	44

Table 4B. Numerical characters of *Inoceramus* (*Cordiceramus*) sp. α aff. *Pseudoregularis* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	2	2		2			2	2	2
m	139.5	1.090		0.920			0.580	0.260	46.0
s	10.61	0.0141		0.0100			0.0990	0.0707	2.38
V	7.61	1.2936		1.0800			17.0690	27.1923	6.15

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 7 and 8 respectively. As is demonstrated in Text-fig. 7, the obliquity increases gradually with growth.

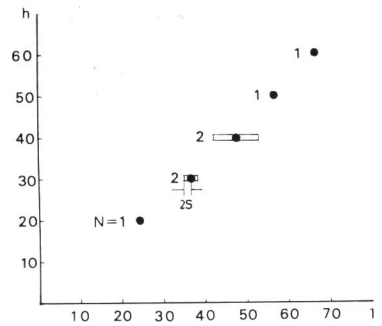


Fig. 7. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) sp. α aff. *pseudoregularis* SORNAY. N: sample size.

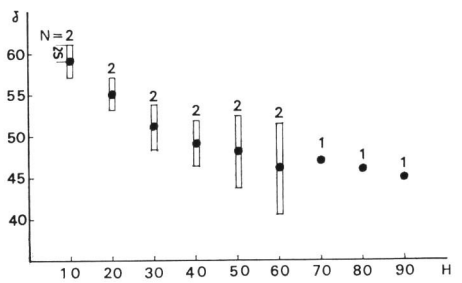


Fig. 8. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) sp. α aff. *pseudoregularis* SORNAY. N: sample size.

The specimens examined closely resemble a certain form of *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY from the Lower to lower Middle Campanian of the Menabe area, southwestern Madagascar, in shell convexity, marginal outline, obliquity and surface ornamentation which is relatively regular in size and strength. But they are distinct in their shorter hinge-line as shown in Table 4A and B and a comparable lesser ratio of l/h.

The present specimens also resemble some representatives of *I. bererensis* SORNAY from the Middle Campanian of the Menabe area, in shell convexity, marginal outline, proportion of simple ratio l/h, relatively short hinge-line and regular concentric ornamentation, but the former shows gradually increasing obliquity with growth and has a distinct haenleinian depression along the growth axis, whereas the latter gradually decreases in obliquity and the haeleinian groove is much weakened or hardly visible.

From the above comparison, the present specimens are referable to both the allied species *I.* (*C.*) *pseudoregularis* and *I. bererensis*.

In the above three species, the PEASON's coefficients of variation of obliquity all show small values, as is demonstrated in Tables 3, 4 and 13, respectively. Thus, the obliquity is an important character at these species. From the similar value of obliquity and its change during ontogeny, it appears more reasonable to place the present form closer to *I.* (*C.*) *pseudoregularis*.

Inoceramus (*Cordiceramus*) sp. β aff. *pseudoregularis* SORNAY

Pl. 7, Fig. 2A, 2B; Pl. 8, Fig. 3

Material.——A single specimen, NSM.PM9353 from loc. Mb18.

Description.——Shell of medium size, equivalve, considerably inflated anteroposteriorly and also very convex dorso-ventrally, with the last ventral part steep to

the valve plane; anterior part broad and truncated, postero-dorsal region flattened and gradually passing to a wing-like area.

Marginal outline equilateral, markedly oblique to the postero-ventral extremity and elongated along the growth axis; from the antero-dorsal border to the ventral border broadly and uniformly rounded, postero-ventral margin narrowly bent, continuing to the long, and almost straight posterior one. Hinge-line relatively long, being slightly shorter than two thirds of shell length, and forming an obtuse angle of about 136° with the posterior margin. Umbo terminal, small and slightly prominent.

Surface ornamented with concentric ribs and striae in earlier stages, ribs relatively crowded, round-topped, regular in size and intensity and gradually broadening with growth, becoming irregular and weakened near the wing-like area. Ribs in later stages much irregular in size and strength. Numerous striae cover the primary ornament. A shallow haenleinian depression indistinctly discernible in the postero-ventral part.

Measurements.——

Table 5. Measurements of *Inoceramus* (*Cordiceramus*) sp. β aff. *pseudoregularis* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9353	127	63.0	80.3		51.5	15	1.27	1.30	0.79	0.77		0.81	0.23	38

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 9 and 10 respectively. As is illustrated by Text-fig. 10, the obliquity increases gradually with growth, and a decrease in the angle δ, between the hinge-line and the posterior margin.

The specimen examined is similar to a form of *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY in marginal outline, obliquity and the presence of a haenleinian depression. But it is clearly distinguished from that species in much more inflated valve,

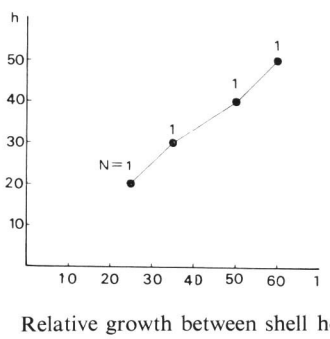


Fig. 9. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) sp. β aff. *pseudoregularis* SORNAY. N: sample size.

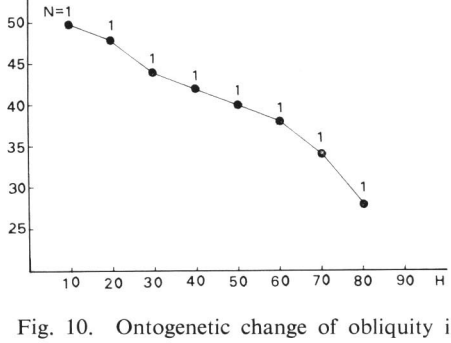


Fig. 10. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) sp. β aff. *pseudoregularis* SORNAY. N: sample size.

truncated anterior region and variable strength on concentric ornamentation which becomes gradually irregular in size and strength with growth.

On the other hand, the present specimen resembles types of *I.* (*C.*) *ampambaensis* SORNAY, 1968, from the Lower Campanian of the Menabe area of Madagascar, in its great shell convexity, antero-posteriorly elongated outline and great obliquity, but differs from the latter in its uniformly bent convexity, broadly rounded ventral margin and irregular ornament.

The present specimen is clearly distinguished from *I.* (*C.*) sp. α aff. *pseudoregularis*, described above, in its greatly inflated shell, lower ratio h/l (refer to Tables 4 and 5), greater obliquity, irregular concentric ribs and the presence of a haenleinian depression.

In summary, this specimen is not referable to any other species known from the Campanian of Madgascar. It may be a new species which is closely allied to *I.* (*C.*) *pseudoregularis*. We defer, however, at present, to create a new specific name due to lack at sufficient material.

Inoceramus (*Cordiceramus*) sp. cf. *heberti* FALLOT

Pl. 1, Fig. 4A, 4B; Pl. 7, Fig. 4

Compare.

1885. *Inoceramus heberti* FALLOT. *Thèse, Paris.*

1968. *Inoceramus* (*Cordiceramus*) *heberti*, SORNAY. *Ann. Paléont.* vol. 54, p. 41, pl. H, fig. 3.

Lectotype.——See SORNAY, 1968, p. 41.

Material.——A single specimen NSM.PM9321 from loc. Mb3.

Description.——Shell of medium size, probably equivalve, moderately inflated along the growth axis and antero-posteriorly; anterior part fairly steep, posterior half gradually flattened, passing to a wing-like area. Marginal outline circular in general aspect, slightly longer than high. Hinge-line of moderate length forming an obtuse angle of about 126° with the postero-dorsal margin. Umbo small, subterminal and less prominent.

Surface ornamented with rather crowded concentric ribs which are regular in size and strength, symmetrically wavy in cross section with round-tops and separated from one another by wider interspaces; in the umbonal region, the ribs are comparatively crowded, low and wavy. A shallow haenleinian depression is visible somewhat posteriorly, running along the growth axis.

Measurements.——

Table 6. Measurements of *Inoceramus* (*Cordiceramus*) sp. cf. *heberti* FALLOT. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9321	122	72.8	86.4	42.3	43.3	17	1.19	1.06	0.84	0.94	0.58	0.59	0.23	67

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 11 and 12 respectively. As is illustrated in Text-fig. 12, the obliquity decreases with growth.

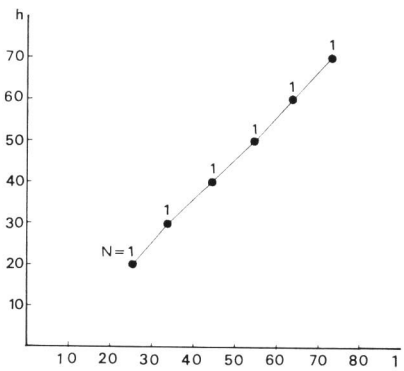


Fig. 11. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) sp. cf. *heberti* FALLOT. N: sample size.

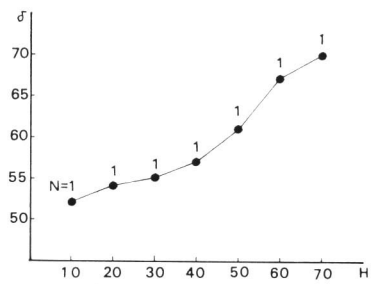


Fig. 12. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) sp. cf. *heberti* FALLOT. N: sample size.

In the specimen examined, the circular outline, subterminal umbo and weak haenleinian depression are in agreement with those of the type specimen of *Inoceramus* (*Cordiceramus*) *heberti* from the Campanian of Veynes (Hautes-Alpes), but there is a minor difference in that the former has a regular ribbing, whereas, in the latter the ribs become gradually irregular and weakened with growth.

The present specimen also resmbles the type of *I. regularis* d'ORBIGNY, in circular outline and shell convexity but the latter has no haenleinian depression.

Inoceramus (*Cordiceramus*) *paraheberti* SORNAY

Pl. 2, Fig. 1

1968. *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY. *Ann. Paléont.* vol. 54, p. 38–44, pl. G, pl. H, figs. 1, 2, text-figs. 8–10.

Holotype.——See SORNAY 1968, p. 38.

Material.——Twelve specimens NSM.PM9303, 9304, 9310, 9311, 9312, 9313, 9314, 9316, 9318, 9320, 9334 and 9335 from loc. Mb3.

Description.——Shell of medium to large size, equivalve, moderately convex antero-posteriorly and also along the growth axis, anterior part steep to the valve plane, posterior part gradually flattened, passing to a wing-like area. Marginal outline markedly oblique, fairly elongated to the postero-ventral corner, antero-dorsal and anterior margins gently curved, continuing to broadly arched ventral and narrowly

bent postero-ventral ones; posterior margin broadly curved, forming an obtuse angle of about 124° on average with the hinge-line. Hinge-line longer than a half of shell length. Umbo terminal or subterminal and less prominent. The angle α between the antero-dorsal margin and the hinge-line is variable, as shown in Table 7A and 7B.

Surface ornamented with rather low concentric ribs which are round-topped and of uniform strength and spacing. A haenleinian depression runs from behind the umbo to the postero-ventral extremity, but varies considerably in strength. Numerous pits are scattered irregularly on the marginal part of the surface of internal mould.

Measurements.——

Table 7A. Measurements of *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	l/h	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9303	129	78.4	96.4	50.4	65.0	18	1.23	1.26	0.81	0.79	0.64	0.83	0.23	44
9304	130	78.0	103.0	56.0	59.1	20	1.32	1.25	0.76	0.80	0.72	0.71	0.24	48
9310	122	61.1	79.0	41.1	51.6	15	1.29	1.28	0.78	0.78	0.67	0.84	0.25	47
9312	127	68.7	88.0	55.1	46.8	17	1.28	1.19	0.78	0.84	0.80	0.68	0.24	44
9313	127	69.5	96.6	43.1	58.6	17	1.39	1.32	0.72	0.76	0.62	0.84	0.24	44
9314	120	78.3	105.5		65.5	15	1.35	1.25	0.74	0.80		0.84	0.19	41
9316	125	54.0	66.7		39.9	11	1.24		0.81			0.74	0.20	44
9318	126	58.0	72.8		42.8	15	1.26		0.79			0.74	0.26	42
9320	126	61.6	76.6		46.8	15	1.24	1.23	0.81	0.81		0.76	0.24	43
9334	130	64.6	81.9		48.9	10	1.27	1.26	0.79	0.79		0.83	0.17	46
9335	128	56.7	73.6	31.0	43.5	18	1.30		0.77		0.55	0.77	0.32	45

Table 7B. Numerical characters of *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	11	11	8	11	8	6	11	11	11
m	126.4	1.288	1.255	0.778	0.796	0.667	0.780	0.235	44.4
s	3.14	0.0496	0.0374	0.0293	0.0233	0.0862	0.0587	0.0396	2.06
V	2.48	3.8509	2.9801	3.7661	2.9271	12.9235	7.5256	16.8511	4.64

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 13 and 14 respectively. As is clear from Text-fig. 14, the obliquity gradually increases with growth.

The morphological characters of the present specimens are somewhat variable, but in good agreement with those of *Inoceramus* (*Cordiceramus*) *paraheberti* from the Lower to Middle Campanian (or Uppermost Santonian?) of the Menabe area, southwestern Madagascar.

The present species is in someways intermediate between *I.* (*Selenoceramus*) *flexus* SORNAY and *I.* (*C.*) *ampambaensis* SORNAY, but it is discriminated from *I.* (*S.*) *flexus* in the somewhat lower value of h/l and the presence of a distinct haenleinian depression. It is distinguished from *I.* (*C.*) *ampambaensis* by a greater h/l and less convex shell (refer to Tables 2A, 2B, 7A, 7B and 8A, 8B).

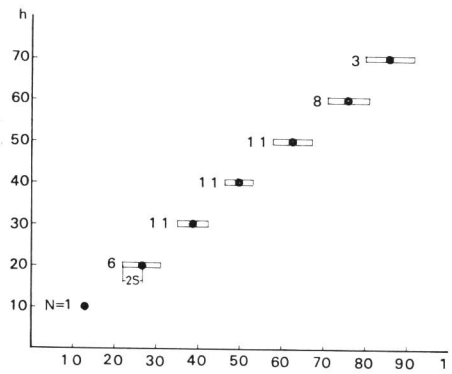


Fig. 13. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY. N: sample size.

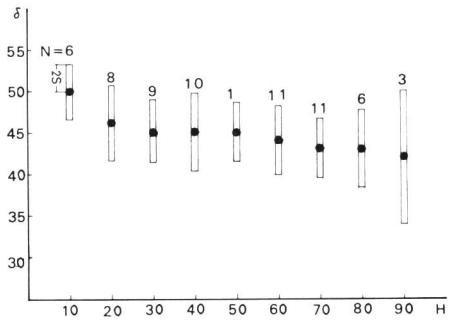


Fig. 14. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY. N: sample size.

Inoceramus (*Cordiceramus*) *ampambaensis* SORNAY

Pl. 3, Figs. 2A, 2B, 3; Pl. 4, Fig. 1A, 1B, 1C; Pl. 5, Figs. 1A, 1B, 3

1968. *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY. *Ann. Paléont.*, vol. 54, p. 29–31, pl. A; pl. B, fig. 2; pl. C.

Holotype.——See SORNAY 1968, p. 29.

Material.——Ten specimens: NSM.PM9309, 9315, 9317, 9319, 9330, 9331, 9332 and 9333 from loc. Mb3 and NSM.PM 9356 and 9358 from loc. Mb18.

Description.——Shell large in size, subequivalve, considerably inflated antero-posteriorly and dorso-ventrally with abrupt bending downwards to the ventral margin. Anterior part thick and steep to the valve plane, posterior half gradually flattened without a notable wing-like area. Marginal outline inequilateral, strongly oblique; much longer than high. Antero-dorsal margin convex, antero-ventral one broadly arched passing gradually into the evenly curved ventral one; postero-ventral margin narrowly bent; posterior border straight or slightly convex. Hinge-line about two thirds of shell length, forming an obtuse angle at about 140° on average with the posterior margin. Umbo terminal or subterminal.

Surface sculptured with various grades of the concentric ornament; the ribs rather crowded, narrow and regular with a sharp-top, the rings distinct on the surface of the adult, very variable in size and strength, faint concentric lines visible on the major ornament. On either valve, where is a broad and shallow haenleinian depression i.e. NSM.PM9319, 9330, 9332 and 9358) or a sharp and deep groove (i.e. NSM.PM 9356) runs from behind the umbo to the postero-ventral extremity, but on the other valve a radial ridge runs at the corresponding position (see Pl. 4, Fig. 1A; Pl. 5, Figs. 1A, 1B and 3).

Measurements.——

Table 8A. Measurements of *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9309	125	61.0	89.9		58.5	15	1.47	1.42	0.68	0.70		0.96	0.25	40
9315	125	51.0	70.8		45.7	14	1.39		0.72			0.90	0.27	35
9317	120	56.0	78.4		58.1	16	1.40		0.71			1.04	0.29	41
9319	119	60.4	81.6		55.4	18	1.35	1.35	0.74	0.75		0.90	0.29	38
9330	124	65.6	96.0	57.5	68.0	17	1.46	1.22	0.68	0.82	0.88	1.04	0.26	40
9331	121	105.6	145.1	76.0	95.0	21	1.37	1.25	0.73	0.80	0.72	0.90	0.20	46
9332	121	76.6	116.5	73.0	69.0	17+	1.52	1.27	0.66	0.79	0.95	0.90	0.22	43
9333	129	62.6	92.0		45.9+	18	1.47	1.42	0.68	0.70		0.73+	0.29	40
9356	134	76.9	110.6	65.6	76.2	22	1.44	1.32	0.69	0.76	0.85	0.99	0.29	40
9358	128	88.8	129.5	65.2	81.2	21	1.46	1.35	0.68	0.74	0.73	0.91	0.24	37

Table 8B. Numerical characters of *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	10	10	8	10	8	5	9	10	10
m	124.6	1.433	1.323	0.697	0.758	0.826	0.949	0.260	40.0
s	4.70	0.0533	0.0740	0.0263	0.0443	0.0991	0.0606	0.0323	3.06
V	3.77	3.7195	5.5933	3.7733	5.8443	11.9976	6.3857	12.4231	7.65

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 15 and 16. As is clear from Text-fig. 16, the obliquity increases with growth.

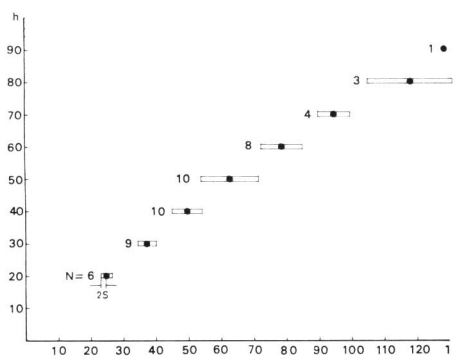


Fig. 15. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY. N: sample size.

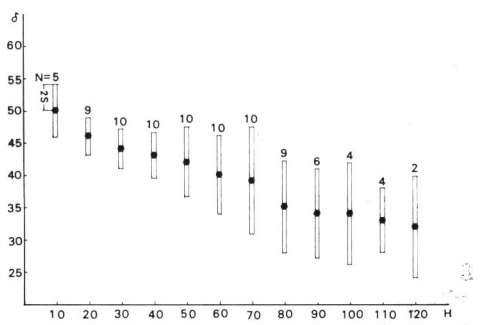


Fig. 16. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY. N: sample size.

The specimens examined are fairly well preserved. The described characters are essentially similar to those of *Inoceramus* (*Cordiceramus*) *ampambaensis*, from the Lower Campanian of the Menabe area, southwestern Madagascar. There is, however, a minor difference, the specimens examined are more convex antero-posteriorly and less

oblique (obliquity 40° in the specimens examined, whereas 30° in SORNAY's). Regardless of the minor difference, the peculiar convexity of shell with an abrupt bending at one point in growth, conspicuously elongated outline becoming more oblique with growth, and together with the wave-like closure of both valves in the posterior part are important specific characters which enable us to identify our specimens with *I.* (*C.*) *ampambaensis* SORNAY (1968).

Inoceramus (*Cordiceramus*) sp. cf. *arculiferus* SORNAY

Pl. 2, Fig. 2

Compare.

1975. *Inoceramus* (*Cordiceramus*) *arculiferus* SORNAY. *Ann. Paléont.*, vol. 61, p. 21–24, pl. 1; pl. 2, figs. 1, 2; pl. 3, figs. 1, 2.

Holotype.——See SORNAY 1975, p. 21.

Material.——Two specimens, NSM.PM9329 from loc. Mb3 and NSM.PM9359 from loc. Mb18.

Description.——Shell of medium size, equivalve, considerably inflated antero-posteriorly and also dorso-ventrally. Umbonal region and anterior part very thick, broad and truncated to the valve plane; posterior part moderately convex and gradually flattened to a narrow wing-like area; convexity of valve changed at one point in growth with abrupt bending downward to the ventral margin. Marginal outline very inequilateral, strongly oblique with decreasing angle δ with growth, apparently subrectangular, much elongated from anterior to posterior; antero-dorsal margin short, anterior one arched passing to the considerably long and slightly curved ventral one, postero-ventral extremity narrowly bent, continuing to a broadly rounded posterior margin. Hinge-line very long, about two thirds of shell length with some extent of variation, and forming an obtuse angle of about 145° on average with the posterior margin. Umbo terminal and slightly projecting above the hinge-line. Test fairly thick (0.5 to 1 mm).

Surface ornamented with concentric ribs and rings; the ribs coarse, sharp-topped, regular in size and intensity and separated by somewhat wider interspaces in earlier growth stages, becoming gradually irregular and weakened on the postero-dorsal area with growth. Numerous concentric rings cover the ribs and interspaces. A shallow furrow is discernible on the postero-ventral area of the growth axis. Many small pits are irregularly scattered on the posterior part of the internal mould.

Measurements.——

Table 9A. Measurements of *Inoceramus* (*Cordiceramus*) sp. cf. *arculiferus* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l_{/=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9329	123	73.8	113.4		66.6	18	1.54	1.63	0.65	0.61		0.90	0.24	32
9359	115	65.0	100.2		81.4	15	1.54	1.31	0.65	0.76		1.25	0.23	34

Table 9B. Numerical characters of *Inoceramus* (*Cordiceramus*) sp. cf. *arculiferus* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	2	2	2	2	2		2	2	2
m	119.0	1.540	1.470	0.650	0.680		1.075	0.235	33.0
s	5.65	—	0.2263	—	0.1061		0.2474	0.0707	1.41
V	4.75	—	15.3946	—	15.4891		23.0040	30.0851	4.27

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity are shown in Text-figs. 17 and 18 respectively.

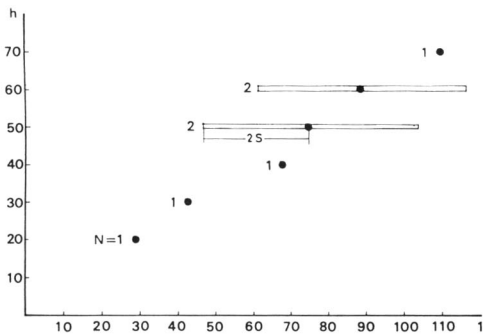


Fig. 17. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) sp. cf. *arculiferus* SORNAY. N: sample size.

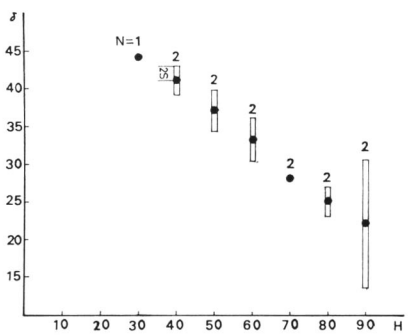


Fig. 18. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) sp. cf. *arculiferus* SORNAY. N: sample size.

With respect to the characters of very inflated valve with abrupt bending, extreme obliquity, much elongated outline with a long hinge-line and thick test, the specimens examined resemble *Inoceramus* (*Cordiceramus*) *arculifirus* SORNAY, from the Upper Senonian (Lower to Middle Campanian) of the Mangoki Basin, southwestern Madagascar. But the species is not yet clearly identified, because of imperfect preservation. A small anterior wing is distinctly developed in the holotype of that species (SORNAY, 1975, pl. 1, fig. 4); this is lacking in the specimens examined, and the simple ratio h/l and obliquity of the SORNAY's specimens are, on average, 0.74 and 40° respectively, whereas those of the present specimens are 0.65 and 33°. However, in our view, the anterior wing of the present specimens has been secondarily lost and the apparent difference in h/l and obliquity may be due to the change with growth (see Table 4 and Text-figs. 17 and 18).

Although there remain some doubts, we tentatively the present specimens to *I.* (*C.*) *arculiferus* based on the above discussion and comparison.

Inoceramus (*Cordiceramus*) sp. aff. *arculiferus* SORNAY

Pl. 8, Fig. 1A, 1B

Material.——Two specimens NSM.PM9342 from loc. Mb7 and NSM.PM9346 from loc. Mb10.

Description.——Shell large, equivalve considerably inflated antero-posteriorly and dorso-ventrally; anterior region very thick, broad and truncated, posterior and postero-dorsal parts moderately convex without forming a wing-like area; at a point about 145 mm length of growth axis, the valve is abruptly bent to form the ventral part almost perpendicular to the valve plane margin. Outline of shell inequilateral, oblique, as long as high or slightly longer than high, apparently rectangular, elongated along the growth axis in general aspect, but in earlier growth stages rather circular. Antero-dorsal margin short, straight or slightly convex, anterior margin broadly rounded and continuing to the evenly curved ventral one. Postero-ventral extremity abruptly bent, forming a right angle between the ventral and posterior margins, posterior border almost straight and forming an obtuse angle with a broadly rounded postero-dorsal one. Hinge-line of moderate length, being about one third of shell length. Umbo terminal or subterminal, slightly projecting above the hinge-line.

Surface sculptured with various grades of concentric ornament; in earlier stages of growth the concentric ribs broad, round-topped and regular in size and intensity, and becoming gradually more widely spaced, irregular in strength with frequent intercalation with growth. In the posterior half of the flank the ribs become lower and weakened. Concentric rings cover the primary ornament and are regular in size and intensity on

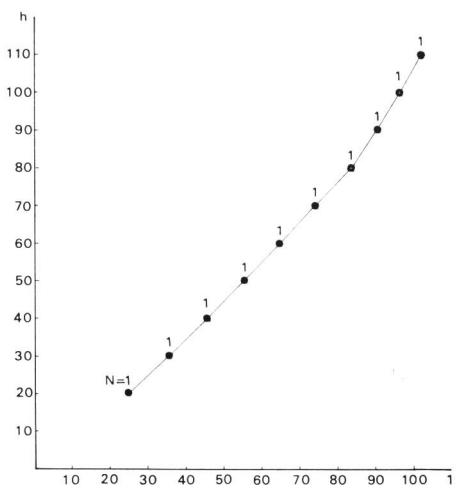


Fig. 19. Relative growth between shell height and length in *Inoceramus* (*Cordiceramus*) sp. aff. *arculiferus* SORNAY. N: sample size.

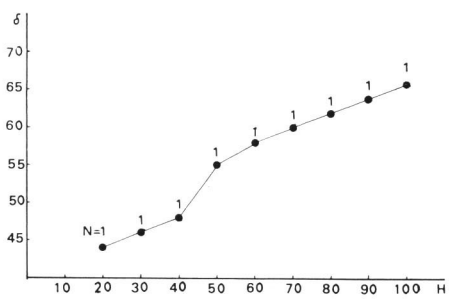


Fig. 20. Ontogenetic change of obliquity in *Inoceramus* (*Cordiceramus*) sp. aff. *arculiferus* SORNAY. N: sample size.

the main part of the flank, becoming irregular near the ventral margin, where the minor rings and the concentric lines cover the coarser ornaments. A broad and shallow depression runs from behind the umbo to the posterior extremity.

Measurements.——

Table 10A. Measurements of *Inoceramus* (*Cordiceramus*) sp. aff. *arculiferus* SORNAY. length in mm.

NSM. PM	α	h	l	T	HL	rib	l/h	$l/_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R.D.	$\delta_{H=60\ mm}$
9342	116	158.6	169.9		50.0	21	1.07	1.00	0.93	1.00		0.32	0.13	52
9346	129	145.7	157.0	118.6	54.6	17	1.08	1.14	0.93	0.88	0.81	0.37	0.12	50

Table 10B. Numerical characters of *Inoceramus* (*Cordiceramus*) sp. aff. *arculiferus* SORNAY.

	α	l/h	$l/h_{=60\ mm}$	h/l	$h_{=60\ mm}/l$	T/h	HL/h	R. D.	$\delta_{H=60\ mm}$
N	2	2	2	2	2		2	2	2
m	122.5	1.075	1.070	0.930	0.940		0.345	0.125	51.0
s	9.19	0.0071	0.0990	—	0.0848		0.0354	0.0071	1.41
V	7.50	0.6605	9.2523	—	9.0213		10.2609	5.6800	2.76

Remarks.——The relative growth of shell height and length and the ontogenetic change of obliquity in the specimen NSM.PM9342 are shown in Text-figs. 19 and 20. The specimens examined are relatively well preserved. They resemble types of *I.* (*C.*) *arculiferus*, but differ from the latter in having a less value of h/l (about 0.93 on average) at the full growth stage (h=158.4 mm) but more elongation along the growth axis, shorter hinge-line and less obliquity (about 51° on average of angle δ at the growth stage of H=60 mm). In short, the present specimens may represent a species which is akin to *I.* (*C.*) *arculiferus* but are clearly different from the typical form of that species. However, the available specimens are in insufficient in number to allow creation of a new specific name.

Part II to be Continued

Explanation of Plates 1–4

Every specimen illustrated is from the Lower Campanian deposit (Member C_8a) at the Menabe area, southwestern Madagascar. (collected by KANIE in 1973; photo by NODA). Pls. 5–8 will be in Part II.

Plate 1

Fig. 1. *Inoceramus* (*Selenoceramus*) *flexus* SORNAY ×0.8
NSM. PM9302 from loc. Mb3. lateral view of left valve.
Fig. 2. *Inoceramus* (*Selenoceramus*) *flexus* SORNAY ×0.8
NSM. PM9306 from loc. Mb3. lateral view of left valve.
Fig. 3. *Inoceramus* sp. aff. *bererensis* SORNAY ×0.8
NSM. PM9325 from loc. Mb3. lateral view of left valve.
Fig. 4. *Inoceramus* (*Cordiceramus*) *heberti* FALLOT ×0.9
NSM. PM9321 from loc. Mb3. 4A: lateral view of left valve and 4B: anterior view somewhat displaced along the valve plane secondarily.

Plate 2

Fig. 1. *Inoceramus* (*Cordiceramus*) *paraheberti* SORNAY ×0.8
NSM. PM9314 from loc. Mb3. lateral view of left valve.
Fig. 2. *Inoceramus* (*Cordiceramus*) sp. cf. *arculiferus* SORNAY ×0.7
NSM. PM9359 from loc. Mb18. lateral view of right valve.
Fig. 3. *Inoceramus regularis* d'ORBIGNY natural size
NSM. PM9350 from loc. Mb18. lateral view of left valve.
Fig. 4. *Inoceramus* sp. aff. *bererensis* SORNAY ×0.9
NSM. PM9345 from loc. Mb10. 4A: lateral view of right valve and 4B: anterior view, left umbo lacking.

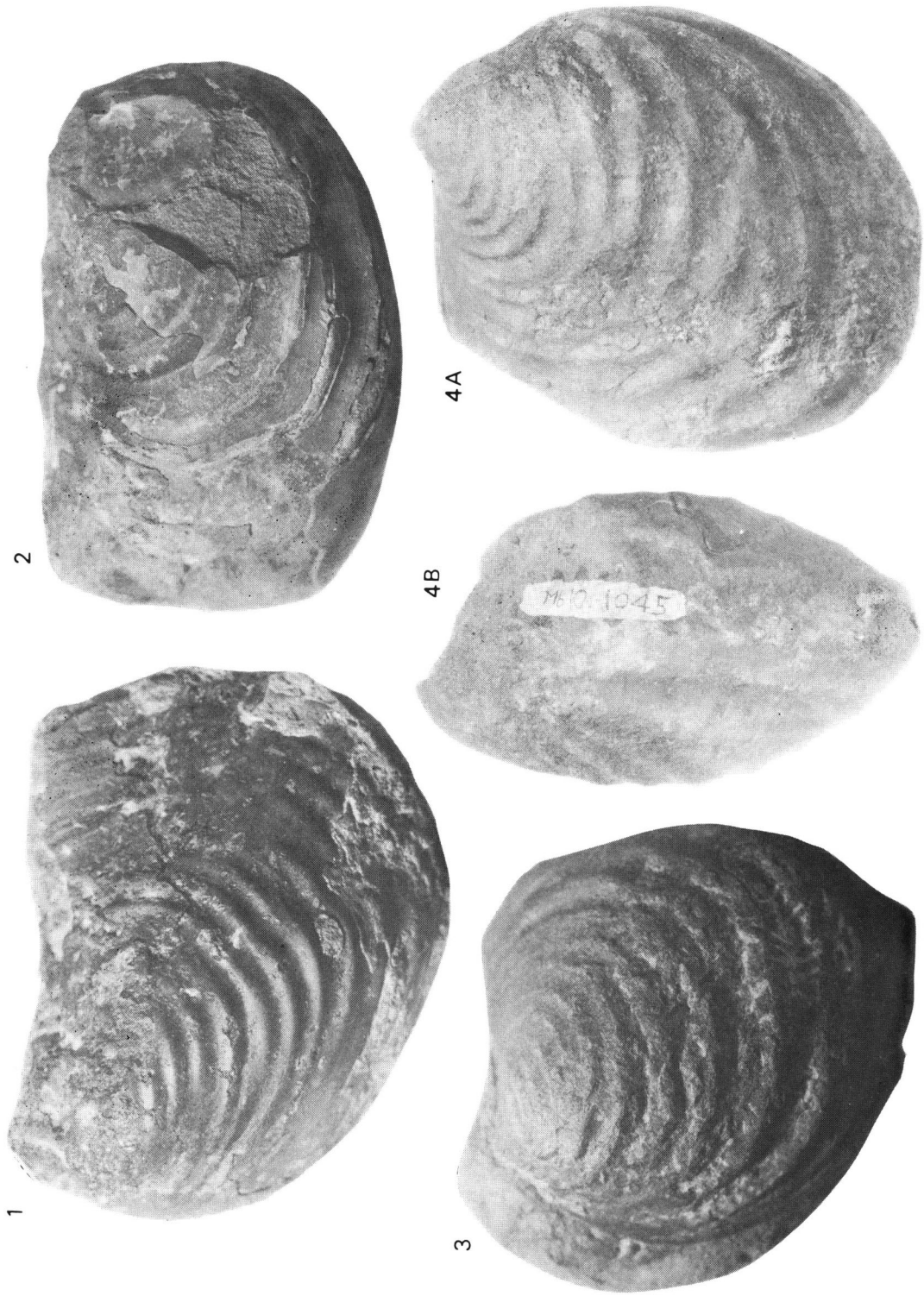
Plate 3

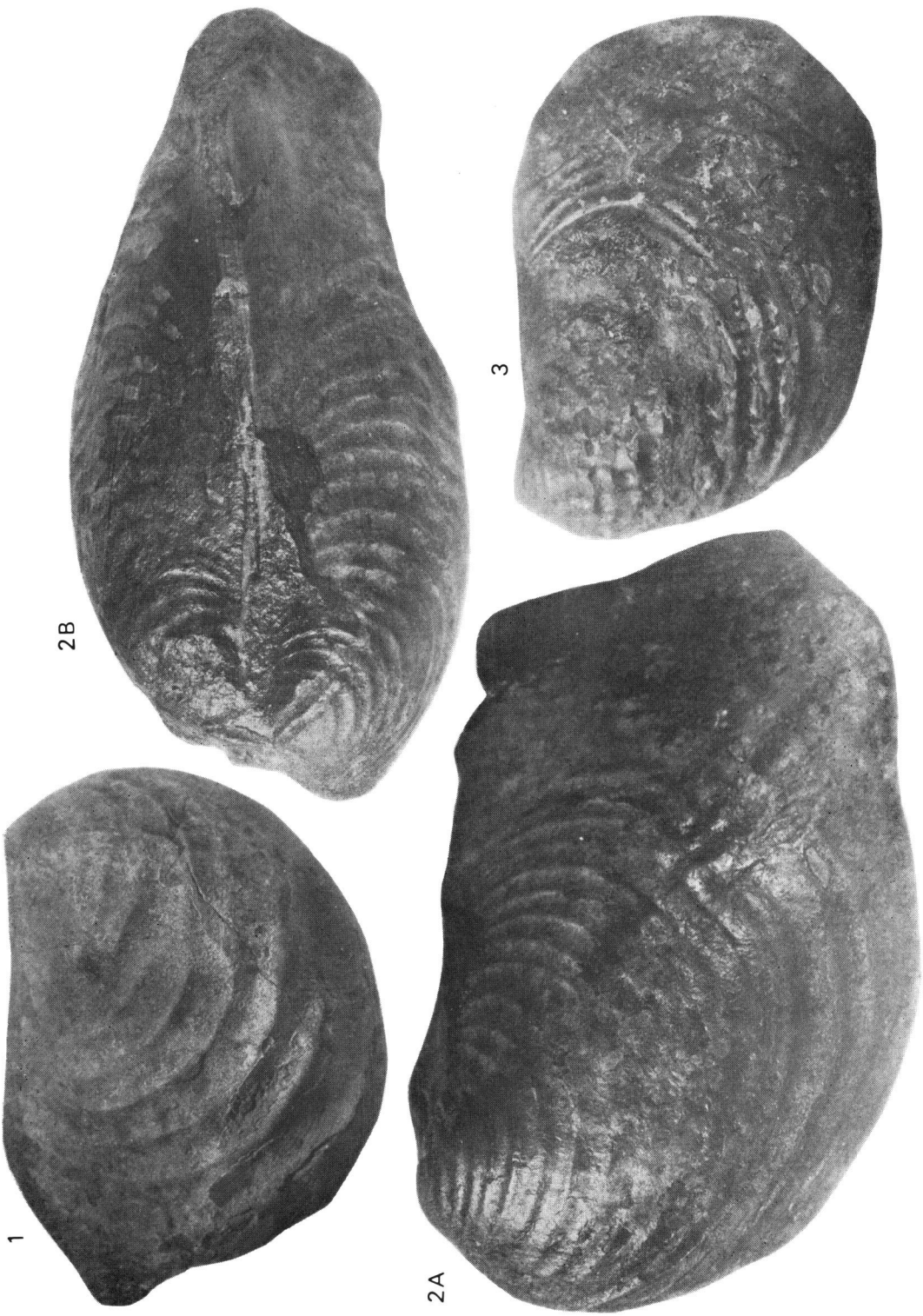
Fig. 1. *Inoceramus* (*Cordiceramus*) *pseudoregularis* SORNAY ×0.9
NSM. PM9354 from loc. Mb18. lateral view of right valve.
Fig. 2. *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY natural size
NSM. PM9356 from loc. Mb18. 2A: lateral view of left valve and 2B: dorsal view.
Fig. 3. *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY natural size
NSM. PM9319 from loc. Mb3. lateral view of left valve.

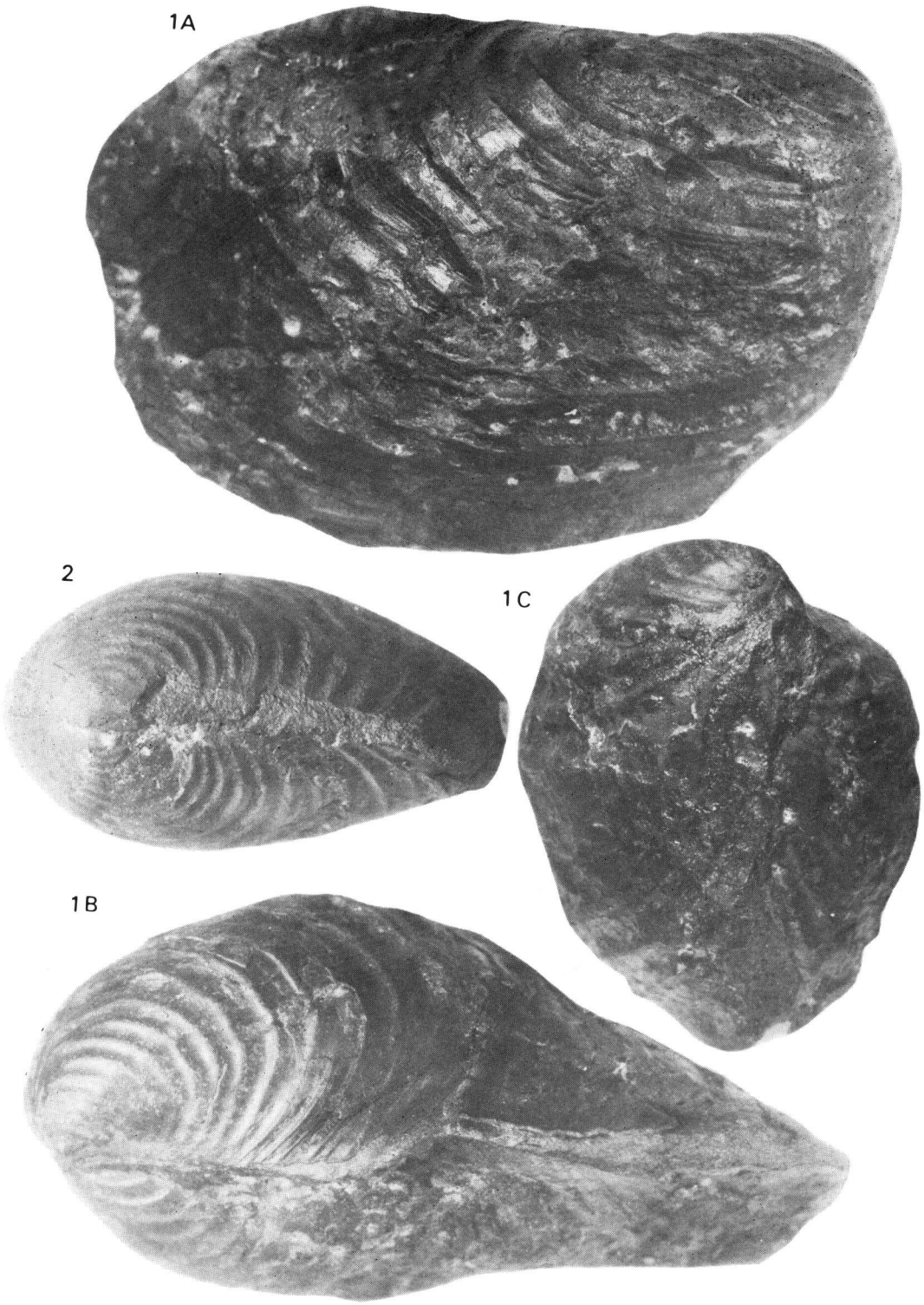
Plate 4

Fig. 1. *Inoceramus* (*Cordiceramus*) *ampambaensis* SORNAY ×0.9
NSM. PM9358 from loc. Mb18. 1A: lateral view of right valve, 1B: dorsal view and 1C: anterior view.
Fig. 2. *Inoceramus* (*Selenoceramus*) *flexus* SORNAY ×0.8
NSM. PM9302 from loc. Mb3. dorsal view.


1
2
3
4A
4B


2
4A
4B
MAD. 1045
1
3


1
2A
2B
3


1A
2
1C
1B