

WITH AUTHORS'
COMPLIMENTS

ANNIE V. DHONDT and IGINIO DIENI

EARLY CRETACEOUS BIVALVES OF EASTERN SARDINIA

(with 25 text-figures and 13 plates)



PADOVA
SOCIETÀ COOPERATIVA TIPOGRAFICA
1988

ANNIE V. DHONDT* and IGINIO DIENI**

EARLY CRETACEOUS BIVALVES OF EASTERN SARDINIA

CONTENTS

ABSTRACT	1
RÉSUMÉ	1
RIASSUNTO	2
INTRODUCTION	2
EARLY CRETACEOUS BIVALVE FAUNAS	2
COMPARISONS AND PALAEOBIOGEOGRAPHY	5
SYSTEMATIC DESCRIPTIONS	9
ACKNOWLEDGMENTS	61
REFERENCES	61

Key words: Bivalves (Mollusca), Early Cretaceous, Eastern Sardinia, taxonomy, palaeobiogeography.

ABSTRACT

Early Cretaceous bivalves from Eastern Sardinia are described for the first time. Their age ranges from Berriasian to latest Albian. Seventy three species, belonging to forty nine genera, have been identified and discussed; their palaeogeographical and stratigraphical distribution is given. Palaeotaxodonta are represented by two species, Pteriomorphia by forty two, Palaeoheterodonta by three, Heterodonta by twenty four and Anomalode-

smata by two. One new genus is erected: *Euthymipecten*, type-species *Pecten Astierianus* D'ORBIGNY, 1850.

The palaeobiogeographical affinities of the Early Cretaceous Sardinian bivalves are indicated. As for ammonites and brachiopods, they are demonstrated to belong to the Tethyan Realm. A consistent wide geographical distribution (South America, East Africa, Eurasia from Western Europe to Japan via the northern Tethys margin) is documented for a series of Valanginian - Hauterivian bivalve species occurring in Sardinia. In the Albian the distribution of the species from the island is less extensive and is generally restricted to Europe and N. Africa.

RÉSUMÉ

Les bivalves du Crétacé inférieur (Berriasien à Albien supérieur) de la Sardaigne orientale sont décrits pour la première fois. Soixante-treize espèces appartenant à quarante-neuf genres ont été identifiées et discutées; leur répartition paléogéographique et stratigraphique est indiquée. Deux espèces représentent les paléotaxodontes, quarante-deux les ptériomorphes, trois les paléohétérodontes, vingt-quatre les hétérodontes, deux les anomalodesmates. Un nouveau genre est créé: *Euthymipecten*, avec pour espèce-type *Pecten Astierianus* D'ORBIGNY, 1850.

Les affinités paléobiogéographiques des faunes éocrétaées de la Sardaigne sont analysées. Comme pour les ammonites et les brachiopodes les bivalves de l'île appartenaient au domaine de la Téthys. Parmi les bivalves valanginiens - hauteriviens de la Sardaigne de nombreuses espèces avaient une aire de répartition très vaste (Amérique du Sud, Afrique orientale et Eurasie, de l'Europe occidentale au Japon par la marge nord de la Téthys). Au contraire, pendant l'Albien la plupart des espèces avaient une répartition moins étendue, en général limitée à l'Europe et à l'Afrique du Nord.

* Koninklijk Belgisch Instituut voor Natuurwetenschappen, Vautierstraat 29, B-1040 BRUSSEL (Belgium).

** Istituto di Geologia dell'Università, Via Giotto 1, I-35137 PADOVA (Italy).

This work is supported by the Consiglio Nazionale delle Ricerche and by the Ministero della Pubblica Istruzione, Legge 382 (grants 40% and 60%, liable I. DIENI).

RIASSUNTO

Vengono descritti per la prima volta i bivalvi del Cretaceo inferiore della Sardegna orientale; la loro età è compresa tra il Berriasiano e l'Albiano superiore. Sono state identificate e discusse settantatre specie appartenenti a quarantanove generi; di esse si riportano la distribuzione stratigrafica e quella geografica. I Palaeotaxodonta sono rappresentati da due specie, gli Pteriomorpha da quarantadue, i Palaeoheterodonta da tre, gli Heterodonta da ventiquattro e gli Anomalodesmata da due. Viene istituito il nuovo genere *Euthymipecten*, con specie-tipo *Pecten Astierianus* D'ORBIGNY, 1850.

Sono inoltre analizzate le affinità paleobiogeografiche dei bivalvi eocretacei della Sardegna orientale: analogamente alle ammoniti e ai brachiopodi della stessa età, essi risultano appartenere al dominio della Tetide. Per una serie di specie presenti nel Valanginiano-Hauteriviano sardo viene documentata un'ampia distribuzione geografica (Sud America, Africa orientale ed Eurasia, dall'Europa occidentale al Giappone lungo il margine settentrionale della Tetide). La distribuzione delle specie presenti nell'Albiano della Sardegna orientale appare invece meno vasta, essendo generalmente limitata all'Europa e all'Africa settentrionale.

INTRODUCTION

This paper is one result of a long term programme of research at the Institute of Geology, University of Padua, directed towards the illustration of various palaeontological and stratigraphical aspects of the Lower Cretaceous of east-central Sardinia. Monographs on Late Valanginian foraminifers (DIENI and MASSARI, 1966), Late Valanginian — Late Albian cephalopods (WIEDMANN and DIENI, 1968) and brachiopods (DIENI, MIDDLEMISS and OWEN, 1975), latest Albian hydrozoans (DIENI and TURNŠEK, 1980) have already been published. Other papers, devoted to gastropods and echinoids, are being prepared and will continue the systematic description of the Sardinian Cretaceous macrofaunas with the intention of increasing knowledge on the palaeogeographical and geodynamic evolution of the western Mediterranean.

The bivalves described herein were collected during field researches by one of us (I.D.) in the period 1962-85 and come from all the areas in Eastern Sardinia where Lower Cretaceous formations outcrop. Their age ranges from Berriasian to latest Albian. The localities from which the specimens were obtained are indicated in the sketch map on text — fig. 1. Geological, lithological and stratigraphical descriptions of the Lower Cretaceous sequences of Eastern Sardinia can be found in DIENI and MASSARI (1963, 1965, 1985a and 1985b, with references), DIENI, MIDDLEMISS and OWEN (1975), etc.

Bivalves occur frequently in Lower Cretaceous sediments of Eastern Sardinia. Especially in the

Lower Hauterivian they are more diverse and numerous than any other macrofossil group. Despite this, until now, except for the Late Cretaceous rudists from NW Sardinia, the only Cretaceous bivalve species described from the island were "*Exogyra Couloni* Defr." and "*Pecten* cf. *crassitesta* Roem." in DENINGER (1907).

The available bivalve material is extensive: 73 species, representing 49 genera, have been recognised so far. Nevertheless, it is certain that further field work aimed exclusively at the collecting of fossils would still increase the number of taxa.

The preservation of the specimens is variable. The Berriasian - Hauterivian material is often present as internal or composite moulds, which is the normal state for bivalve fossils of that age from SW Europe. The Albian specimens are fairly well preserved, though rare for some species.

The purpose of this paper is to give a taxonomic inventory of the bivalve species collected so far from Eastern Sardinia. This allows to situate the Sardinian faunas in a wider palaeobiogeographic setting. No palaeoecological reconstruction is attempted. When all the macrofossil groups shall have been studied the complete data shall be used for a palaeoenvironmental interpretation.

EARLY CRETACEOUS BIVALVE FAUNAS

The Early Cretaceous species recognised are the following:

PALAEOTAXODONTA

NUCULIDAE

Nucula (*Leionucula*) *planata* DESHAYES in LEYMERIE

NUCULANIDAE

Nuculana (*Jupiteria*?) *phaseolina* (MICHELIN)

PTERIOMORPHIA

PARALLELODONTIDAE

Grammatodon (*Nanonavis*) *securis* (LEYMERIE)

CUCULLAEIDAE

Cucullaea (*Idonearca*) *glabra* PARKINSON

Cucullaea (*Noramyia*) *gabrielis* LEYMERIE

Cucullaea (*Noramyia*) "*gresslyi*" (DE LORIOI)

MYTILIDAE

Inoperna *flagellifera* (FORBES)

PINNIDAE

Pinna (*Pinna*) *robinaldina* D'ORBIGNY

Pinna (*Pinna*) *sulcifera* DESHAYES in LEYMERIE

Pinna (*Stegoconcha*?) *hombresi* PICTET and

CAMPICHE

BAKEVELLIIDAE

Gervillaria *alaeformis* (SOWERBY)

Gervillaria *sowerbyana* (MATHÉRON)

Gervillaria cf. *sowerbyana* (MATHÉRON)
Gervillella anceps (DESHAYES in LEYMERIE)
Gervillella cf. *sublanceolata* (D'ORBIGNY)
Pseudoptera anomala (SOWERBY)

INOCERAMIDAE
Inoceramus ex gr. *neocomiensis* D'ORBIGNY
Birostrina concentrica (PARKINSON)
Birostrina subsulcata (WILTSHIRE)
Birostrina sulcata (PARKINSON)

ISOGNOMIDAE
Isognomon (*Isognomon*) *ricordeanus* (D'ORBIGNY)

PROPEAMUSSIIDAE
Propeamussium ninae (KARAKASCH)

PECTINIDAE
Entolium orbiculare (SOWERBY)
Camptonectes cottaldinus (D'ORBIGNY)
Chlamys? *archiaciana* (D'ORBIGNY)
Chlamys? cf. *elongata* (LAMARCK)
Mimachlamys robinaldina (D'ORBIGNY)
Euthymipecten astierianus (D'ORBIGNY)
Neithea (*Neithea*) *atava* (ROEMER)
Neithea (*Neithella*) *valangiensis* (PICTET and CAMPICHE)

PLICATULIDAE
Plicatula placunaea LAMARCK

SPONDYLIDAE
Spondylus gibbosus D'ORBIGNY
Spondylus roemeri DESHAYES in LEYMERIE

LIMIDAE
Acesta dorbignyana (MATHÉRON)
Acesta subovalis (SOWERBY)
Acesta cf. *subrigida* (ROEMER)
Ctenoides? *undatus* (DESHAYES in LEYMERIE)
Limaria? *dubisiensis* (PICTET and CAMPICHE)
Limaria? *elongata* (SOWERBY)
Plagiostoma globosum (SOWERBY)

GRYPHAEIDAE
Aetostreon latissimum (LAMARCK)
Ceratostreon boussingaulti (D'ORBIGNY)
Ceratostreon cf. *tuberculiferum* (KOCH and DUNKER)

OSTREIDAE
Rastellum "rectangulare" (ROEMER)

PALAEOHETERODONTA

TRIGONIIDAE
Trigonia (*Trigonia*) *carinata* AGASSIZ
Quadratrigonia nodosa (SOWERBY)
Pterotrigonia sp.

HETERODONTA

LUCINIDAE
"Lucina" valdensis PICTET and CAMPICHE
"Lucina" sp.

MACROMYIDAE
Thetis minor SOWERBY

FIMBRIIDAE
Sphaera corrugata SOWERBY

ASTARTIDAE
Astarte (*Astarte*) *numismalis* D'ORBIGNY
Eriphyla gigantea (DESHAYES in LEYMERIE)
Ptychomya (*Ptychomya*) *plana* AGASSIZ

CARDIIDAE
"Cardium" gillieronii PICTET and CAMPICHE
"Cardium" sp.
Integricardium deshayesianum (DE LORIOI)
Pleuriocardia? *raulianiana* (D'ORBIGNY)
Pleuriocardia? *voltzii* (D'ORBIGNY)
Protocardia impressa (DESHAYES in LEYMERIE)
Protocardia peregrina (D'ORBIGNY)

ARCTICIDAE
Proveniella bernensis (LEYMERIE)
Proveniella crassicornis (AGASSIZ)

VENERIDAE
Flaventia brongniartina (LEYMERIE)
"Venus" cornueliana D'ORBIGNY
"Venus" thurmanni DE LORIOI
"Venus" vendoperana (LEYMERIE)

GASTROCHAENIDAE
Gastrochaena cf. *brevis* PICTET and CAMPICHE
Gastrochaena cf. *sinuosa* PICTET and CAMPICHE

HIATELLIDAE
Panopea gurgitis (BRONGNIART in CUVIER)

REQUIENIIDAE
Matheronia (*Matheronia*) *rougonensis* MONGIN

ANOMALODESMATA

PHOLADOMYIDAE
Pholadomya gigantea (SOWERBY)

LATERNULIDAE
Platymyoidea rostrata (AGASSIZ).

The frequency of bivalve species in the various Lower Cretaceous formations of Eastern Sardinia is not uniform.

In Berriasian - Early Valanginian deposits the specimens are generally poorly preserved. The following species have been collected: *Gervillaria* cf. *sowerbyana* (MATHÉRON) *Pterotrigonia* sp. *"Lucina" sp.* *"Cardium" gillieronii* PICTET and CAMPICHE *"Cardium" sp.* *Matheronia* (*Matheronia*) *rougonensis* MONGIN.

Macrofossils of early Late Valanginian age are uncommon and badly preserved. The following bivalve species have been collected: *Euthymipecten astierianus* (D'ORBIGNY) *Astarte* (*Astarte*) *numismalis* D'ORBIGNY *Pholadomya gigantea* (SOWERBY).

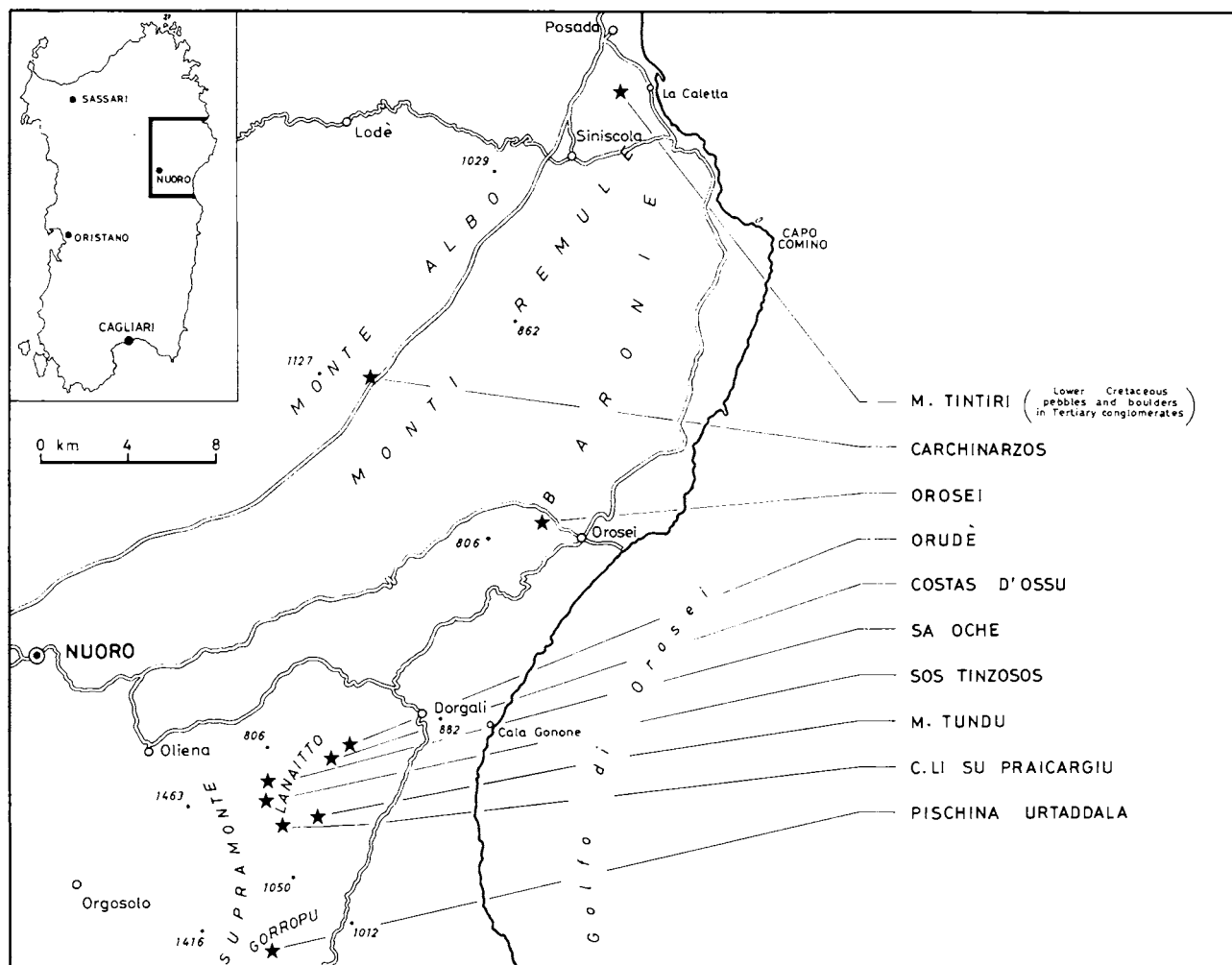


FIG. 1 - Localities from which the described Early Cretaceous bivalves were obtained.

Latest Valanginian - Early Hauterivian⁽¹⁾ beds are very rich in macrofossils and are extended widely and outcropping practically everywhere in Eastern Sardinia where the Lower Cretaceous is present. From those deposits the following bivalve species have been collected:

Nucula (*Leionucula*) *planata* DESHAYES in LEYMERIE
Grammatodon (*Nanonavis*) *securis* (LEYMERIE)
Cucullaea (*Noramyia*) *gabrielis* LEYMERIE
Cucullaea (*Noramyia*) "*gresslyi*" (DE LORIO)
Pinna (*Pinna*) *robinaldina* D'ORBIGNY
Pinna (*Pinna*) *sulcifera* DESHAYES in LEYMERIE
Pinna (*Stegoconcha*?) *hombresi* PICTET and CAMPICHE
Gervillaria *alaeformis* (SOWERBY)
Gervillaria *sowerbyana* (MATHÉRON)
Gervillella *anceps* (DESHAYES in LEYMERIE)
Inoceramus ex gr. *neocomiensis* D'ORBIGNY

Isognomon (*Isognomon*) *ricordeanus* (D'ORBIGNY)
Entolium *orbiculare* (SOWERBY)
Camptonectes *cottaldinus* (D'ORBIGNY)
Chlamys? *archiaciana* (D'ORBIGNY)
Chlamys? cf. *elongata* (LAMARCK)
Mimachlamys *robinaldina* (D'ORBIGNY)
Neithea (*Neithea*) *atava* (ROEMER)
Neithea (*Neithella*) *valangiensis* (PICTET and CAMPICHE)
Plicatula *placuna* LAMARCK
Spondylus *roemeri* DESHAYES in LEYMERIE
Acesta *dorbignyana* (MATHÉRON)
Acesta cf. *subrigida* (ROEMER)
Ctenoides? *undatus* (DESHAYES in LEYMERIE)
Limaria? *dubisiensis* (PICTET and CAMPICHE)
Aetostreon *latissimum* (LAMARCK)
Ceratostreon *boussingaulti* (D'ORBIGNY)
Ceratostreon cf. *tuberculiferum* (KOCH and DUNKER)
Rastellum "*rectangulare*" (ROEMER)
Trigonia (*Trigonia*) *carinata* AGASSIZ
Quadratrigonia *nodosa* (SOWERBY)
Thetis *minor* SOWERBY
Sphaera *corrugata* SOWERBY

⁽¹⁾ In Eastern Sardinia uppermost Valanginian and Lower Hauterivian occur in the same facies and therefore they have been considered together; generally the species recognised in the uppermost Valanginian are also found in the Lower Hauterivian.

Astarte (Astarte) numismalis D'ORBIGNY
Eriphyla gigantea (DESHAYES in LEYMERIE)
Ptychomya (Ptychomya) plana AGASSIZ
Pleuriocardia? voltzii (LEYMERIE)
Protocardia impressa (DESHAYES in LEYMERIE)
Protocardia peregrina (D'ORBIGNY)
Integricardium deshayesianum (DE LORIOL)
Proveniella bernensis (LEYMERIE)
Flaventia brongniartina (LEYMERIE)
"Venus" cornueliana D'ORBIGNY
"Venus" thurmanni DE LORIOL
"Venus" vendoperana (LEYMERIE)
Gastrochaena cf. sinuosa PICTET and CAMPICHE
Panopea gurgitis (BRONGNIART in CUVIER)
Pholadomya gigantea (SOWERBY)
Platymyoidea rostrata (AGASSIZ).

Late Aptian and Late Albian bivalves have been found only in small outcrops in the Oro-sei area. From Upper Aptian only two species were collected:

Spondylus gibbosus D'ORBIGNY
"Lucina" valdensis PICTET and CAMPICHE.

The Late Albian (Vraconian included) bivalves are represented by the following species:

Nuculana (Jupiteria?) phaseolina (MICHELIN)
Cucullaea (Idonearca) glabra PARKINSON
Inoperna flagellifera (FORBES)
Gervillella cf. sublanceolata (D'ORBIGNY)
Pseudoptera anomala (SOWERBY)
Birostrina concentrica (PARKINSON)
Birostrina subsulcata (WILTSHIRE)
Birostrina sulcata (PARKINSON)
Propeamussium ninae (KARAKASCH)
Acesta subovalis (SOWERBY)
Limaria? elongata (SOWERBY)
Plagiostoma globosum (SOWERBY)
Pleuriocardia? rauliniana (D'ORBIGNY)
Proveniella crassicornis (AGASSIZ)
Gastrochaena cf. brevis PICTET and CAMPICHE.

The absence in the paper of descriptions of Late Hauterivian — Early Aptian bivalves is due to the fact that the generally scarce material collected from the hard limestones which represent that time interval is too incomplete for precise identification.

COMPARISONS AND PALAEOBIOGEOGRAPHY

Early Cretaceous bivalves have been frequently studied, but not all the published information is comparable. In some regions more palaeontological work has been done than in others, some faunas have been studied or re-studied recently, others not; the subjective interpretations of species change very much from one author to another, etc. The

result is a disparate set of data which have been re-interpreted herein partly after seeing original specimens, partly after critically reassessing existing literature. Whenever possible the interpretation has been based on publications with illustrations; records of species quoted only in lists generally have been avoided.

The regions selected for comparisons have been chosen pragmatically. Although Siberian and Canadian Early Cretaceous bivalves have been well studied recently (ZAKHAROV, 1966, 1970; etc.), they are not discussed here because they have virtually no elements in common with the Sardinian faunas. They belong to different palaeobiogeographic regions: the "boreal Lower Cretaceous" of CASEY and RAWSON (1973).

North American faunas from Texas and Mexico have been described frequently from Early Cretaceous deposits, especially of Aptian - Albian age (BÖSE, 1910; ADKINS, 1928; ALENCÁSTER, 1957; PERKINS, 1960; SCOTT, 1970; etc.), but they seem to have relatively few species in common with other areas and are therefore not used for comparison herein.

Between the regions selected for comparisons the data available are not equally complete. Good data exist for Switzerland (PICTET and ROUX, 1847-53; PICTET and RENEVIER, 1854-58; DE LORIOL, 1861, 1868; PICTET and CAMPICHE, 1864-71), England (WOODS, 1899 - 1913; KELLY, 1984), Germany (WOLLEMAN, 1896, 1900, 1909; KEMPER, 1968; etc.), Poland (PASSENDORFER, 1930; KOKOSZYNSKA, 1949; CIEŚLINSKI, 1960), Bulgaria (DIMITROVA, 1974), USSR (Moldavia: SOBETSKI, 1961, 1977. Ukraine: PASTERNAK *et al.*, 1968. Crimea - Caucasus: KARAKASCH, 1897, 1907; RENNGARTEN, 1926; PČELINCEV, 1927; MORDVILKO *et al.*, 1949; ERISTAVI, 1955, 1957; MUROMTSIEVA and JANIN, 1960; KOTETISHVILI, 1965, 1977. Kopet Dag, Mangyshlak, Turkmenia: BOGDANOVA, 1961, 1966; PROZOROVSKII *et al.*, 1961; KRIMHOLZ, 1962), Somalia - Ethiopia (COX, 1935; TAVANI, 1948, 1949). Less comprehensive literature exists for France (D'ORBIGNY, 1844-1847; GILLET, 1924-1925; FRENEIX, 1959; MONGIN, 1979a). For Spain no well illustrated revision of the Early Cretaceous bivalve faunas has been published since COQUAND (1865-66). NW African faunas have been studied frequently (COQUAND, 1862; PÉRON, 1889-91; PERVINQUIÈRE, 1912; GIGOUT, 1951; DARTEVELLE and FRENEIX, 1957; FRENEIX, 1972; etc.). This applies equally to the Tendaguru Beds of Tanzania (KRENKEL, 1910; LANGE, 1914; DIETRICH, 1933), and to Madagascar (COLLIGNON, 1949, etc.). For Japan many very reliable data are known (HAYAMI, 1965a,b, 1966, 1975, etc.), but a somewhat provincial nomenclature makes their in-

terpretation difficult. Publications, sometimes somewhat incomplete, are available for South America (D'ORBIGNY, 1842; BURCKHARDT, 1900, 1903; WEAVER, 1931; FERUGLIO, 1936-1938; etc.).

Despite the limitations of the information existing on Early Cretaceous bivalve faunas their comparison with those from Eastern Sardinia remains worthwhile. The results allow to confirm the palaeogeographic position of the island before its Tertiary counterclockwise rotation.

The stratigraphic and geographic distribution, often visualised on palaeogeographic maps, is added in the systematic part for each species described from Eastern Sardinia.

Unfortunately, only the latest Valanginian — Early Hauterivian and Late Albian bivalve assemblages from Eastern Sardinia are extensive enough to warrant a comparison with those of other regions.

For the latest Valanginian — Early Hauterivian the results are as follows: the fauna studied consists of 49 species (see p. 4), of which 47 are useable for comparison [*Cucullaea* (N.) "*gresslyi*" and *Gastrochaena* cf. *sinuosa* have not been considered for different reasons]. After comparing data on these 47 species we notice that:

- 46 (= 98%) are in common with the Swiss Valanginian - Hauterivian faunas;
- 42 (= 89%) are in common with the Paris Basin Valanginian - Hauterivian faunas;
- 39 (= 83%) are in common with the Valanginian - Hauterivian from Crimea;
- 38 (= 81%) are in common with the Valanginian - Hauterivian from SE France;
- 37 (= 79%) are in common with the Valanginian - Hauterivian from the Caucasus;
- > 30 (= > 64%) are in common with Valanginian - Hauterivian faunas from Bulgaria (the figure obtained does not include data on the oysters, which have not been described in recent literature);
- 31 (= 66%) are in common with the Valanginian - Hauterivian from N. Germany;
- 22 (= 47%) are in common with the Valanginian-Barremian from Kazakhstan and Central Asia (Kopet Dag, Mangyshlak, Turkmenia);
- 21 (= 45%) are in common with Valanginian - Aptian faunas of S. England;
- 19 (= 40%) are in common with Neocomian and mainly Aptian faunas from Spain;
- 18 (= 38%) are in common with Neocomian and Aptian faunas from NW Africa;
- 15 (= 32%) are in common with Barremian - Aptian faunas of Somalia - Ethiopia;
- 13 (= 28%) are in common with Neocomian -

Aptian faunas from the Tendaguru Beds in Tanzania;

- 12 (= 26%) are in common with the Neocomian faunas from Chile and Argentina;
- 9 (= 19%) are in common with Neocomian and mainly Aptian faunas from Japan;
- 7 (= 15%) are in common with Valanginian - Hauterivian faunas of N. England;
- 6 (= 13%) are in common with Neocomian faunas from Peru and Columbia.

These data cannot all be taken literally: an evaluation is certainly necessary for those regions for which no "complete" or recent publications exist. Hence f.i. it is highly probable that new research would allow to increase the number of species in common with SE France and possibly also with Spain. For regions in Africa and South America it is at present difficult to judge how the affinities are oriented.

Taking the results of the comparisons into account, it is obvious that during the latest Valanginian - Early Hauterivian and from a palaeobiogeographic view point, Sardinia was part of the same entity as Switzerland, the Paris Basin, the region around Marseille, Bulgaria, Crimea, Caucasus. These regions (except for the Paris Basin) are considered by KAUFFMAN (1973) as belonging to the Mediterranean Province of the Tethyan Realm. The most striking affinity exists between Sardinian and Swiss faunas. There seem not to be quite as many similarities with SE France, and definitely fewer with N. Africa and Spain. As said above these latter data have to be interpreted with caution because they are probably based on incomplete information.

Our results are in accordance with the palaeobiogeographic subdivisions of MIDDLEMISS (1979) based on brachiopods. He distinguished three faunas: Boreal Fauna, Tethyan Fauna, Jura Fauna. The bivalve assemblage of Valanginian-Hauterivian age from Eastern Sardinia can be easily related to the "Jura Fauna" subdivision, even more so than it is the case for brachiopods since no faunal elements have been found in the island which are not already present in Switzerland. The "Jura Fauna" of MIDDLEMISS extends into SE France and Central Asia. The incomplete data which we have for Central Asia do not allow to completely confirm MIDDLEMISS's interpretation but it seems plausible.

Data for Spain and NW Africa are scant and bring no definite answer. On the other hand comparison of Sardinian Valanginian - Hauterivian bivalves with northern regions shows, as stated earlier, no similarity with Siberia and Canada; very few species are in common with N. England but more with N. Germany, and this when data are definitely good on all four regions.

Results obtained for bivalves agree not only with the brachiopod distribution, but also the Sardinian ammonites from that time interval (WIEDMANN and DIENI, 1968) undoubtedly belong to the "Mediterranean Province": none of them are "boreal" [unlike what THIEULOY (1977) described for the ammonite faunas from SE France, "province subméditerranéenne"]. KOTETISHVILI (1983) divided the Early Cretaceous ammonite genera depending on their palaeobiogeographic distribution. The taxa from Sardinia fall within the "Mediterranean" fauna as understood by her. But her "Mediterranean" province is largely restricted to the northern Tethys border. Hence, the problem becomes one of definition. In how far the southern border (i.e. North Africa) had the same fauna is difficult to judge: the differences indicated may be real, but the available information could be incomplete, especially for bivalves.

For other regions, further away from Europe, data are relatively rare, but f.i. already LANGE (1914, p. 271) stressed the presence of Mediterranean elements in the Tendaguru faunas, and many authors have pointed out similarities between South American and European Neocomian faunas.

For Japan since the last century authors indicated close relationships between some Japanese and European bivalves; HAYAMI (1965, 1966, and later) showed the analogies especially between Aptian Japanese taxa and those mainly from S. England of the same age (many Aptian species originate in the Valanginian - Hauterivian and therefore the comparison is justified here). Hence, it is tempting to include Japan in the Tethys, and further research with less provincial nomenclature shall probably confirm this palaeobiogeographic hypothesis.

For the Late Albian 15 species have been identified from Eastern Sardinia. Literature on bivalves of this age is not as abundant as on those from the Valanginian - Hauterivian interval. Nevertheless, comparisons have been attempted, and if the result is not totally convincing it certainly indicates a trend.

On the 15 species recorded from Orosei, 14 can be used for comparisons (*Gastrochaena* cf. *brevis* has been excluded):

- 12 (= 86%) occur also in the Paris Basin (Albian);
- 9 (= 64%) occur also in Switzerland (Aptian - Albian);
- 9 (= 64%) occur also in Poland (Albian);
- 8 (= 57%) occur also in Belgium (Albian);
- 8 (= 57%) occur also in England (Albian: "Gault");
- 6 (= 43%) occur also in SE France (Aptian - Albian);

- 6 (= 43%) occur also in Crimea (Aptian - Albian);
- 6 (= 43%) occur also in the Caucasus (Aptian - Albian);
- 5 (= 36%) occur also in England (Late Albian - Cenomanian: "Upper Greensand");
- 5 (= 36%) occur also in N. Germany (Aptian - Albian);
- 4 (= 29%) occur also in Spain (Aptian - Albian);
- 4 (= 29%) occur also in Morocco (Albian);
- 4 (= 29%) occur also in Bulgaria (Albian);
- 4 (= 29%) occur also in Moldavia (Albian);
- 3 (= 21%) occur also in Transcaucasia (Albian).

Among the species from the Albian four have a very wide geographic distribution: *Inoperna flagellifera*, *Birostrina concentrica*, *B. subsulcata*, *B. sulcata*. The others generally have a more limited areal occurrence: from S. England to the North to the Caucasus in the East. They are present in the northern part of the epicontinental seas in the North European Province of the North Temperate Realm and in the Indo-Mediterranean Region of the Tethyan Realm (KAUFFMAN, 1973).

Despite its small size the Late Albian bivalve assemblage of Eastern Sardinia shows obvious similarities with coeval Anglo - Paris Basin, Swiss and Polish faunas. Areas on the northern Tethys margin, such as the Caucasus, Crimea etc., have some species in common. The pattern is possibly the same as during the Valanginian - Hauterivian interval, but a more northern influence is also marked.

The relatively wide distribution of the species during the Late Albian is probably connected with the wide spread transgression which characterised that time-span. The lack of similarity with Upper Greensand faunas reflects differences in palaeoenvironment between the Sardinian deposits and Upper Greensand. On the other hand the faunas from the "Gault" facies are near those from the Orosei area.

The absence of species belonging to *Aucellina* POMPECKJ, 1901, in the Sardinian assemblage shows that the influence of northern European faunas was not very strong. *Aucellina coquandiana* (D'ORBIGNY, 1845), described from Escagnolles (Alpes-Maritimes) (as confirmed later by PARONA and BONARELLI, 1897) and from the stratotype of the Vraconian (PICTET and CAMPICHE, 1869; MORTER and WOOD, 1983) has so far not been found in beds of exactly the same age in Sardinia.

When comparing Albian and Valanginian - Hauterivian bivalve faunas from Eastern Sardinia, it becomes evident that the Albian species are on

average less widely distributed: except for inoceramids and *Inoperma flagellifera*, none of the species extend into America or East Africa.

We have in the preceding part compared faunas in a semi-quantitative analysis: giving equal value to each species and only taking into account the number of species from each area also occurring in Sardinia; the extension of the geographic distribution of the species has been given at the same time.

The only paper written about biogeography of Cretaceous Bivalvia on a worldwide scale is that of KAUFFMAN (1973) and it uses a more qualitative approach of the taxa. Though very interesting the paper, based only on genera, has limitations which are due to the origin of the data, taken mainly from the *Treatise* (MOORE ed., 1969-1971), as clearly stated by the author. As a result, the lists of the genera given by him as occurring f.i. in "restricted" regions such as the North European Province of the North Temperate Realm contain several taxa which seem to have had a much wider distribution in the Early Cretaceous. Examples of such genera occurring in Sardinia with species of Early Hauterivian age and which have a much wider distribution (South America, W. Europe, W. Asia, E. Africa, sometimes reaching as far as Japan) including South and North Temperate and Tethyan Realms are:

Gervillaria (*G. alaeformis* and *G. sowerbyana*, distribution on text-fig. 7), *Ceratostreon* (*C. boussingaulti*, distribution on text-fig. 18), *Aetostreon* (*A. latissimum*, distribution on text-fig. 18), *Sphaera* (*Sphaera corrugata*, distribution on text-fig. 20), *Ptychomya* (*Ptychomya*) (*Pt. plana*, distribution on text-fig. 21), *Platymyoidea* (*Pl. rostrata*, distribution on text-fig. 25). Similar occurrence is found for *Grammatodon* (*Nanonavis*) (*G. securis*, distribution on text-fig. 2), in KAUFFMAN only "North Temperate". Genera not mentioned by KAUFFMAN but with an equally wide distribution are *Gervillella* (*G. anceps*, distribution on text-fig. 7) and *Mimachlamys* (*M. robinaldina*, distribution on text-fig. 13). We also find wide distributions for some of the genera which KAUFFMAN did already list as cosmopolitan or as trans-temperate: *Pinna* (*Pinna robinaldina*, distribution on text-fig. 6), *Inoceramus* (*In. neocomiensis*), *Isognomon* (*Is. ricordeanus*, distribution on text-fig. 10), *Entolium* (*E. orbiculare*, distribution on text-fig. 12), *Neithea* (*Neithea*) (*N. atava*, distribution on text-fig. 14), *Rastellum* (*R. rectangulare*), *Trigonia* (*T. carinata*, distribution on text-fig. 19), *Pholadomya* (*Ph. gigantea*, distribution on text-fig. 25), *Panopea* (*P. gurgitis*, distribution on text-fig. 24). However, we would like to draw attention to the fact that during the Neocomian certain of these "cosmopoli-

tan" genera did not reach Siberia and Canada: throughout the Cretaceous they are generally restricted to warm-temperate and Tethyan seas. Examples: *Neithea*, *Rastellum* (already stated by KAUFFMAN), *Trigonia*, etc. (when Cretaceous "warm-temperate" bivalve genera are found in relatively northern localities they occur in deposits of shallow water and are often accompanied by corals and solitary rudists).

Among the 49 species recorded from the Upper Valanginian - Lower Hauterivian of Eastern Sardinia, 21 species have a very wide geographical distribution. The 28 remaining species can be divided in four groups.

Group 1 is found in the Tethys and in the Paris Basin (the latter a part of the North Temperate Realm): 13 species [*Pinna* (*P.*) *sulcifera*, *Camptonectes cottaldinus*, *Chlamys? archiaciana*, *Neithea* (*Neithella*) *valangiensis*, *Spondylus roemeri*, *Acesta dorbignyana*, *Thetis minor*, *Eriphyla gigantea*, *Pleuriocardia? voltzii*, *Protocardia impressa*, *Protocardia peregrina*, *Proveniella bernensis*, *Flaventia brongniartina*].

Group 2 is found in the Tethys, the Paris Basin and Germany (the last two part of the North Temperate Realm): 8 species [*Pinna* (*Stegoconcha?*) *hombresi*, *Chlamys? elongata*, *Plicatula placunaea*, *Ctenoides? undatus*, *Limaria? dubisiensis*, *Ceratostreon tuberculiferum*, *Quadratortrigonia nodosa*, *Integricardium deshayesianum*].

Group 3 is found in the Tethys, the Paris Basin, Germany and Northern England ("Yorkshire") (the last three part of the North Temperate Realm): 2 species [*Nucula* (*Leionucula*) *planata*, *Acesta subrigida*].

Group 4 is found mainly in Sardinia and Switzerland (sometimes in the Paris Basin and occasionally in Spain): 5 taxa [*Cucullaea* (*Noramyia*) "*gresslyi*", "*Venus*" *cornueliana*, "*V.*" *thurmanni*, "*V.*" *vendoperana*, *Gastrochaena* cf. *sinuosa*]. These five taxa are poorly known and therefore not significant palaeobiogeographically.

The first three groups which can be individualised after isolating the widespread cosmopolitan species, demonstrate the same palaeobiogeographic patterns as already discussed above and reached through the semi-quantitative method. Both systems thus show that during the Neocomian two major faunal entities existed: 1) boreal fauna *sensu* CASEY and RAWSON (= cold North Temperate Realm of KAUFFMAN, 1973), 2) warm-temperate - Tethyan fauna (= southern part of North Temperate + Tethyan + northern part of South Temperate Realms of KAUFFMAN, *op. cit.*). In regions connecting the boreal and northern warm-temperate seas a mixture of the two faunas is found,

and that especially at moments of maximal transgressions. In Europe and North Africa, within the second entity, a smaller faunal region can be recognised, which includes the Paris Basin *s.l.* and the northern Tethys margin from Spain to Central Asia, for which MIDDLEMISS (1979) introduced the name "Jura Fauna".

SYSTEMATIC DESCRIPTIONS

The bivalves from the Lower Cretaceous of Eastern Sardinia have generally been classified in this paper according to MOORE (1969, 1971). Most instances of change therefrom are explained in the text. For the Pectinidae the classification is that used recently by most pectinid workers (WALLER, 1978; JOHNSON, 1984; etc.).

Abbreviations used:

n.: number referring to the specimens in the Collections of the Geological Institute of the University of Padua, Italy (Coll. Sardinian Lower Cretaceous Bivalves and Gastropods).

H: height (distance between two planes parallel to cardinal axis and perpendicular to plane of commissure which just touch most dorsal and ventral parts of shell; MOORE, 1969).

L: length (antero-posterior distance of the valves, as defined in MOORE, 1969).

B: distance between two planes parallel to planes of commissure and touching the outermost parts of the two valves or of their moulds (= "inflation" in MOORE, 1969).

B': distance between plane of commissure and a parallel plane touching the point of maximum convexity of an isolated valve or its mould.

UA: umbonal angle.

R: rib number.

IRScNB: Institut royal des Sciences naturelles de Belgique, Bruxelles, Belgium.

MAFI: Magyar Allami Földtani Intézet, Institutum geologicum hungaricum, Budapest, Hungary.

MG: Muséum d'Histoire naturelle de Genève, Geneva, Switzerland.

MNHN: Muséum national d'Histoire naturelle, Institut de Paléontologie, Paris, France.

Palaeogeographical distributions of significant species are shown on maps in text-figures. The maps are based on BARRON *et al.* (1981): 120 million yrs. for the Valanginian-Hauterivian interval, 100 million yrs. for the Aptian-Albian. Because of lack of accuracy in stratigraphic indications for some occurrences outside Sardinia, we have also included records which fall somewhat outside the time interval of the map (for instance: for a species occurring in the Hauterivian of Sardinia, the indica-

tions for other regions on the distribution map could be as young as Aptian).

The age of the Sardinian deposits has been calibrated by ammonites for the Late Valanginian - Albian interval [WIEDMANN and DIENI (1968) and other unpublished data] and by Foraminifera for the Berriasian - Early Valanginian interval [DIENI and MASSARI (1985a) and other unpublished data].

CL. BIVALVIA

Subcl. PALAEOTAXODONTA

Fam. NUCULIDAE

Nucula (Leionucula) planata DESHAYES in LEYMERIE, 1842

Text-fig. 2

- + 1842 *Nucula planata* Desh. - DESHAYES in LEYMERIE, p. 7, pl. 9, figs. 3, 4.
- . 1844 *Nucula obtusa* Fitton - D'ORBIGNY, p. 163, pl. 300, figs. 1-5 (sub *N. planata* Desh.).
- . 1844 *Nucula impressa* Sowerby - D'ORBIGNY, p. 165, pl. 300, figs. 6-10 (sub *N. Cornueliana* d'Orb.).
- . 1858 *Nucula impressa* J. Sowerby - PICTET et RENEVIER, p. 108, pl. 15, figs. 5, 6.
- . 1861 *Nucula Cornueliana*, d'Orbigny - DE LORIOL, p. 84, pl. 10, fig. 6.
- . 1866 *Nucula planata*, Deshayes - PICTET et CAMPICHE, p. 404, pl. 129, figs. 7, 8.
- 1884 *Nucula planata* Desh., in Leym. - GARDNER, p. 126, pl. 5, figs. 1-4.
- 1897 *Nucula planata*, Deshayes - KARAKASCH, p. 65.
- . 1899 *Nucula planata* Deshayes - WOODS, p. 12, pl. 2, figs. 11-15.
- 1900 *Nucula planata* Desh. - WOLLEMAN, p. 82.
- . 1905 *Nucula planata* Desh. - HARBORT, p. 52, pl. 9, fig. 11.
- 1912 *Nucula planata* Deshayes - PERVINQUIÈRE, p. 92.
- 1922 *Nucula planata* Desh. et var. *Cornueliana* d'Orb. - GILLET, p. 55.
- 1924 *Nucula planata* Desh. in Leym. - GILLET, p. 8.
- 1924 *Nucula planata* Desh. var. *Cornueliana* d'Orb. - GILLET, p. 8.
- . 1960 *Nucula planata* Deshayes - MUROMTSIEVA, JANIN, p. 172, pl. 1, figs. 1-4.
- ? 1974 *Nucula planata* Deshayes - OEKENTORP & SIEGFRIED, p. 123, pl. 1, fig. 1.
- 1984 *Nucula planata* Deshayes - FRICOT *et al.*, p. 22, pl. 2, fig. 7.

Material: Two composite bivalved moulds from Carchinarzos (Monte Albo) (n. 345) and from Orosei (n. 759), Lower Hauterivian.

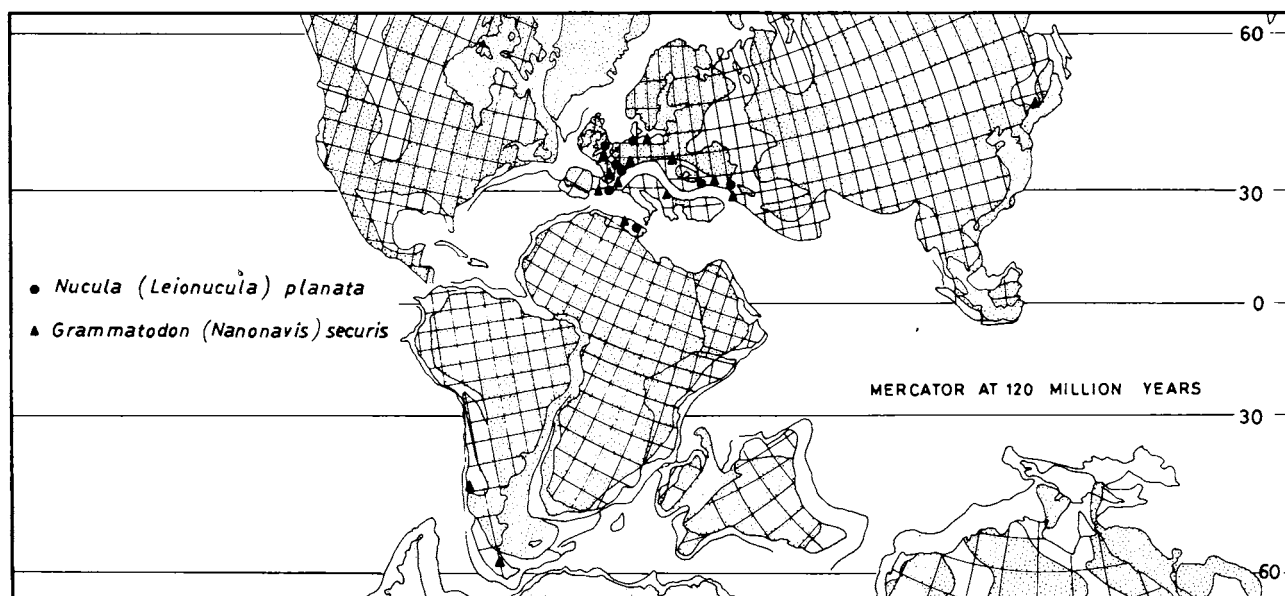


FIG. 2

Dimensions (mm): n. 345: H = 16.3; L = (23.2); B = 10.5.

Discussion: The general outline of the moulds, their inflation, the traces of the lunula and the faint commarginal ornamentation indicate that they belong to *Nucula planata*. They are most similar to fig. 8, on pl. 129 in PICTET and CAMPICHE (1866).

Generic attribution: *Nucula planata* DESHAYES in LEYMERIE is fairly similar to *N. albensis* D'ORBIGNY, type species of *Leionucula* QUENSTEDT. Hence the generic assignment suggested here.

Distribution: Hauterivian to Aptian, North Temperate and Tethyan Realms: S. England, Germany, France, Sardinia, USSR (Crimea, Caucasus), North Africa (Text-fig. 2).

Fam. NUCULANIDAE

Nuculana (*Jupiteria*?) *phaseolina* (MICHELIN, 1938)
Pl. 1, figs. 1a-1c

- + 1838 *Nucula phaseolina* - MICHELIN, p. 102, pl. 12, fig. 6.
- . 1844 *Nucula subrecurva*, Phillips - D'ORBIGNY, p. 170, pl. 301, figs. 7-11 (*non* PHILLIPS, 1829).
- . 1866 *Leda phaseolina*, Pict. et Camp. - PICTET et CAMPICHE, p. 401.
- 1884 *Leda phaseolina*, Michelin - GARDNER, p. 135, pl. 3, figs. 22 - 24; ? pl. 5, figs. 26 - 29.
- 1899 *Nuculana phaseolina* (Michelin) - WOODS, p. 9, pl. 2, figs. 1-3.
- ? 1985 *Nuculana* (*Jupiteria*) *subrecurva* Phillips - MONGIN, p. 50.

Material: One almost complete specimen, with hinge preserved, from the Upper Albian (probably Vraconian) of Orosei (n. 205).

Dimensions (mm): H = (3.6), L = (5.7), B = 2.4.

Discussion: The bivalved shell is translucent and hinge teeth are visible in transparency. The shell is small, subelliptical, convex, slightly inequilateral; escutcheon is narrow, elongate and delimited by ridges; the umbo is not very prominent. The shell is covered with growth lines but not with ribs, and appears smooth. The only specimen from Sardinia agrees better with the figures and description given by D'ORBIGNY (1844) than with the figures in WOODS (1899), especially where it concerns the proportions of the shell shape; it is somewhat more rounded than the English specimens seem to be (GARDNER, 1884; WOODS, 1899).

MONGIN (1985) combined two species generally considered different into *Nuculana* (*Jupiteria*) *subrecurva*: her synonymy included both *Nucula subrecurva* PHILLIPS, 1829 and *N. subrecurva* D'ORBIGNY (= *N. phaseolina* MICHELIN). She added no explanation nor figure, hence the impossibility of interpreting her identification.

Nucula Neckeriana PICTET and ROUX, 1853 (p. 469, pl. 39, fig. 1) from the Albian of E. France resembles *Nuculana phaseolina*, but was described as internal moulds and is therefore difficult to compare. It is not impossible that shelled material of *Nucula Neckeriana* might prove them to be conspecific.

Distribution: Albian of England, France, Sardinia, ? Switzerland.

Subcl. PTERIOMORPHIA

Fam. PARALLELODONTIDAE

Grammatodon (Nanonavis) securis (LEYMERIE, 1842)

Pl. 1, fig. 2; text-fig. 2

- + 1842 *Cucullaea Securis* var. *major* Leym. - LEYMERIE, p. 6, pl. 7, fig. 6.
- ? 1842 *Cucullaea Securis* var. *minor* Leym. - LEYMERIE, p. 6, pl. 7, fig. 7.
- v . 1844 *Arca securis* d'Orbigny - D'ORBIGNY, p. 203, pl. 309, figs. 9, 10.
- . 1861 *Arca securis* (Leym.), d'Orbigny - DE LORIO, p. 85, pl. 10, fig. 7.
- . 1866 *Arca securis* (Leym.), d'Orbigny - PICTET et CAMPICHE, p. 443.
- . 1890 *Cucullaea* cf. *striatella* Mich. - YOKOYAMA, p. 199, pl. 25, fig. 13.
- . 1896 *Arca securis* Leymerie - WOLLEMAN, p. 845.
- . 1897 *Arca (Scapharca) securis* (Leym.), d'Orbigny - KARAKASCH, p. 60, pl. 1, fig. 16; pl. 5, fig. 5.
- . 1899 *Grammatodon securis* (Leymerie) - WOODS, p. 44, pl. 7, figs. 14, 15; pl. 8, figs. 1, 2 (*cum syn.*).
- . 1900 *Arca securis* Leymerie - WOLLEMAN, p. 76.
- . 1900 *Arca (Cucullaea) securis* Leymerie - MAYER - EYMAR in BURCKHARDT, p. 18, pl. 26, figs. 3-5.
- 1907 *Cucullaea securis* Leym. sp. - HAUPT, p. 213, pl. 9, fig. 8.
- 1926 *Grammatodon yokoyamai* Yabe and Nagao nom. nov. - YABE *et al.*, p. 44, pl. 12, figs. 12, 13, 25.
- . 1948 *Arca securis* Leymerie sp. - CHARLES, p. 17.
- 1949 *Grammatodon securis* (d'Orb.) - KOKOSZYNSKA, p. 55, pl. 12, fig. 12.
- ? 1955 *Arca (Grammatodon) securis* Leym. v. *major* Leym. - ERISTAVI, p. 8.
- . 1960 *Grammatodon securis* Leymerie - MUROMTSIEVA, JANIN, p. 177, pl. 2, figs. 9, 10.
- v . 1965 *Nanonavis (Nanonavis) yokoyamai* (Yabe and Nagao) - HAYAMI, p. 238, pl. 27, figs. 8-13.
- 1970 *Grammatodon securis major* Leymerie - KOTETISHVILI, p. 48, pl. 1, fig. 7.
- ? 1974 *Grammatodon (Grammatodon) securis major* (Leymerie) - DIMITROVA, p. 50, pl. 22, figs. 5, 6.
- . 1975 *Grammatodon (Nanonavis) yokoyamai* Yabe and Nagao - HAYAMI, p. 29.

1977 *Grammatodon securis* (Leymerie) - KOTETISHVILI, p. 17, pl. 1, fig. 1.

. 1980 *Grammatodon (Nanonavis) yokoyamai* Yabe and Nagao - HAYAMI and OJI, p. 428, pl. 52, figs. 1-6.

1980 *Grammatodon (Nanonavis) securis* Deshayes - MONGIN, p. 119.

Material: One incomplete left valve, with hinge "teeth" preserved, from Orosei, uppermost Valanginian (n. 4).

Dimensions (mm): H = 20.5; L = 34.8; B' = 11.2.

Description: Ornamentation consists of radial ribs distributed uniformly over the valve and crossed by commarginal growthlines; the resulting pattern is irregularly cancellated. The anterior part of the valve is short and covered with 6 - 7 strongly developed and more widely separated ribs.

Discussion: LEYMERIE (1842) originally divided his *Cucullaea Securis* into var. *major* (of Valanginian age) and var. *minor* (of Albian age); both taxa are similar. Later authors sometimes considered them different but others lumped them together, according to their species concept. As a result a rather confused taxonomic situation arose which is most clearly illustrated in DIMITROVA (1974). The objective differences between var. *major* and var. *minor* are unclear and may be only due to preservation or to size. A series of well preserved specimens of *Grammatodon securis* would probably prove the "varieties" of LEYMERIE to be conspecific.

As already stated by DE LORIO (1861) and by WOODS (1899), *G. carinatum* (SOWERBY, 1813), known from Aptian and Albian deposits, could be synonymous with *G. securis*, which is generally recorded from Valanginian to Aptian. This also applies to *G. (Nanonavis) yokoyamai* YABE and NAGAO as figured and described by HAYAMI (1965a, 1975) and by HAYAMI and OJI (1980).

Distribution: Valanginian to Aptian (Albian ?), Temperate and Tethyan Realms: Southern England, Germany, Poland, France (Paris Basin and SE), Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus), Japan, Tunisia, South America (Chile and Argentina) (Text-fig. 2).

Fam. CUCULLAEIDAE

Cucullaea (Idonearca) glabra PARKINSON, 1811

Pl. 1, fig. 3; text-fig. 3

- + 1811 *Cucullaea glabra* - PARKINSON, p. 171.
- . 1814 *Cucullaea glabra* - SOWERBY, p. 151, pl. 67.
- . 1818 *Cucullaea carinata* - SOWERBY, p. 9, pl. 207, fig. 1.
- . 1818 *Cucullaea fibrosa* - SOWERBY, p. 9, pl. 207, fig. 2.

- p . 1837 *Arca glabra* nobis - GOLDFUSS, p. 149, pl. 124, figs. 1a, 1b (non fig. 1c).
- v . 1844 *Arca fibrosa*, d'Orbigny - D'ORBIGNY, p. 212, pl. 312, figs. 1-6.
- . 1852 *Arca fibrosa* Sowerby - PICTET et ROUX, p. 463, pl. 37, fig. 2.
- . 1852 *Arca obesa* Pictet et Roux - PICTET et ROUX, p. 464, pl. 38, figs. 1 (?), 2 (non *Arca obesa* SOWERBY, 1833).
- 1866 *Arca glabra* (Park.), Sow. - PICTET et CAMPICHE, p. 456.
- 1866 *Arca obesa*, Pictet et Roux - PICTET et CAMPICHE, p. 459.
- v . 1868 *Arca glabra*, Park. sp. - BRIART et CORNET, p. 55, pl. 5, figs. 1-6.
- p . 1873 *Arca glabra* Park. sp. - GEINITZ, p. 221, pl. 49, fig. 2 (non figs. 1 and 3).
- . 1897 *Arca (Cucullaea) glabra*, (Park.) Sowerby - KARAKASCH, p. 62, pl. 3, fig. 8.
- . 1899 *Cucullaea glabra*, Parkinson - WOODS, p. 57, pl. 11, figs. 8-12; pl. 12, figs. 1-5 (*cum syn.*).
- . 1899 *Cucullaea obesa*, (Pictet et Roux) - WOODS, p. 61, pl. 12, figs. 6 - 8.
- v . 1939 *Cucullaea glabra*, Parkinson - MARLIÈRE, p. 14, pl. 1, fig. 4.
- v . 1949 *Cucullaea glabra* (Parkinson) - MORDVILKO *et al.*, p. 126, pl. 20, figs. 11, 12; pl. 21, fig. 1.
- . 1960 *Cucullaea glabra*, Parkinson - MUROMT-SIEVA, JANIN, p. 176, pl. 2, figs. 3, 4 (*cum syn.*).
- . 1965 *Cucullaea glabra*, (Parkinson) - CIEŚLIŃSKI, p. 22, pl. 1, fig. 5.
- . 1968 *Cucullaea glabra*, Parkinson - GAVRISHILIN in PASTERNAK *et al.*, p. 108, pl. 13, figs. 1-4.
- . 1974 *Cucullaea glabra*, Parkinson - KOCIUBYNSKIJ, SAVCZINSKAJA, p. 74, pl. 12, figs. 1-3.
- 1976 *Cucullaea (Idonearca) glabra* Sow. - MONGIN in DESTOMBES et MONGIN, p. 33, pl. 1, fig. 17.
- ? 1977 *Cucullaea glabra*, Parkinson - SOBETSKI, p. 22, pl. 1, fig. 10.
- 1985 *Cucullaea (Idonearca) glabra* Sowerby - MONGIN, p. 52.

Material: Two separate left valves [largest specimen L = (31) mm] from Orosei (n. 44, 67), uppermost Albian (Vraconian); about 60 specimens from the "Meule de Bracquegnies", Belgium, Albian; 3 specimens from Blackdown, England, Upper Albian, England; 2 specimens from Géraudot, Aube, France, Albian. All non-Sardinian specimens from the coll. IRScNB.

Discussion: The preservation of the Sardinian specimens suffices for identification, but does not bring new information on this well known species. *Cucullaea glabra* has been illustrated and described in detail by WOODS (1899). The specimens from the "Meule de Bracquegnies" show its very broad variability. Already D'ORBIGNY (1844, p. 212) stated that the shape of the species (named *Arca fibrosa* by him) changed during ontogeny to the extent that young (= small) and old (= large) specimens could easily be assigned to different species. This was confirmed later a.o. by PICTET and ROUX (1852) and by PICTET and CAMPICHE (1866). VAN DE POEL (1956) discussed the extent of the variability in Cucullaeids generally, and also reviewed statements of older authors commenting on this problem for fossil and recent species. It is obvious that besides a strong allometric growth process, each ontogenetic stage is characterised by a wide variability. As a result the characteristics traditionally used in specific descriptions of Cucullaeids such as convexity, obliquity and ratio H/L have to be interpreted with extreme caution. This was understood already by palaeontologists in the last century (they accepted that *C. glabra*, *C. fibrosa* and *C. carinata* represented the same species), but extreme specimens previously described as "*C. obesa*" (PICTET and ROUX, 1852, non SOWERBY, 1833) can be included in the same species without hesitation. Indeed, the measurements given by WOODS for *glabra* and *obesa* do not allow differentiation: the proportions f.i. of H/B do not show a real difference, when taking into consideration the increase of inflation with age.

Cucullaea cornueliana (D'ORBIGNY, 1844) as already stated by WOODS (1899), is closely related to *C. glabra*. *C. acuticarinata* NAGAO, 1934 as described in HAYAMI (1965a, p. 242, pl. 27, fig. 15; pl. 28, figs. 1-10) from the Aptian-Albian of Japan, seems very closely related, and shows a great similarity especially with the larger specimens of *C. glabra*. *C. (Idonearca) chouberti* FRENEIX, 1972 (p. 69, pl. 2, figs. 1-4; pl. 3, figs. 1-2) from the Albian-Cenomanian of Tarfaya, Morocco, belongs to the same group but seems more oblique, and the hinge margin is relatively shorter and different in some details. In the Mons Basin ("Meule de Bracquegnies") small specimens of *C. glabra* could be superficially confused with a co-occurring species generally known in Belgium as *C. aequilateralis* BRIART and CORNET, 1868 (= *C. fittoni* PICTET and CAMPICHE, 1866 from the Aptian). After examining abundant material of both species it becomes obvious that the differentiation is easy using the carina, the depressed postero-dorsal area with a thread-like narrow riblet occurring in *C. aequilateralis*.

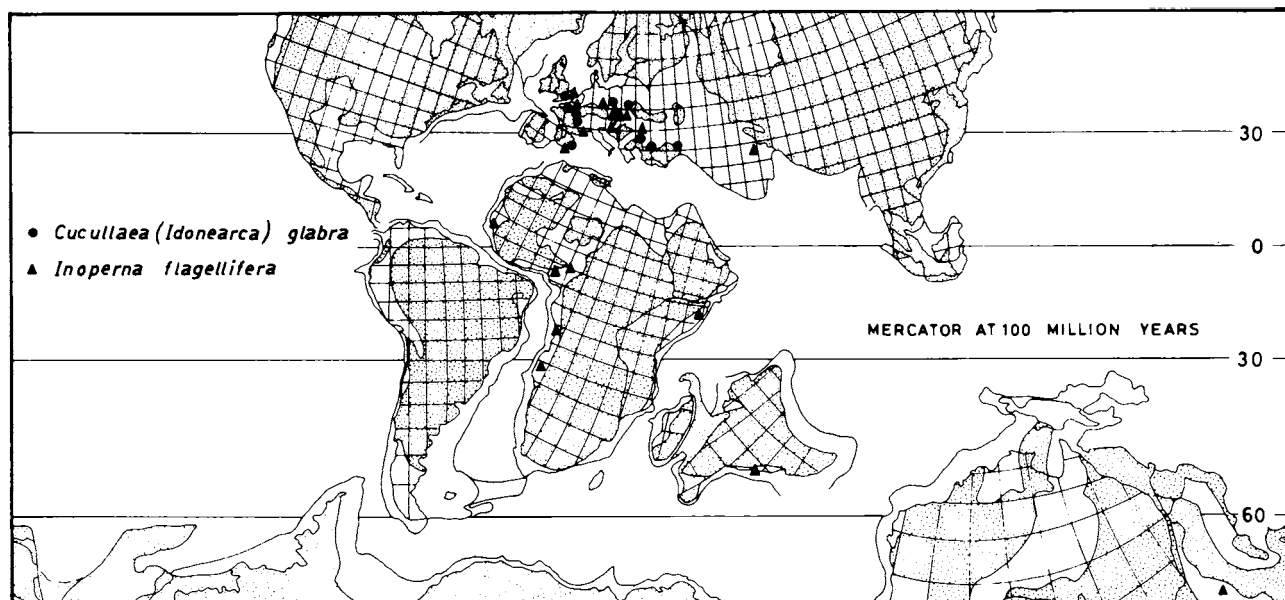


FIG. 3

In the synonymy given above only correct references to *C. glabra* are included. Those which were later proved to belong to the Late Cretaceous *C. subglabra* (D'ORBIGNY, 1850) are not mentioned, because that seems beyond the scope of this paper and because *C. subglabra* has already been discussed in detail by VAN DE POEL (1956).

Distribution: Upper Aptian, Albian — ? Cenomanian: S. England, Belgium, France (Paris Basin and SE), Switzerland, Sardinia, Germany (Saxony)?, Poland, USSR (W. Ukraine, Moldavia, Crimea, Caucasus) (Text-fig. 3).

Cucullaea (Noramya) gabrielis LEYMERIE, 1842
Pl. 1, figs. 5-7b; pl. 2, figs. 1-3; text-fig. 4

- + 1842 *Cucullaea gabrielis*, Leym. - LEYMERIE, p. 6, pl. 7, fig. 5.
- . 1842 *Cucullaea dilatata* d'Orbigny - D'ORBIGNY, p. 89, pl. 20, figs. 5-7.
- . 1843 *Cucullaea tumida*, Math. - MATHÉRON, p. 159, pl. 19, figs. 1,2 (non *Cucullea Tumida* D'ARCHIAC, 1837).
- . 1843 *Cucullaea cor*, Math. - MATHÉRON, p. 160, pl. 19, figs. 3,4.
- v . 1844 *Arca Gabrielis*, d'Orbigny - D'ORBIGNY, p. 198, pl. 308, figs. 1-5.
- . 1865-1866 *Arca dilatata*, H. Coquand - COQUAND, p. 329 (1865), pl. 22, figs. 1,2 (1866).
- . 1866 *Arca Gabrielis* (Leym.), d'Orbigny - PICTET et CAMPICHE, p. 450.
- . 1866 *Arca Forbesi*, Pictet et Campiche - PICTET et CAMPICHE, p. 471.
- . 1899 *Cucullaea Forbesi* (Pictet and Campiche) - WOODS, p. 49, pl. 9, figs. 1-3.
- . 1900 *Arca Gabrielis* Leymerie - WOLLEMAN, p. 79.

- . 1900 *Arca Gabrielis* Leym. - BURCKHARDT, p. 21, pl. 24, figs. 1,2.
- 1903 *Cucullaea Gabrielis* Leym. - BURCKHARDT, p. 70, pl. 12, figs. 1,2.
- ? 1905 *Cucullaea Gabrielis* Leymerie - DACQUÉ, p. 15, pl. 2, fig. 12.
- ? 1914 *Cucullaea Gabrielis* d'Orb. - LANGE, p. 221, pl. 22, figs. 15, 16.
- 1922 *Arca (Idonearca) Gabrielis* Desh. - GILLET, p. 58.
- 1924 *Idonearca Forbesi* Pict. et Camp. - GILLET, p. 17.
- . 1931 *Cucullaea gabrielis* Leymerie - WEAVER, p. 192, pl. 13, fig. 52; pl. 14, figs. 56, 57.
- 1933 *Cucullaea gabrielis* Leym. - DIETRICH, p. 28.
- 1948 *Arca (Idonearca) Gabrielis* Leym. - TAVANI, p. 115, pl. 6, fig. 5; pl. 7, figs. 9, 14, 15; pl. 8, fig. 9.
- . 1948 *Arca Gabrielis* Leymerie sp. - CHARLES, p. 15, pl. 2, fig. 1.
- . 1948 *Arca cor* Matheron sp. - CHARLES, p. 16, pl. 2, fig. 2.
- 1956 *Cucullaea gabrielis* Leymerie - BENAVIDES-CÁCERES, p. 369.
- . 1960 *Cucullaea gabrielis* Leymerie - MUROMTSIEVA, JANIN, p. 175, pl. 2, fig. 1.
- . 1960 *Cucullaea forbesi* Pictet et Campiche - MUROMTSIEVA, JANIN, p. 176, pl. 2, fig. 2.
- 1961 *Noramya forbesi* (Pictet & Campiche) - CASEY, p. 605.
- 1961 *Noramya gabrielis* (Leymerie) - CASEY, p. 605.
- 1974 *Cucullaea (Idonearca) gabrielis* Leymerie - DIMITROVA, p. 51, pl. 22, fig. 15; pl. 23, fig. 1.

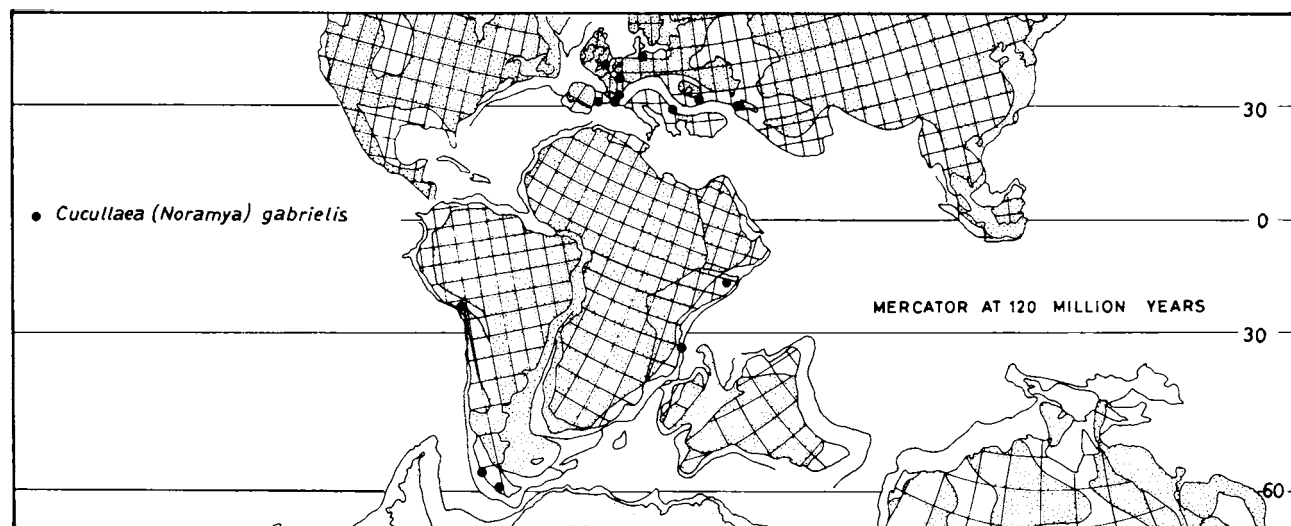


FIG. 4

- . 1974 *Cucullaea (Idonearca) cor* Matheron - DIMITROVA, p. 52, pl. 23, fig. 2.
- . 1974 *Cucullaea (Idonearca) tumida* Matheron - DIMITROVA, p. 52, pl. 24, fig. 1.
- . 1974 *Cucullaea (Idonearca) forbesi* (Pictet et Campiche) - DIMITROVA, p. 53, pl. 25, fig. 2.
- . 1980 *Cucullaea (Idonearca) gabrielis* d'Orbigny - FISCHER, p. 214, pl. 98, fig. 12.

Material: Forty two internal and rarely composite moulds of Early Hauterivian age. Five specimens from Orosei have retained part of the shell (n. 578, 684, 754, 769, 854); the other specimens come from Carchinarzos (M. Albo), Orosei and from the Sa Oche and Su Praicargiu areas (Lanaïto). On some specimens (f. i. n. 593, 847) imprints of the hinge can be seen.

Dimensions (mm; internal moulds):

n.	H	L	B	B'	H/L	B/H
142	70	77	—	—	0.91	—
583	70	(82)	(80)	—	(0.85)	(1.14)
598	75	(90)	(65)	—	(0.83)	(0.87)
590	80	89	—	44	0.90	(1.10)
226	82	(97)	90	—	(0.85)	1.10
603	85	94	79	—	0.90	0.93
599	85	105	79	—	0.81	0.93
592	91	102	92	—	0.89	1.01
227	92	100	90	—	0.92	0.98
579	93	100	80	—	0.93	0.86
604	94	105	90	—	0.90	0.96

Discussion: The shell fragments show the shell thickness and the presence of shallow radial grooves and commarginal growth lines over the complete valve (and not only on the umbonal part of the valve, as was stated by LEYMERIE, 1842 and by PICTET and CAMPICHE, 1866). Despite occasional

plastic deformation the Sardinian specimens certainly belong to only one species, characterised by variability in the obliquity and inflation of the valves, and by allometric growth. They show the extreme shapes figured as *C. gabrielis*, *C. cor* MATHÉRON, 1843, *C. tumida* MATHÉRON, 1843 (*non* D'ARCHIAC, 1837) (see also DIMITROVA, 1974) and all the intermediate forms. Therefore we think that these three taxa represent only one species.

Arca Forbesi PICTET and CAMPICHE, 1866, generally recorded from Aptian deposits, has been considered as a separate species by previous authors because of the presence of radial and commarginal ornamentation over the entire shell surface, also on large specimens. At the same time, for *C. gabrielis* only the young stages are said to show this ornamentation. After examining the figures and descriptions of both taxa in literature it becomes obvious that all transitions between *C. gabrielis* and "*C. forbesi*" exist. Despite its imperfect preservation, the Sardinian material allows to confirm this. The variation in ornamentation could easily be ascribed to intraspecific variability, which might have been induced by environmental factors. In some instances the preservation has undoubtedly been responsible for the partial obliteration of the ornamentation.

C. gabrielis LEYMERIE, 1842 (based on French material) and *C. dilatata* D'ORBIGNY, 1842 (based on Colombian material) have been erected using internal moulds which are identical (LEYMERIE also had one specimen with shell preservation when he described *C. gabrielis*). The possible identity of the two taxa was suggested by D'ORBIGNY (1844). Later authors describing South American specimens used the name *C. gabrielis*, and not *C. dilatata*, and thus indirectly confirmed the synonymy suggested.

Generic attribution: CASEY (1961) erected the genus *Noramya* (type-species *Arca Forbesi* PICTET and CAMPICHE, 1866) and listed *C. gabrielis* as belonging to it. His description, especially of the shell ornamentation, tallies perfectly with what can be seen on the Sardinian specimens. NEWELL in MOORE (1969) tentatively synonymized *Noramya* and *Megacucullaea* RENNIE, 1936. However, the strong radial plications which characterise *Megacucullaea* do not exist on *Noramya*, indeed they are totally absent on the species generally considered as belonging to *Noramya*. Therefore it seems preferable to keep the two genera separate. We also agree with FRENEIX (1972, p. 69) that *Noramya* should be considered as a subgenus of *Cucullaea*.

Distribution: Valanginian - Hauterivian to Aptian, Temperate and Tethyan Realms: S. England, France, Germany, Switzerland, Spain, Sardinia, Bulgaria, USSR (Crimea, Caucasus), Somaliland, Tanzania, Argentina, Peru, Colombia (Text-fig. 4).

Cucullaea (*Noramya*) "*gresslyi*" (DE LORIO, 1861) Pl. 1, figs. 4a, 4b

+ 1861 *Arca Gresslyi*, de Loriol - DE LORIO, p. 87, pl. 11, figs. 1-3.

1866 *Arca Gresslyi*, de Loriol - PICTET et CAMPICHE, p. 452.

1924 *Idonearca Gresslyi*, de Lor. - GILLET, p. 17.

Material: Ten internal and composite moulds from uppermost Valanginian of Orosei (n. 711, 804, 853) and Su Praicargiu (n. 137) and from Lower Hauterivian of Carchinarzos (M. Albo) (n. 377) and Sa Oche (n. 255, 586, 601, 718, 740).

Dimensions (mm): n. 255 (internal mould): H = 42; L = 47; B = 35; H/L = 0.89; B/L = 0.83.

Discussion: *Arca Gresslyi* was introduced by DE LORIO (1861) for a large series of *Cucullaeids* from the Hauterivian beds of the Salève near Geneva. He discussed their similarity to *Arca Gabrielis*, but because the numerous specimens from the Salève were consistently smaller, he preferred to consider them as a separate species. He argued that true *C. gabrielis* was never collected in that locality, and even elsewhere no intermediate forms were known.

In Sardinia from the same formations in which *C. (N.) gabrielis* is common, small *Cucullaeids* have occasionally been collected; they agree well with the description of *Arca Gresslyi* DE LORIO. Even if it could be that they are young *C. (N.) gabrielis* specimens, the fact remains that as on the Salève, specimens of intermediate size have so far not been found. For that reason we prefer, for the time being, to continue to use DE LORIO's name, especially as it was observed that generally in Sardinia *C. (N.) "gresslyi"* occurs in marly beds, whereas *C. (N.) gabrielis* is frequent in more calcareous horizons.

Generic attribution: This species is very similar to *Cucullaea* (*Noramya*) *gabrielis*, to the extent that they could be one and the same species. Hence the same generic assignment is used for both taxa.

Distribution: Hauterivian of Mont Salève (Haute-Savoie, France); uppermost Valanginian and Lower Hauterivian of Eastern Sardinia.

Fam. MYTILIDAE

Inoperna flagellifera (FORBES, 1846)

Text-fig. 3

? 1843 *Inoceramus siliqua* Math. - MATHÉRON, p. 174, pl. 25, fig. 6.

v + 1846 *Mytilus* (*Modiolus*) *flagelliferus*, sp. nov. - FORBES, p. 152, pl. 16, fig. 9.

1850 *Mytilus flagelliferus* Forbes - D'ORBIGNY, p. 247.

v . 1866 *Modiola flagellifera* Forbes - ZITTEL, p. 82, pl. 12, figs. 2a-c.

1867 *Modiolus flagelliferus*, Forbes - PICTET et CAMPICHE, p. 513.

. 1871 *Modiola flagellifera* Forbes - STOLICZKA, p. 379, pl. 24, figs. 1,2.

. 1875 *Mytilus* (*Modiola*) *flagellifera* Forbes sp. - GEINITZ, p. 55, pl. 15, fig. 5.

v . 1900 *Modiola flagellifera*, Forbes - WOODS, p. 99, pl. 17, figs. 1,2.

v . 1939 *Modiola flagellifera* Forbes sp. - MARLIÈRE, p. 106, pl. 6, fig. 6.

1948 *Modiola flagellifera* Forbes - TAVANI, p. 90.

. 1957 *Modiolus* (*Inoperna*) *flagelliferus* (Forbes) - FRENEIX in DARTEVELLE et FRENEIX, p. 47.

. 1959 *Inoperna flagellifera* (Forbes) - FRENEIX, p. 195.

1981 *Modiolus flagelliferus* (sic) Forbes - TZANKOV in TZANKOV *et al.*, p. 78, pl. 19, fig. 5.

. 1986 *Inoperna flagellifera* (Forbes) - ABDEL-GAWAD, p. 138, pl. 27, fig. 4.

v . 1987 *Inoperna flagellifera* (Forbes) - DHONDT, p. 55, pl. 1, figs. 11-13.

Material: One incomplete right valve (n. 110), from the Upper Albian at Orosei.

Discussion: The typical commarginal ridges are visible on the valve, which is relatively large for the species.

Distribution: The presence of *I. flagellifera* at Orosei and at Bracquagnies (Belgium) definitely extends its range downwards into the Late Albian. Albian - Maastrichtian in Temperate and Tethyan Realms: S. England, Belgium, Germany, Austria, Poland, SE France, Sardinia, Yugoslavia, Bulgaria, USSR (Central Asia), India, New Zealand, Somalia, Congo, Angola, Cameroon, Guinea Bissau (Text-fig. 3).

Fam. PINNIDAE

Pinna (Pinna) robinaldina D'ORBIGNY, 1844

Pl. 2, figs. 4, 5; pl. 3, figs. 1a, 1b; text-figs. 5A, 6

v + 1844 *Pinna Robinaldina*, d'Orbigny - D'ORBIGNY, p. 251, pl. 330, figs. 1-3.. 1858 *Pinna Robinaldina*, d'Orbigny - PICTET et RENEVIER, p. 117, pl. 16, fig. 5.. 1859 *Pinna Robinaldina* d'Orb. - VILANOVA, pl. 3, fig. 17.1865 *Pinna Robinaldina*, Orbigny - COQUAND, p. 333.. 1867 *Pinna Robinaldina*, d'Orbigny - PICTET et CAMPICHE, p. 532, pl. 139, figs. 3 - 6.. 1882 *Pinna Robinaldina*, d'Orbigny - DE LORIOL, p. 82, pl. 10, figs. 3-5.? 1888 *Pinna Robinaldina* d'Orbigny - CHOFFAT in CHOFFAT et de LORIOL, p. 86, pl. 3, figs. 3, 4.1896 *Pinna Robinaldina* d'Orbigny - WOLLMANN, p. 845.1900 *Pinna Robinaldina* d'Orb. - BURCKHARDT, p. 18, pl. 21, figs. 4-6.. 1903 *Pinna Robinaldina* d'Orb. - BUCKHARDT, p. 79, pl. 15, figs. 6. 1905 *Pinna raricosta* n. sp. - HARBORT, p. 45, pl. 8, fig. 1.. 1905 *Pinna* cf. *Robinaldi* d'Orb. - HARBORT, p. 47, pl. 5, fig. 5; pl. 7, figs. 2, 3.. 1906 *Pinna Robinaldina* d'Orbigny - WOODS, p. 96, pl. 12, figs. 11-15; pl. 13, fig. 1.? 1912 *Pinna Robinaldina* d'Orbigny - PERVINQUIÈRE, p. 130.. 1921 *Pinna Robinaldina* d'Orb. - GILLET, p. 23.1924 *Pinna Robinaldina* d'Orb. - GILLET, p. 28, text-fig. 10.. 1931 *Pinna robinaldina* d'Orbigny - WEAVER, p. 197, pl. 13, fig. 54.? 1947 *Pinna*, cf. *robinaldina* d'Orbigny - RENNIE, p. 14, pl. 1, figs. 4, 5.1948a *Pinna robinaldina* d'Orb. - TAVANI, p. 83.1955 *Pinna robinaldina* d'Orb. - ERISTAVI, p. 17.. 1960 *Pinna robinaldina* d'Orbigny - MUROMT-SIEVA, JANIN, p. 181, pl. 3, figs. 17 - 20.. 1962 *Pinna (Pinna) robinaldina* d'Orbigny - ABBASS, p. 45, pl. 5, figs. 7, 8.v . 1965a *Pinna* sp. cf. *P. robinaldina* d'Orbigny - HAYAMI, p. 281, pl. 39, figs. 2, 3.. 1968 *Pinna robinaldina* d'Orbigny - KEMPER, p. 57, p. 11, fig. 7;? pl. 18, fig. 1.. 1974 *Pinna* (s.l.) *robinaldina* d'Orbigny - DIMITROVA, p. 59, pl. 26, fig. 10.. 1974 *Pinna robinaldina* d'Orbigny - OEKENTORP & SIEGFRIED, p. 128, pl. 3, fig. 1.v . 1975 *Pinna (Pinna)* sp. cf. *P. (P.) robinaldina* d'Orbigny - HAYAMI, p. 40.1986 *Pinna (Pinna)* sp. cf. *P. (P.) robinaldina* d'Orbigny-TASHIRO and MATSUDA, p. 373, pl. 75, fig. 9.

Material: Fourteen bivalved internal moulds, often with shell at least partially preserved from Orosei (n. 326, 484, 623) and Sa Oche area (Lanaitto) (n. 183, 240, 246, 620, 624-626, etc.), Lower Hauterivi-an.

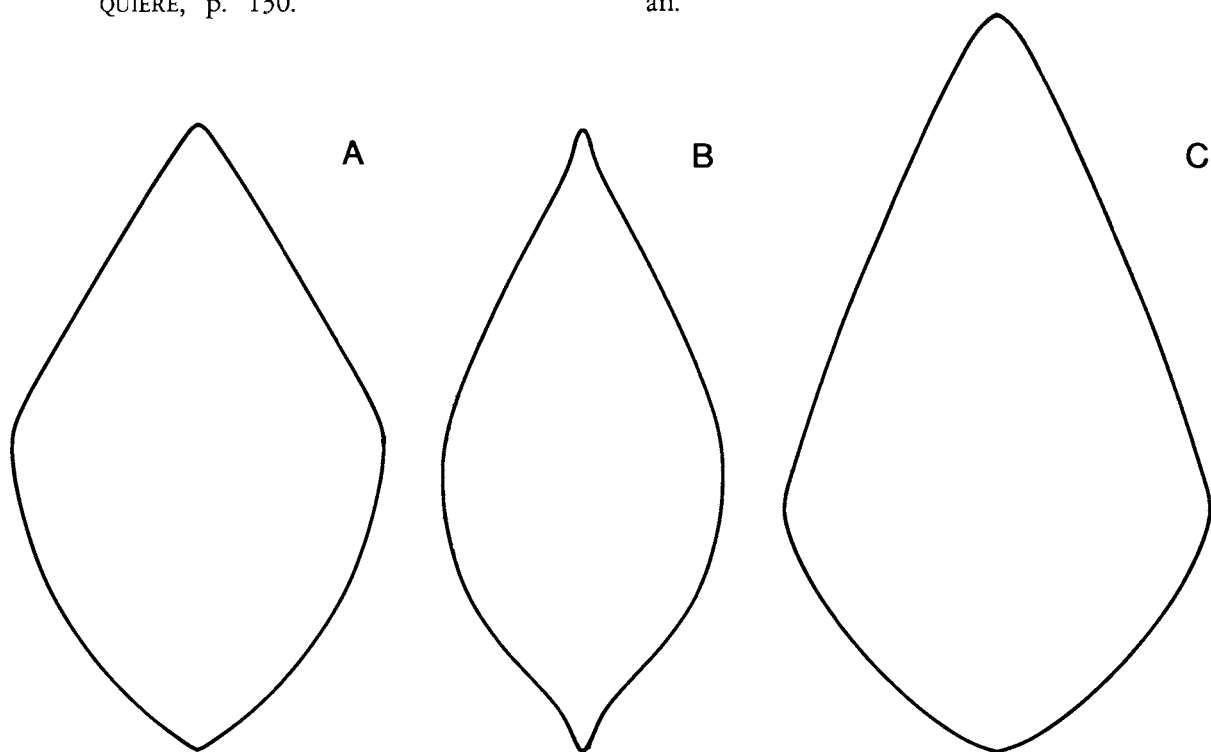


FIG. 5 - Transversal sections at the maximum thickness of *Pinna robinaldina* (A), *Pinna sulcifera* (B) and *Pinna hombresi* (C) (internal moulds; distance of about 120, 100 and 100 mm respectively from the beak; x 1; n. 183, 180, 252).

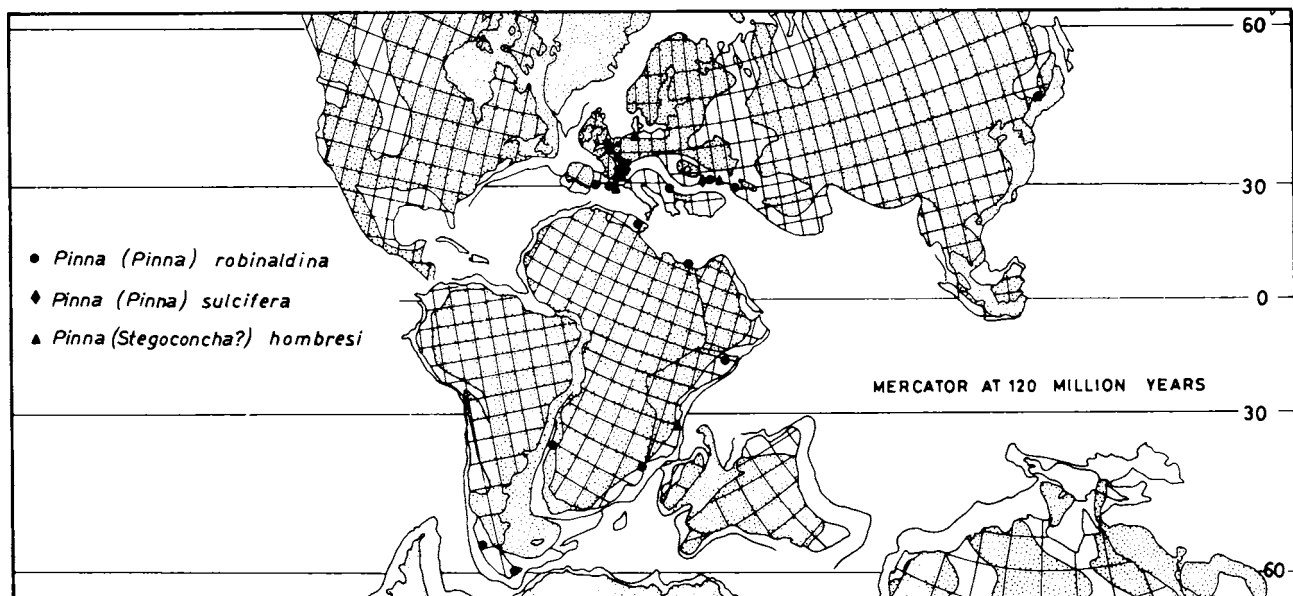


FIG. 6

Dimensions (mm): Incomplete specimen, n. 246: H => 55; L => 210; UA = about 40°. Ribnumber, max = ± 33.

Discussion: The state of preservation of the specimens from Sardinia does not allow to present new information on *P. robinaldina*.

Distribution: Valanginian - Albian (? Cenomanian), Temperate and Tethyan Realms: S. England, Germany, France (Paris Basin and SE), Spain, Sardinia, Switzerland, Bulgaria, USSR (Crimea - Caucasus), Japan, Egypt, Somalia, Tunisia, Angola?, Chile, Argentina (Text-fig. 6).

Pinna (Pinna) sulcifera DESHAYES in LEYMERIE, 1842

Pl. 3, figs. 4,5; text-figs. 5B,6

+ 1842 *Pinna sulcifera*, Desh. - LEYMERIE, p. 8, pl. 9, fig. 9.

v . 1844 *Pinna sulcifera*, Leymerie - D'ORBIGNY, p. 250, pl. 329, figs. 1-3.

1861 *Pinna sulcifera*, Leymerie - DE LORIO, p. 90.

. 1867 *Pinna sulcifera*, Leymerie - PICTET et CAMPICHE, p. 527.

1869 *Pinna sulcifera*, Deshayes - DE LORIO et GILLIERON, p. 19.

1924 *Pinna sulcifera* Desh. (in Leym.) - GILLET, p. 28, text-fig. 11.

. 1969 *Pinna (Pinna) sulcifera* Deshayes in Leymerie - DIMITROVA, p. 62, pl. 1.

. 1974 *Pinna (Pinna) sulcifera* Deshayes - DIMITROVA, p. 57, pl. 27, fig. 1.

Material: Four bivalved internal moulds with shell fragments from the Sa Oche area (Lanaitto), Lower Hauterivian (n. 180, 618, 619, 622).

Dimensions (mm): n. 180: H = (107); L = (162); B = (34); UA = ± 40°.

Discussion: The Sardinian specimens most closely resemble the original figure in LEYMERIE (1842) for the general shape, the details of the imprint of the internal side of the shell, the rib number and the width of the umbonal angle. The figure in D'ORBIGNY (1844) is probably based on an inaccurate reconstruction. The section at the maximum thickness (B) is different from the drawing in GILLET (1924, text-fig. 11) as shown on text-fig. 5B.

Distribution: Hauterivian on the northern Tethys margin: France (Paris Basin and SE), Sardinia, Switzerland, Bulgaria (Text-fig. 6).

Pinna (Stegoconcha?) hambresi PICTET and CAMPICHE, 1867

Pl. 4, figs. 1a, 1b; text-figs. 5C, 6

v + 1867 *Pinna Hambresi*, Pictet et Campiche - PICTET et CAMPICHE, p. 531, pl. 136, fig. 6; pl. 137, fig. 1.

. 1884 *Pinna Iburgensis* n. sp. - WEERTH, p. 48, pl. 9, figs. 1, 2.

. 1900 *Pinna Iburgensis* Weerth - WOLLMANN, p. 71, pl. 3, fig. 1.

. 1905 *Pinna Iburgensis* Weerth-HARBORT, p. 46, pl. 6, figs. 1, 2; pl. 7, fig. 1.

1924 *Pinna Hambresi* Pict. et Camp. - GILLET, p. 29.

? 1933 *Pinna cf. hambresi* P. & C. - DIETRICH, p. 61.

v . 1961 *Pinna (Stegoconcha) cf. hambresi* Pictet & Campiche - CASEY, pp. 587 and 606.

1969 *Pinna (Pinna) hambresi* Pictet et Cam-

piche - DIMITROVA, p. 64, pls. 4 - 6.

- . 1974 *Pinna (Pinna) hambresi* Pictet et Campiche - DIMITROVA, p. 58, pl. 28, fig. 2; pl. 29, fig. 2.

- . 1974 *Pinna iburgensis* Weerth - OEKENTORP & SIEGFRIED, p. 128, pl. 3, fig. 2.

Material: Two, somewhat incomplete, bivalved internal moulds (one with small shell fragments) from the Sa Oche area (Lanaitto), Lower Hauterivian (n. 252, 627).

Dimensions (mm): n. 252: H => 115; L => 166; B = 50; UA = ± 55°.

Discussion: Although incomplete and relatively small, the specimens agree especially well with the type specimen figured on pl. 136, fig. 6 in PICTET and CAMPICHE. The "sillon assez apparent" mentioned in the original description is clearly visible on the internal moulds from Sardinia.

We agree with DIMITROVA (1969) that *Pinna hambresi* and *P. iburgensis* WEERTH, 1884 are synonymous. Their shape is virtually identical and their stratigraphic range is the same. CASEY in 1961 considered *P. hambresi* as belonging to *Stegoconcha* BOEHM, 1907. COX and HERTLEIN in MOORE [1969, p. N283, fig. C24(3)] give a description of *Stegoconcha* which does not completely agree with *P. hambresi*, which has no radial ornamentation; on the other hand the shape of *P. hambresi* resembles *Stegoconcha* more than that of *Pinna s.s.*. Hence, we tentatively retain CASEY's opinion.

Distribution: *Pinna hambresi* appears to be a rare species: only few specimens have been recorded from the Hauterivian of France (Paris Basin and ?SE), Germany, Switzerland, Sardinia, Bulgaria, ? Tanzania and from the Aptian of S. England and S. France (coll. P. MASSE, Marseille) (Text-fig. 6).

Fam. BAKEVELLIIDAE

Gervillaria alaeformis (SOWERBY, 1819)

Pl. 4, figs. 2-4; text-fig. 7

- v + 1819 *Modiola ? alaeformis* - SOWERBY, p. 93, pl. 251.
- 1836 *Perna aliformis* - SOWERBY in FITTON, p. 243.
- . 1843 *Avicula allaudiensis*, Math. - MATHÉRON, p. 175, pl. 26, fig. 1.
- . 1845 *Perna alaeformis* Sow. - FORBES, p. 246.
- v . 1846 *Gervilia alaeformis*, d'Orbigny - D'ORBIGNY, p. 484, pl. 395, figs. 1-3.
- 1852 *Avicula Rhodani* Pictet et Roux - PICTET et ROUX, p. 494, pl. 41, fig. 2.
- . 1858 *Gervilia aliformis*, (Sow.) d'Orb. - PICTET et RENEVIER, p. 120, pl. 18, figs. 1, 2.
- v . 1865 *Gervilia aliformis*, Orbigny - COQUAND, p. 334.

- . 1869 *Gervilia allaudiensis* (Math.), Pictet et Campiche - PICTET et CAMPICHE, p. 81, pl. 155, fig. 1.
- . 1869 *Gervilia aliformis* (Sow.), Pictet et Campiche - PICTET et CAMPICHE, p. 86, pl. 156, fig. 1.
- ? 1896 *Gervillia J. Böhmi* n. sp. - WOLLEMAN, p. 842, pl. 21, fig. 3.
- . 1905 *Gervillia alaeformis* (Sowerby) - WOODS, p. 79, text-figs. 9-14, pl. 11, figs. 9-11.
- p . 1912 *Gervilleia alaeformis* Sowerby - PERVINQUIÈRE, p. 121 [non pl. 8, fig. 1 (var. *Mrhilensis* Pervinquier) = *Gervillaria sowerbyana* (MATHÉRON, 1843)].
- . 1914 *Gervillia* aff. *alaeformis* Sow. - LANGE, p. 205, pl. 16, fig. 5; pl. 18, fig. 1.
- 1916 *Gervillia alaeformis* Sowerby - DOUVILLÉ, p. 170, pl. 20, figs. 10, 11.
- 1924 *Gervillia aliformis* Sow. - GILLET, p. 42, text-fig. 16.
- v ? 1926 *Gervillia haradae* (Yokoyama) - YABE, NAGAO and SHIMIZU, p. 58, pl. 13, figs. 1 - 3, 7; pl. 14, fig. 2 (non YOKOYAMA, 1890 ?).
- v ? 1926 *Gervillia shinanoensis* Yabe and Nagao - YABE, NAGAO and SHIMIZU, p. 59, pl. 14, figs. 17, 18.
- . 1931 *Gervillia alaeformis* (Sowerby) - WEAVER, p. 201, pl. 15, figs. 61-63.
- non 1933 *Gervilleia (s. str.) alaeformis* (Sow.) var. *percrassa* Müller - DIETRICH, p. 59 [= *Gervillaria sowerbyana* (MATHÉRON, 1843)?].
- ? 1948 *Gervilleia alaeformis* (Sow.) - TAVANI, p. 85, pl. 1, fig. 7 [non fig. 8 (= var. *Mrhilensis*) = *Gervillaria sowerbyana* (MATHÉRON, 1843)].
- . 1948 *Avicula Allaudiensis* Mathéron - CHARLES, p. 3.
- . 1955 *Gervilleia alaeformis* Sow. - PETTER-RECEVEUR, p. 71, pl. 3, figs. 1-3.
- . 1960 *Gervillia allaudiensis* Mathéron - MUROMTSIEVA, JANIN, p. 182, pl. 5, figs. 1, 2.
- . 1960 *Gervillia alaeformis* Sowerby - MUROMTSIEVA, JANIN, p. 182, pl. 4, figs. 4, 5.
- . 1961 *Gervillia alaeformis* (Sowerby) - PROZOROVSKII, p. 111, pl. 7, figs. 4-6.
- non 1962 *Gervillia alaeformis* (Sowerby) - AB-BASS, p. 36, pl. 4, fig. 1 [= *Gervillaria sowerbyana* (MATHÉRON, 1843)].
- . 1962 *Gervillia alaeformis* (Sowerby) - PIRIATINSKY et al. in KRIMHOLZ, p. 37, pl. 40, fig. 4; pl. 41, fig. 1.
- v . 1965a *Gervillaria haradae* (Yokoyama) - HAYAMI, p. 269, pl. 35, figs. 3-6; pl. 36, fig. 1; pl. 37, fig. 2 (non YOKOYAMA, 1890 ?).

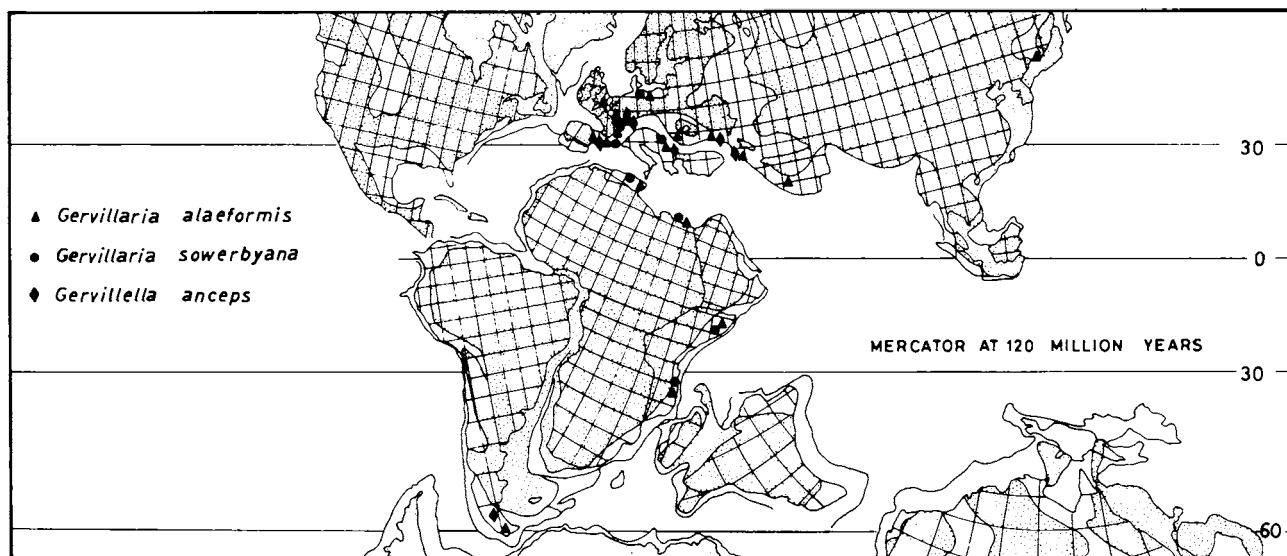


FIG. 7

- . 1971 *Gervilleia alaeformis* Sow. - TURCULET, p. 104, pl. 15, figs. 1, 2.
- . 1974 *Gervillaria allaudiensis* (Mathéron) - DIMITROVA, p. 61, pl. 31, figs. 2, 3; pl. 32, fig. 3.
- . 1974 *Gervillaria alaeformis* (Sowerby) - DIMITROVA, p. 62, pl. 31, fig. 1; pl. 32, figs. 1, 2.
- 1975 *Gervillaria haradae* (Yokoyama) - HAYAMI, p. 46.
- ? 1985 *Gervillaria alaeformis* (Sowerby) - MONGIN, p. 54, pl. 4, figs. 1, 2.
- ? 1985 *Gervillaria alaeformis rhodani* Pictet et Roux - MONGIN, pl. 4, fig. 3.
- ? 1985 *Gervillaria haradae* (Yokoyama) - TASHIRO and MATSUDA, p. 373, pl. 75, figs. 1-5, 13.

Material: Fifteen specimens usually preserved as internal moulds from the Sa Oche area (Lanaitto) and from Costas d'Ossu (Dorgali), Lower Hauterivian.

Dimensions (mm): Best and largest specimen, n. 445: H = 98; L = (135); B = 42.

Discussion: No hinges have been preserved on the Sardinian specimens of *Gervillaria alaeformis* but they correspond well with the descriptions by previous authors.

We consider *Avicula allaudiensis* MATHÉRON, 1843, which has been recorded only rarely, as synonymous with *Gervillaria alaeformis*. Its obliquity and general shape are identical and the "differences" are referable to preservation and to the absence/presence of the shell.

The types of *Gervillia shinanoensis* YABE and NAGAO, 1926 are poorly preserved, but seem to have all the characteristics of *Gervillaria alaeformis*, and are, as already stated by these authors, if not synonymous, extremely close.

G. haradae (YOKOYAMA, 1890) in HAYAMI, 1965a seems identical with *G. alaeformis*; concerning the former taxon, the figured types of YOKOYAMA are extremely small and therefore it is difficult to judge whether they are conspecific with *G. haradae* of later authors. The specimens figured by YABE *et al.*, 1926 as belonging to *G. haradae* are poorly preserved and do not fully allow an identification.

Also *Gervillia J. Böhmii* WOLLEMAN, 1896 is based on a poorly preserved specimen; without seeing this type it is impossible to know whether the taxon is synonymous with *G. alaeformis*, but the description in WOLLEMAN makes this probable.

Distribution: *G. alaeformis* occurs frequently in the Sardinian Hauterivian. It is known from the Tethys and from Temperate Realms, Hauterivian to Aptian (? Albian): S. England, Germany, France (Paris Basin and SE), Spain, Switzerland, Bulgaria, Romania, USSR (Crimea, Caucasus, Central Asia), Tunisia, Egypt, Tanzania, Somalia, Japan, Argentina (Text-fig. 7).

Gervillaria sowerbyana (MATHÉRON, 1843)
Pl. 5, figs. 3-5; text-fig. 7

- + 1843 *Avicula sowerbyana*, Math. - MATHÉRON, p. 175, pl. 26, figs. 2, 3.
- . 1846 *Avicula Cottaldina*, d'Orbigny - D'ORBIGNY, p. 470, pl. 389, figs. 1, 2.
- v . 1846 *Avicula Carteroni*, d'Orbigny - D'ORBIGNY, p. 472, pl. 390, figs. 1-3.
- . 1869 *Avicula Carteroni*, d'Orbigny - PICTET et CAMPICHE, p. 63, pl. 151, figs. 1-6.
- 1869 *Avicula Sowerbyana*, Matheron - PICTET et CAMPICHE, p. 70.

- 1896 *Avicula Cottaldina* d'Orb. - WOLLEMAN, p. 842.
- 1900 *Avicula Cottaldina* d'Orbigny - WOLLEMAN, p. 54.
- 1912 *Avicula Carteroni* d'Orbigny - PERVINQUIÈRE, p. 107.
- . 1912 *Gervilleia alaeformis* Sowerby, var. *Mrhilensis* Pervinquier - PERVINQUIÈRE, p. 122, pl. 8, fig. 1.
- 1922 *Avicula Cottaldina* d'Orb. et var. *Carteroniana* d'Orb. - GILLET, p. 98.
- 1924 *Avicula Cottaldina* d'Orb. et var. *Carteroniana* d'Orb. - GILLET, p. 32.
- 1924 *Avicula Sowerbyana* Matheron - GILLET, p. 32.
- ? 1933 *Gervilleia* (s. str.) *alaeformis* (Sow.) var. *percrassa* Müller - DIETRICH, p. 59.
- ? 1934 *Gervillia miyakoensis* nov. sp. - NAGAO, p. 197, pl. 31, figs. 1, 2; pl. 32, fig. 7.
- 1948 *Avicula Sowerbyi* Matheron - CHARLES, p. 3.
- . 1948 *Gervillia alaeformis* (Sow.) var. *Mrhilensis* Perv. - TAVANI, p. 86, pl. 1, fig. 8.
- . 1962 *Gervillia alaeformis* (Sowerby) - ABBASS, p. 36, pl. 4, fig. 1 (*non* SOWERBY, 1819).
- . 1962 *Gervillia magharensis* (nov. sp.) - ABBASS, p. 37, pl. 4, figs. 2, 3.
- v ? 1965a *Gervillaria miyakoensis* (Nagao) - HAYAMI, p. 271, pl. 36, figs. 2-4; pl. 37, fig. 1.
- ? 1974 *Pterinella? carteroni* (d'Orbigny) - DIMITROVA, p. 61, pl. 24, fig. 2.

Material: Ten incomplete bivalved moulds with partial shell preservation from Sa Oche and Su Praicargiu areas (Lanaitto), Lower Hauterivian (n. 438, 441, 443, 446, 451, 452, etc.). Often the interior shell layer is adhering to the mould; one specimen has a partial hinge.

Dimensions (mm): largest specimen, n. 441: H = 105; B = 43.

Discussion: The shell shape is as described by previous authors. The preservation shows different stages: 1) completely smooth moulds, 2) smooth seeming shells with weak commarginal ornamentation (described as *Avicula sowerbyana* by MATHÉRON), 3) shells with relatively strong radial ribs over the valve and auricles (described as *A. Carteroni* and *A. Cottaldina* by D'ORBIGNY). Already PICTET and CAMPICHE (1869) illustrated these different preservational stages and pointed out the variability in the rib ornamentation between different specimens.

DIETRICH (1933) described as "*Gervilleia* (s. str.) *alaeformis* (Sow.) var. *percrassa* Mueller" specimens from the Tendaguru beds (Tanzania) which

are less oblique and have a less convex anterior margin than the typical specimens of *Gervillaria alaeformis*. Hence, these Tanzanian specimens seem to be identical with *G. sowerbyana*.

The types of *Gervillia miyakoensis* NAGAO, 1934 from the Aptian-Albian of Northern Honshu (Japan) seem similar to *Gervillaria sowerbyana* but their preservation makes it difficult to draw definite conclusions.

Gervillia magharensis ABBASS, 1962 has the same characteristics as *Gervillaria sowerbyana*, especially in the preservation stage described by D'ORBIGNY as *Avicula Carteroni*.

Distribution: *Gervillaria sowerbyana* is probably closely related to *G. alaeformis* and they are not always easily distinguishable; as a result some recorded occurrences of *G. alaeformis* might in fact be referable to *G. sowerbyana*. ?Valanginian, Hauterivian-Aptian, ?Albian, Temperate and Tethyan Realms: France (Paris Basin and SE), Germany, Sardinia, Bulgaria, Tunisia, Egypt, Somalia, Tanzania, ? Japan (Text-fig. 7).

Gervillaria cf. *sowerbyana* (MATHÉRON, 1843)

Two poorly preserved specimens (n. 884, 890b) from the Sos Tinzosos area (Lanaitto), Upper Berriasian - lowermost Valanginian, are identified as *Gervillaria* cf. *sowerbyana*. They are somewhat smaller [H = (35) and (46) mm respectively] than *G. sowerbyana* specimens of Hauterivian age from the same area, and bear traces of narrow radial ribs and of light commarginal ornamentation.

Gervillella anceps (DESHAYES in LEYMERIE, 1842) Pl. 3, figs. 6a, 6b; text-fig. 7

- ? 1842 *Gervillia anceps* Desh. - LEYMERIE, p. 9, pl. 10, fig. 3.
- v . 1846 *Gervillia anceps* Deshayes - D'ORBIGNY, p. 482, pl. 394, figs. 1-4.
- non 1858 *Gervillia anceps*, Deshayes - PICTET et RENEVIER, p. 121, pl. 17, figs. 1-4 [= *G. sublancoolata* (D'ORBIGNY, 1850) *sensu* WOODS 1905].
- . 1869 *Gervill. extenuata* m. - EICHWALD, p. 526, pl. 22, fig. 12.
- . 1869 *Gervillia anceps*, Deshayes - PICTET et CAMPICHE, p. 82, pl. 155, fig. 5.
- 1898 *Gervillia anceps*, Deshayes - SKEAT and MADSEN, p. 162, pl. 4, figs. 1, 2.
- . 1902 *Gervilleia anceps* Deshayes - FRECH, p. 612, 1 text-fig.
- . 1931 *Gervillia anceps* Deshayes - WEAVER, p. 203, pl. 14, figs. 58, 59.
- . 1957 *Gervilleia anceps* Des. - ERISTAVI, p. 39, pl. 1, fig. 2.
- . 1960 *Gervillia anceps* Deshayes - MUROMT-SIEVA, JANIN, p. 182, pl. 4, figs. 1-3.

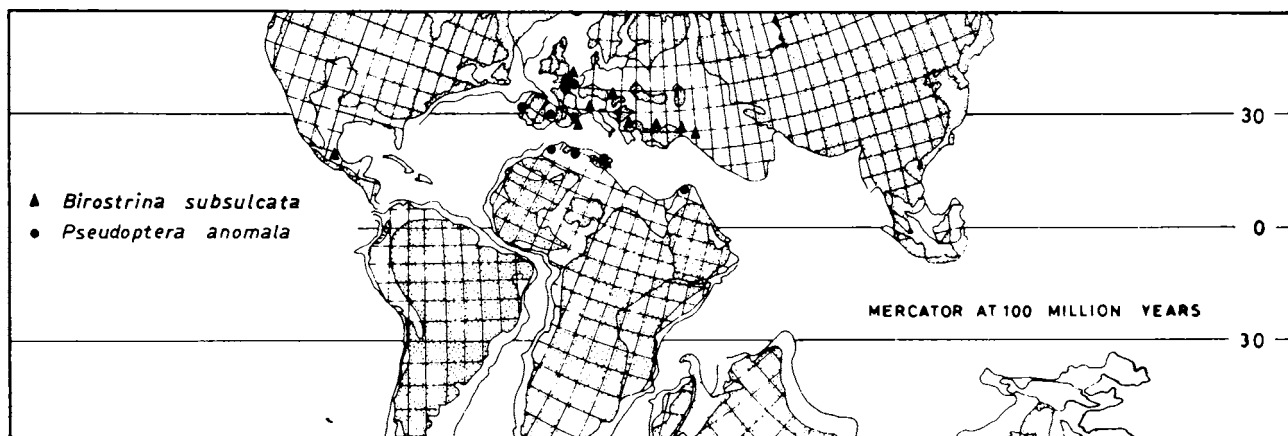


FIG. 8

. 1960 *Gervillia extenuata* Eichwald - MUROMT-SIEVA, JANIN, p. 183, pl. 6, figs. 1, 2.

1974 *Gervillella anceps* (Deshayes) - DIMITROVA, p. 63, pl. 132, fig. 4; pl. 33, fig. 7.

Material: Five incomplete internal moulds, relatively small for the species, with partial shell preservation, and of which one shows ligamental pits, have been collected in Su Praicargiu (n. 217, 219, 221, 222) and Sa Oche (n. 453) areas (Lanaitto), uppermost Valanginian.

Discussion: The Sardinian specimens do not bring new information on the differentiation between *Gervillella anceps* and *G. subulanceolata* (D'ORBIGNY, 1850). Therefore we follow the opinion of WOODS (1905, p. 76) and maintain *G. anceps* as a separate species.

Distribution: *G. anceps* is rare in the uppermost Valanginian of Eastern Sardinia. It has been recorded from France to the Caspian [France (Paris Basin and SE), Switzerland, Bulgaria, USSR (Crimea, Caucasus)] and from Argentina in Valanginian-Hauterivian to possibly Aptian deposits; recorded from boulders in Denmark (Text-fig. 7).

Gervillella cf. *subulanceolata* (D'ORBIGNY, 1850).

One internal mould from Orosei, Upper Albian (n. 114), belongs to *Gervillella* and is close to the figure 3 on pl. 41 in PICTET and ROUX, 1854, for *Gervilia alpina*. This taxon was later placed in the synonymy of *G. subulanceolata* D'ORBIGNY, 1850, by WOODS (1905, p. 74).

Pseudoptera anomala (SOWERBY, 1836)

Text-fig. 8

+ 1836 *Avicula anomala* M. - SOWERBY in FITTON, pp. 240 and 342, pl. 17, fig. 18.

v . 1846 *Avicula anomala*, Sowerby - D'ORBIGNY, p. 478, pl. 392, figs. 1-3.

v . 1862 *Avicula Pomeli* H. Coq. - COQUAND, p. 215, pl. 12, figs. 12, 13.

v . 1868 *Avicula anomala*, Sow. - BRIART et CORNET, p. 52, pl. 4, fig. 7.

v . 1880 *Avicula sitifensis* H. Coq. - COQUAND, p. 145.

. 1882 *Gervilia bicostata* n. sp. - SEGUENZA, p. 103, pl. 14, fig. 7.

v . 1905 *Pteria (Pseudoptera) anomala* (Sowerby) - WOODS, p. 64, pl. 9, figs. 2 - 4.

. 1924 *Pseudoptera anomala* (Sow.) - GILLET, p. 46, text-fig. 21.

. 1937 *Gervilleia anomala* Sow. - TREVISAN, p. 52, pl. 3, fig. 1.

v . 1939 *Avicula (Pseudoptera) anomala* Sowerby - MARLIÈRE, p. 81, pl. 5, fig. 6.

1951 *Avicula* aff. *anomala* Sow. - GIGOUT, p. 370, pl. 12, fig. 9.

non 1954 *Pteria (Pseudoptera) anomala* (Sowerby) - HÄGG, p. 34, pl. 4, fig. 48.

v . 1957 *Pseudoptera anomala* (d'Orbigny) - DARTEVELLE et FRENEIX, p. 65, pl. 8, fig. 8.

v . 1959 *Pseudoptera anomala* (Sowerby) subsp. *orbignyi* - FRENEIX, p. 205.

. 1969 *Pseudoptera anomala* (J. Sowerby) - COX in MOORE, p. N310, fig. C42 (4a).

. 1972 *Pseudoptera anomala* (Sowerby) *tarfayensis* nov. subsp. - FRENEIX, p. 76, text-fig. 67; pl. 3, figs. 4, 5.

. 1984 *Pseudoptera* sp. nov. - SAVAZZI, p. 315, text-fig. 2.

Material: One incomplete left valve from Orosei, Upper Albian (n. 79); 15 specimens from the "Meule de Bracquignies", Albian at Bracquignies, Hainaut, Belgium (coll. IRScNB).

Discussion: The incomplete specimen from Sardinia shows the typical ornamentation of *Pseudopte-*

ra anomala as described by WOODS (and figured by him on pl. 9, fig. 2c) and seen on the specimens from Bracquagnies. The "differences" between English, French and Moroccan specimens mentioned by WOODS (1905) and FRENEIX (1959, 1972) are not such that they must necessarily be subspecific: they might simply indicate diverse preservational conditions and ontogenetic stages. This is made probable by the differential preservation of radial and commarginal ornamentation, by the influence of the sediment on the "coarseness" of the fine ornamentation, and by the fact that larger specimens develop folds (WOODS, 1905; SAVAZZI, 1984): all these aspects indicate the wide variability occurring in this species. The type of subsp. *orbigny* FRENEIX, 1959 is an unusually large specimen [FRENEIX (1972) called it "g rontique"], and subsp. *tarfayensis* FRENEIX, 1972 concerns somewhat smaller specimens close to that figured by WOODS (1905, pl. 9, fig. 2a).

Distribution: Upper Albian-Cenomanian: S. England, Belgium, W. France, Portugal (coll. BERTHOU, Paris), Spain (coll. FLOQUET, Dijon), Sardinia, Sicily, Syria (MNHN), Morocco, Algeria (Text-fig. 8).

Fam. INOCERAMIDAE

Inoceramus ex gr. *neocomiensis* D'ORBIGNY, 1846

- + 1846 *Inoceramus neocomiensis*, d'Orbigny - D'ORBIGNY, p. 503, pl. 403, figs. 1, 2.
- . 1911 *Inoceramus neocomiensis* d'Orbigny - WOODS, p. 262, pl. 45, figs. 1, 2.
- 1912 *Inoceramus neocomiensis*, d'Orb. - WOODS, p. 5, fig. 27.
- . 1960 *Inoceramus neocomiensis* Orbigny - MUROMTSIEVA, JANIN, p. 184, pl. 7, figs. 11, 12.
- ? 1970 *Inoceramus* ex gr. *neocomiensis* d'Orbigny - KOTETISHVILI, p. 49, pl. 1, fig. 8.
- v . 1973 *Inoceramus neocomiensis* Orbigny - GLAZUNOVA, p. 49, pl. 19, fig. 1.
- . 1974 *Inoceramus neocomiensis* d'Orbigny - DIMITROVA, p. 63, pl. 33, figs. 3, 4, 6.

Material: One specimen from Su Praicargiu (Lanaitto), Lower Hauterivian (n. 159).

Dimensions (mm): H => 35, L = (39); UA = 90 .

Discussion: This incomplete small inoceramid shows the ornamentation and the general features of the *I. neocomiensis* group as described in literature (CRAME, 1985, p. 481). A more precise specific assignment is at present not possible. Furthermore, it cannot be excluded that *I. neocomiensis* of different authors does refer to more than one species: indeed the stratigraphic range (? Valanginian to Aptian) found in literature (SORNAY, 1965) is long for an inoceramid species.

Distribution: Valanginian?, Hauterivian - Aptian, probably almost cosmopolitan.

Birostrina concentrica (PARKINSON, 1819)

Pl. 5, figs. 6-13c; text-fig. 9

- + 1819 *Inoceramus concentricus* - PARKINSON, p. 58, pl. 1, fig. 4.
- v . 1821 *Inoceramus concentricus* - SOWERBY, p. 183, pl. 305, figs. 1 - 6.
- v . 1822 *Inoceramus concentricus* - MANTELL, p. 95, pl. 19, fig. 19.
- v . 1835 *Inoceramus concentricus* Sow. - GOLDFUSS, p. 111, pl. 109, figs. 8a - c (non figs. 8d - e).
- . 1846 *Inoceramus concentricus*, Sowerby - D'ORBIGNY, p. 506, pl. 404, figs. 1-5.
- . 1853 *Inoceramus concentricus* Parkinson - PICTET et ROUX, p. 500, pl. 42, fig. 2.
- 1897 *Inoceramus* (*Aucella*?) *concentricus* Park. - KARAKASCH, p. 54, pl. 7, fig. 9.
- 1904 *Inoceramus concentricus* Park. - AIRAGHI, p. 183, fig. 2.
- v . 1911 *Inoceramus concentricus*, Parkinson - WOODS, p. 265, pl. 45, fig. 11; pl. 46, figs. 1-10; pl. 47, figs. 1, 2.
- . 1912 *Inoceramus concentricus* Park. - WOODS, p. 2, figs. 5-9.
- 1932 *Actinoceramus concentricus* Park. - HEINZ, p. 56.
- v . 1939 *Inoceramus concentricus* Park. - MARLI RE, p. 209, etc.
- 1947 *Inoceramus concentricus* Parkinson - RICHARDS in KNECHTEL *et al.*, p. 48, pl. 4, figs. 8, 9.
- 1956 *Inoceramus concentricus* Parker - BENAVIDES-C CERES, p. 376.
- 1956 *Inoceramus concentricus* Park. - ANDELKOVI , p. 164, pl. 10, fig. 4; pl. 11, figs. 3, 5; pl. 12, figs. 1, 2, 6 - 9.
- 1956 *Inoceramus concentricus* Park. var. nov. - ANDELKOVI , p. 164, pl. 10, figs. 1, 2.
- 1957 *Actinoceramus* (*Inoceramus*) *concentricus* Parkinson - ZACHARIEVA-KOVATCHEVA, p. 263, pl. 23, fig. 2; ?pl. 35, fig. 2.
- 1960 *Inoceramus concentricus* Parkinson - PAUC  si PATRULIUS, p. 90, pl. 2, fig. 15.
- . 1960 *Inoceramus concentricus* Parkinson - CIE LSKI, p. 13, pl. 6, figs. 2, 3.
- . 1960 *Inoceramus concentricus* Parkinson - MUROMTSIEVA, JANIN, p. 184, pl. 7, figs. 5, 6.
- 1962 *Inoceramus concentricus* Parkinson - SAVELIEV, p. 235, pl. 7, figs. 3-7, pl. 8, figs. 1, 2.
- v . 1962 *Inoceramus concentricus* Parkinson - BRITISH MUSEUM, p. 158, pl. 57, fig. 3.

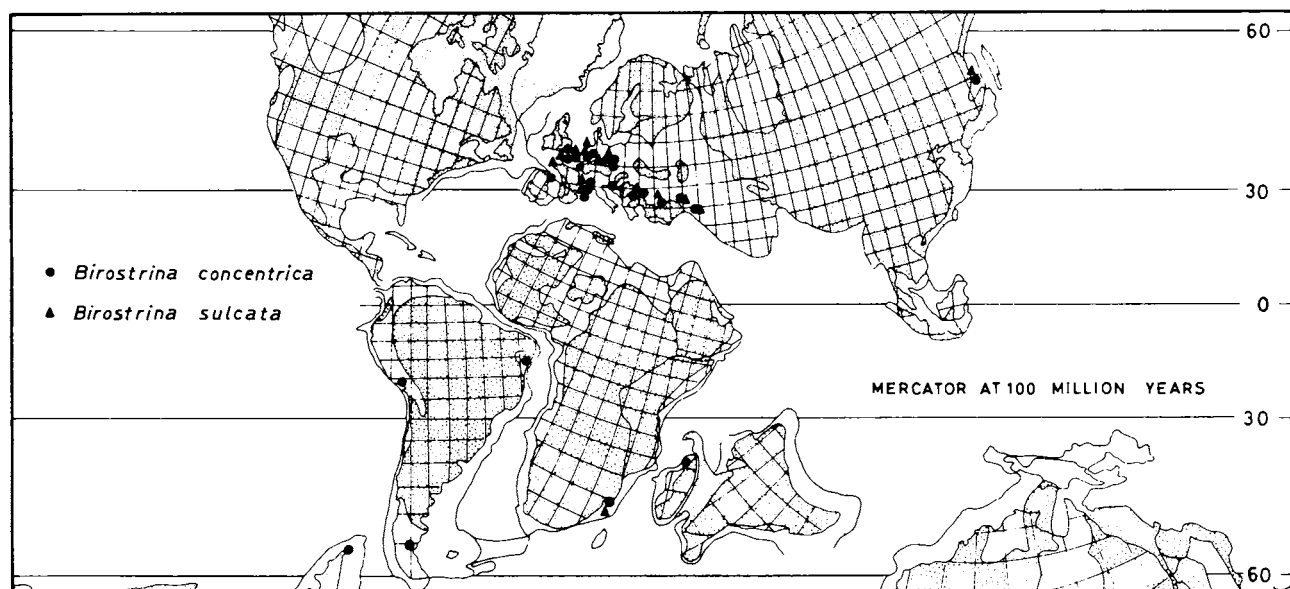


FIG. 9

- 1965 *Inoceramus concentricus* Parkinson - VERESTCHAGIN in VERESTCHAGIN *et al.*, p. 32, pl. 16, fig. 1; pl. 17, fig. 1.
- 1966 *Inoceramus* cf. *concentricus* Park. - PERGAMENT, p. 30, pl. 1, figs. 1-4.
- 1974 *Inoceramus* (*Inoceramus*) *concentricus* Parkinson - OEKENTORP & SIEGFRIED, p. 132, pl. 5, fig. 1.
- 1974 *Inoceramus concentricus* Parkinson - DIMITROVA, p. 65, pl. 34, figs. 1, 2.
- 1975 *Inoceramus concentricus* Parkinson - FÖRSTER, p. 30.
- ? 1976 *Inoceramus concentricus* Park. - MONGIN in DESTOMBES et MONGIN, p. 33, pl. 2, fig. 3.
- ? 1977 *Inoceramus concentricus* Parkinson - KOTETISHVILI, p. 21, pl. 2, figs. 6-9; pl. 3, fig. 1.
- 1978 *Birostrina concentrica* (Parkinson) - KAUFFMAN, p. XVII-1, pl. 1, figs. 1-5, 16, 18 (with subsp.).
- 1978 *Birostrina concentrica* (Parkinson) - WIEDMANN and KAUFFMAN, p. III-4, pl. 1, figs. 1-10, 12-14 (with subsp.).
- ? 1979a *Inoceramus* (*Birostrina*) *concentricus* Parkinson - MONGIN, p. 415, pl. 9-2, fig. 3.
- 1980 *Inoceramus concentricus* Parkinson - CRAME, p. 283, figs. 2a-c.
- 1980 *Inoceramus concentricus* Parkinson - FISCHER, p. 214, pl. 99, fig. 1.
- 1980 *Inoceramus concentricus* Parkinson - SORNAY in ROBASYNSKI et AMÉDRO, p. 259.
- 1983 *Inoceramus concentricus* Parkinson - WEIDICH, SCHWERD & IMMEL, p. 563.
- 1983 *Inoceramus concentricus* - VAN DIGGELLEN, p. 32, fig. 62.
- 1984 *Inoceramus concentricus* Parkinson - MAREK *et al.*, p. 92, pl. 30, fig. 3.
- 1985 *Birostrina concentrica* Parkinson - CRAME, p. 506, pl. 59, figs. 1-8, 11, 13; non figs. 9, 10? = *B. subsulcata* (WILTSHIRE)?
- ? 1985 *Birostrina*? cf. *concentrica* Parkinson - CRAME, p. 510, pl. 59, figs. 12, 14; pl. 60, figs. 1-4.
- 1985 *Inoceramus concentricus* Parkinson - AMÉDRO, pl. 7, fig. 7.

Material: *Birostrina concentrica* occurs very frequently (more than 40 specimens collected) in the Upper Albian at Orosei, where it is the most abundant bivalve species. The shell is generally preserved, and strong commarginal "ribs" are present; especially in the central very convex part of the valves occasional radial "striae" can be seen.

Dimensions (mm): The largest specimen, n. 81: H => 45.

Discussion: The Sardinian specimens agree with the description of WOODS (1911) and CRAME (1985). Rare radial riblets can be observed in the umbonal part of some internal moulds. The Sardinian specimens are of relatively small size. This may be due to environmental conditions. SORNAY (1980) stated that at the Blanc Nez section (NW France) from the bottom to the top of the Albian deposits the average size of the *I. concentricus* specimens increases from 20 to 60 mm. When taking into consideration that at Orosei the Upper Albian section is condensed and contains

all Upper Albian Ammonite Zones (WIEDMANN and DIENI, 1968), it is not impossible that the average small size of Sardinian *B. concentrica* specimens reflects a particular moment of the Late Albian. By the same reasoning the large specimens described by CRAME (1985) as cf. *concentrica* might include specimens from the top range only.

Distribution: *B. concentrica* is recorded by some authors as occurring in Albian and in Cenomanian strata. Detailed stratigraphic work, such as by OWEN (1984), demonstrated that *B. concentrica* occurs from the *Douvilleiceras mammillatum* Zone (upper Lower Albian) to the Upper Albian (*Hysterocheras varicosum* Subzone included). Already SEITZ (1956) was of a similar opinion. This distribution is probably the same wherever the species occurs (see also TRÖGER, 1981). Virtually global from NW Europe to the Antarctic, and from Eastern Siberia (Japan?) to South America (Brazil, Peru, ?S. Argentina), Madagascar, Mozambique, Zululand (Text-fig. 9).

Birostrina subsulcata (WILTSHIRE, 1869)

Pl. 5, figs. 14a-16; text-fig. 8

- p 1853 *Inoceramus sulcatus* Parkinson - PICTET and ROUX, p. 499, pl. 42, figs. 1 d - f [non figs. 1 a - c = *B. sulcata* (PARKINSON)].
- + 1869 *Inoceramus subsulcatus*, mihi - WILTSHIRE, p. 188, p. 190.
- . 1911 *Inoceramus concentricus* var. *subsulcatus*, Wiltshire-WOODS, p. 268, pl. 47, figs. 3-14.
- . 1912 *Inoceramus concentricus* var. *subsulcatus* Wiltsh. - WOODS, p. 2, figs. 10-18.
- 1930 *Inoceramus concentricus* var. *subsulcatus* Wiltshire - PASSENDORFER, p. 239.
- . 1960 *Inoceramus subsulcatus* Wiltshire - MURROMTSIEVA, JANIN, p. 185, pl. 7, figs. 7,8.
- . 1969 *Inoceramus* (*Birostrina*) *subsulcatus* Wiltshire - COX in MOORE, p. N315, fig. C46 (2b).
- . 1974 *Inoceramus* (*Birostrina*) *sulcatus subsulcatus* Wiltshire - DIMITROVA, p. 66, pl. 34, fig. 3.
- . 1977 *Actinoceramus subsulcatus* (Wiltshire) - KOTETISHVILI, p. 22, pl. 4, fig. 4.
- 1978 *Birostrina subsulcata* - KAUFFMAN, p. IV 10.
- 1978 *Birostrina subsulcata* - KAUFFMAN, p. XXX 10.
- . 1978 *Inoceramus subsulcatus* Wiltshire - ZONNOVA, p. 79, pl. 7, figs. 4-6.
- ? 1985 *Birostrina concentrica* Parkinson-CRAME, p. 509, pl. 59, figs. 9,10.

Material: Four internal moulds from Orosei, Upper Albian (n. 36, 82, 106, 771).

Dimensions (mm): The largest specimen, n. 106 : H => 25.

Discussion: The internal moulds collected in Sardinia show more or less radially arranged impressions which can only be explained by the presence of "rib"-like structure on the internal part of the valves and which are typical for *B. subsulcata*.

The origin and precise taxonomic rank of *B. subsulcata* are difficult to decide on. OWEN (1984, p. 339, 340) considered the taxon as a "stage" of *B. concentrica* and mentioned it as occurring at the base of the *Cristatum* Subzone and at the top of the *Orbigny* Subzone. The specimens from Orosei are from a condensed Upper Albian section and it is not possible to distinguish the zones and subzones from which the different *Birostrina* species come.

Tentatively, we have left specific rank to *B. subsulcata*, but we are aware that a systematic revision of the *Birostrina* group may prove this to be wrong.

Some of the *B. concentrica* specimens described and figured by CRAME (1985) from Albian strata of the Antarctic bear traces of up to five radiating riblets separated by slightly concave sulci. It could be that these specimens actually represent the taxon *B. subsulcata*, but not having seen them we cannot draw a conclusion.

Distribution: Restricted to the Upper Albian (lower Upper Albian according to OWEN, 1984): England, Poland Switzerland, Bulgaria, USSR (Crimea, Caucasus, Far Eastern USSR), Mexico, ?Antarctic (Text-fig. 9).

Birostrina sulcata (PARKINSON, 1819)

Pl. 5, fig. 17; text-fig. 9

- v + 1819 *Inoceramus sulcatus* - PARKINSON, p. 59, pl. 1, fig. 5.
- v . 1821 *Inoceramus sulcatus* - SOWERBY, p. 184, pl. 306, figs. 1-7.
- v . 1822 *Inoceramus sulcatus* - MANTELL, p. 95, pl. 19, fig. 16.
- 1822 *Inoceramus sulcatus* Park. - BRONGNIART in CUVIER et BRONGNIART, pp. 97, 100, pl. 6, fig. 12.
- v . 1835 *Inoceramus sulcatus* Sow. - GOLDFUSS, p. 112, pl. 110, fig. 1.
- . 1846 *Inoceramus sulcatus*, Sowerby - D'ORBIGNY, p. 504, pl. 403, figs. 3-5.
- p . 1863 *Inoceramus sulcatus* Parkinson - PICTET et ROUX, p. 499, pl. 42, figs. 1a - c [non figs. 1d-f = *B. subsulcata* (WILTSHIRE)].
- 1869 *Inoceramus sulcatus*, Parkinson - PICTET et CAMPICHE, p. 105.
- . 1904 *Inoceramus praedigitatus* n. sp. - AIRAGHI, p. 183, fig. 1, pl. 1, figs. 13, 14.
- . 1909 *Inoceramus sulcatus* Park. - WOLLMANN, p. 273, pl. 6, fig. 10.

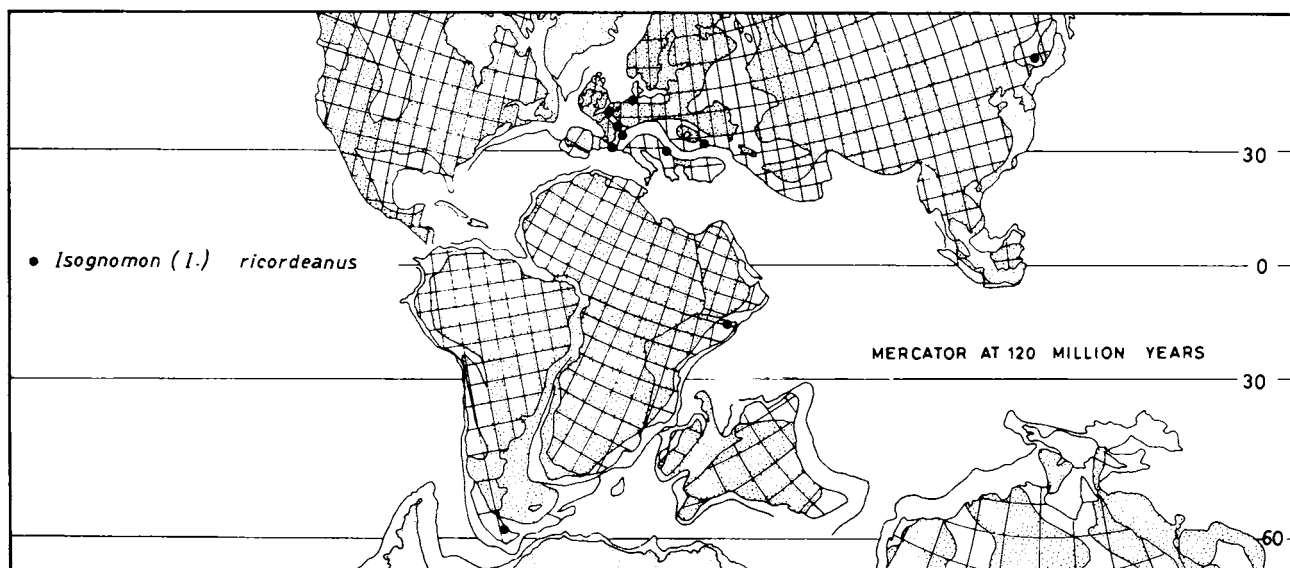


FIG. 10

- . 1911 *Inoceramus sulcatus*, Parkinson - WOODS, p. 269, pl. 47, figs. 15-20.
 - . 1912 *Inoceramus sulcatus* Park. - WOODS, p. 4, figs. 19-21.
 - 1930 *Inoceramus sulcatus* Park. - PASSENDORFER, p. 590.
 - 1939 *Inoceramus sulcatus* Park. - MARLIÈRE, p. 208, etc.
 - v . 1960 *Inoceramus sulcatus* Parkinson - MUROMTSIEVA, JANIN, p. 185, pl. 7, figs. 9, 10.
 - v . 1962 *Inoceramus sulcatus* Parkinson - BRITISH MUSEUM, p. 156, pl. 56, fig. 5.
 - 1962 *Actinoceramus sulcatus* Parkinson - SAVELIEV, p. 242, pl. 11, figs. 1-8.
 - . 1969 *Inoceramus (Birostrina) sulcatus* Parkinson - COX in MOORE, p. N315, fig. C46 (2a).
 - 1974 *Inoceramus (Birostrina) sulcatus* Parkinson - OEKENTORP & SIEGFRIED, p. 134, pl. 5, fig. 5.
 - . 1974 *Inoceramus (Birostrina) sulcatus sulcatus* Parkinson - DIMITROVA, p. 66, pl. 34, fig. 4.
 - 1975 *Inoceramus (Birostrina) sulcatus* Parkinson - FÖRSTER, p. 30.
 - . 1976 *Inoceramus (Birostrina) sulcatus* Park.-MONGIN in DESTOMBES et MONGIN, pl. 2, fig. 4.
 - . 1977 *Actinoceramus sulcatus* (Parkinson) - KOTETISHVILI, p. 21, pl. 4, fig. 5.
 - 1978 *Birostrina sulcata* (Parkinson) - KAUFFMAN, p. XVII 1, pl. 1, fig. 22.
 - ? 1978 *Inoceramus ex gr. sulcatus* Parkinson - ZONOVA, p. 80, pl. 7, figs. 7-10.
 - 1979a *Inoceramus (Birostrina) sulcatus* Park. - MONGIN, p. 415, pl. 9-2, fig. 4.
 - . 1980 *Inoceramus (Birostrina) sulcatus* Parkinson - FISCHER, p. 214, pl. 99, figs. 2, 3.
 - 1982 *Inoceramus sulcatus* Parkinson - STÜHMER, SPAETH, SCHMID, text-fig. 17.
 - 1983 *Inoceramus sulcatus* - VAN DIGGELEN, p. 32, fig. 63.
 - . 1985 *Inoceramus sulcatus* Parkinson - AMÉDRO, pl. 7, fig. 9.
- Material:** Three more or less complete internal moulds (2 left and 1 right valve) from Orosei, Upper Albian (n. 14, 125, 126).
- Dimensions** (mm): n. 125: H = 27; L = (19).
- Discussion:** The Sardinian material is in agreement with the detailed description in WOODS (1911).
- Distribution:** Restricted to the uppermost Middle and Upper Albian (SEITZ, 1956; SORNAY in ROBASYNSKI and AMÉDRO, 1980; SORNAY, 1981); according to OWEN (1984) limited to the lower part of the *Inflatum* Zone (*Cristatum* and *Orbigny* Subzones). S. England, Anglo-Paris Basin (including Belgium), Germany (Heligoland), Poland, Switzerland, SE France, Sardinia, Bulgaria, USSR (Crimea, Caucasus, West Kazakhstan, Far Eastern USSR), Mozambique (Text-fig. 9).
- Fam. ISOGNOMIDAE
- Isognomon (Isognomon) ricordeanus* (D'ORBIGNY, 1846)
- Pl. 3, fig. 3; text-fig. 10
- v + 1846 *Perna Ricordeana*, d'Orbigny - D'ORBIGNY, p. 494, pl. 399, figs. 1-3.
- ? 1846 *Perna Raulimiana*, d'Orbigny - D'ORBIGNY, p. 497, pl. 401, figs. 4, 5.

- . 1858 *Perna Ricordeana*, d'Orb. - PICTET et RENEVIER, p. 125.
- . 1869 *Perna Ricordeana*, d'Orbigny - PICTET et CAMPICHE, p. 93, pl. 157, fig. 1.
- . 1869 *Perna Germani*, Pictet et Campiche - PICTET et CAMPICHE, p. 94, pl. 157, fig. 3.
- . 1869 *Perna Fittoni*, Pictet et Campiche - PICTET et CAMPICHE, p. 95, pl. 157, fig. 2.
- . 1889 *Perna bulgarica* nov. spec. - TOULA, p. 78, pl. 5, figs. 1, 2.
- . 1892 *Perna Aprilovi* nov. spec. - VANKOV, p. 87, pl. 1, figs. 1, 2.
- 1892 *Perna Bulgarica* Toula-VANKOV, p. 88.
- 1900 *Perna Ricordeana* d'Orbigny - WOLLE-MANN, p. 61.
- . 1905 *Perna Ricordeana*, d'Orbigny - WOODS, p. 90, text-figs. 16 - 18.
- 1922 *Perna Ricordeana* d'Orb. - GILLET, p. 108.
- 1924 *Perna Ricordeana* d'Orb. - GILLET, p. 38.
- v ? 1926 *Perna sanchuensis* Yabe and Nagao sp. nov. - YABE et al., p. 57, pl. 12, figs. 1-4.
- . 1931 *Perna ricordeana* d'Orbigny - WEAVER, p. 208, pl. 16, figs. 66-70.
- v . 1935 *Isognomon* cf. *ricordeanum* (d'Orbigny) - COX, p. 199, pl. 23, fig. 4.
- . 1960 *Isognomon ricordeanus* Orbigny - MUROMTSIEVA, JANIN, p. 183, pl. 7, figs. 1-3.
- . 1974 *Isognomon (Isognomon) ricordeanus* (d'Orbigny) - DIMITROVA, p. 67, pl. 35, figs. 1, 2; pl. 36, figs. 2, 3.

Material: One somewhat deformed internal mould from the Lower Hauterivian of the Su Praicargiu area (Lanaitto) (n. 195).

Dimensions (mm): H = 66; L = 49; B = (32).

Discussion: The specimen from Sardinia agrees with the figure of *Perna Ricordeana* in PICTET and CAMPICHE (1869) and with those of *P. Germani* and *P. Fittoni*, erected by the same authors. All three are considered synonymous herein. It is also very similar to the specimen (internal mould) figured by D'ORBIGNY (1846) as *P. Rauliniana* which again might be conspecific with *Isognomon ricordeanus*. The incomplete specimen figured by MUROMTSIEVA and JANIN (1960, pl. 7, fig. 3) also agrees well with the Sardinian specimen.

P. sanchuensis YABE and NAGAO, 1926 from the Aptian-Albian deposits in Honshu, Japan, seems similar, but is difficult to judge definitively: the type specimen has been partly broken since YABE and NAGAO figured it in 1926.

Among the many *Isognomon* species described from Northern Siberia by ZAKHAROV (1966) several are very similar to *I. ricordeanus*: *I. cuneatus* from the Volgian (p. 88, pls. 30, 31; pl. 32, fig. 1), *I. trivialis* from the Berriasian - Lower Valanginian (p. 90, pl. 32, fig. 2; pl. 33, fig. 1), *Isognomon* "sp. 2" from the Lower Volgian (p. 93, pl. 25, fig. 3; pl. 32, fig. 3). This probably only indicates the wide distribution of the group, already suggested by the Japanese and South American occurrences.

Distribution: Valanginian - Aptian, in Temperate and Tethyan Realms: S. England, Germany, France, Switzerland, Sardinia, Bulgaria, USSR (Crimea), Somalia, Japan, Argentina (Text-fig. 10).

Fam. PROPEAMUSSIIDAE

Propeamussium ninae (KARAKASCH, 1897)

Pl. 3, figs. 2a, 2b; text-fig. 11

- ? 1852 *Pecten pygmaeus*, Buv. - BUVIGNIER, p. 46, pl. 4, figs. 15-17 (non *Pecten pygmaeus* MÜNSTER in GOLDFUSS, 1835).
- v + 1897 *Pecten (Amusium) Ninae*, nov. sp. - KARAKASCH, p. 48, pl. 5, fig. 1.
- v . 1926 *Pecten Ninae* Karak. - RENNIGARTEN, p. 53.
- v . 1955 *Pecten* cf. *ninae* Kar. - ERISTAVI, p. 21.
- v . 1960 *Variamussium ninae* Karakash - MUROMTSIEVA, JANIN, p. 187, pl. 8, figs. 8, 9.
- v . 1977 *Variamussium ninae* (Karakash) - KOTETISHVILI, p. 23, pl. 2, figs. 1, 2.
- . 1977 *Propeamussium (Parvamussium) ninae* (Karakasch) - SOBETSKI, p. 80, pl. 4, figs. 19-21.

Material: One well preserved right valve from Orosei, Upper Albian (n. 856).

Dimensions (mm): H = 6.

Description: By transparency about 11 interior ribs (which begin at about 2.5 mm from the umbo, but not synchronously) can be seen; additional intercalary interior ribs are sometimes added further away from the umbo. On the outside the shell has a relatively strong commarginal striation.

Discussion: *P. ninae* differs from *Pecten alpinus* D'ORBIGNY, 1847, of Barremian age, by its straight internal ribs, and from *Pecten inversus* NILSSON, 1827, of Cenomanian-Campanian age, by the lower number of internal ribs, but this last fact could be related to its smaller average size.

Distribution: *P. ninae* has not been recorded with certainty previously from outside the S. USSR. Upper Albian-Cenomanian (?), from NW France (?), Sardinia, USSR (Crimea - Caucasus) (Text-fig. 11).

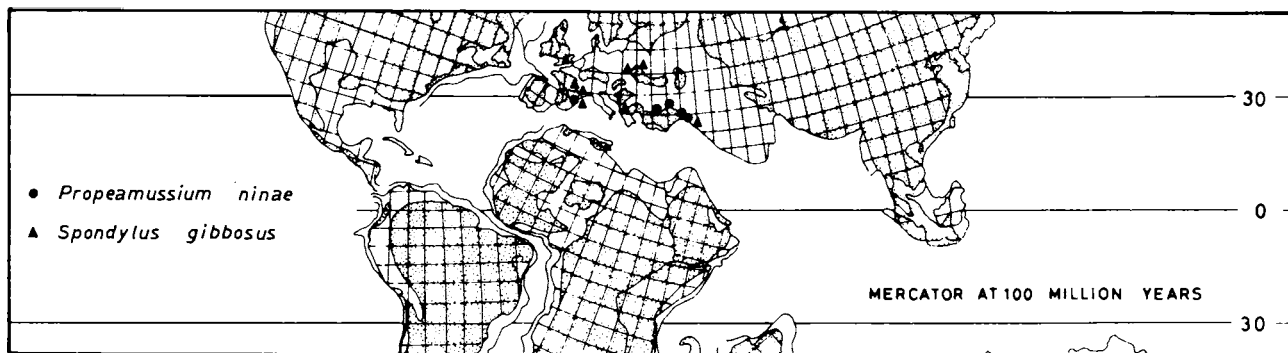


FIG. 11

Fam. PECTINIDAE

Entolium orbiculare (SOWERBY, 1827)

Pl. 6, fig. 9; text-fig. 12

v + 1817 *Pecten orbicularis* - SOWERBY, p. 193, pl. 186.1900 *Pecten Germanicus* n. sp. - WOLLEMAN, p. 41, pl. 8, figs. 13-19.v . 1902 *Pecten (Syncyclonema) orbicularis*, Sowerby - WOODS, p. 145, pl. 27, figs. 1-3, 5-13 [non pl. 27, fig. 4 = *Syncyclonema baldonensis* (WOODS, 1902)].v . 1960 *Syncyclonema germanica* Wolleemann - MUROMTSIEVA, JANIN, p. 186, pl. 8, figs. 4, 5.v . 1960 *Syncyclonema orbicularis* Sowerby - MUROMTSIEVA, JANIN, p. 186, pl. 8, figs. 6, 7.v . 1961 *Syncyclonema orbiculare* (Sowerby) - SOBETSKI, p. 22, pl. 1, figs. 1-9.v . 1961 *Syncyclonema noetlingi* Sobetski - SOBETSKI, p. 27, pl. 1, figs. 10-14.v . 1962 *Entolium orbiculare* (J. Sowerby) - BRITISH MUSEUM, p. 156, pl. 56, fig. 2.. 1968 *Syncyclonema orbiculare* (Sow.) - KEMPER, p. 59, etc.; pl. 17, fig. 3.v . 1971 *Entolium orbiculare* (Sowerby) - DHONDT, p. 8, pl. 1, fig. 1 (*cum syn.*).v . 1972 *Syncyclonema orbiculare* Sowerby - GLAZUNOVA, p. 66, pl. 13, figs. 1-4.. 1974 *Syncyclonema germanica* Wolleemann - DIMITROVA, p. 69, pl. 37, figs. 1, 2.1974 *Syncyclonema orbicularis* (Sowerby) - OEKENTORP & SIEGFRIED, p. 144, pl. 10, fig. 4.1974 *Syncyclonema orbiculare* (Sowerby) - KOCIUBINSKIJ, SAVCZINSKAJA, p. 91, pl. 27, figs. 3, 4.1975 *Entolium orbicularis* (Sowerby) - FÖRSTER, p. 16.v . 1977 *Entolium orbiculare* (Sowerby) - SOBETSKI, p. 34, pl. 3, figs. 9-13.v . 1977 *Entolium noetlingi* (Sobetski) - SOBETSKI, p. 36, pl. 2, figs. 14, 15.1980 *Entolium orbiculare* Sowerby - FISCHER, p. 246, pl. 119, fig. 8.1982 *Pecten (Entolium) orbiculare* Sow. - COLLETÉ in COLLETÉ *et al.*, p. 34, pl. 4, fig. 8.. 1982 *Entolium (Entolium) orbiculare* (J. Sowerby) - FÜRSICH, p. 38, pl. 15, figs. A, B, D, E.1984 *Entolium (Entolium) orbiculare* (J. Sowerby) - JOHNSON, p. 55, text-figs. 38-42, pl. 1, fig. 19.1984 *Entolium (Entolium) orbiculare* (J. Sowerby) - KELLY, p. 76, text-fig. 52, pl. 13, figs. 1-10.1984 *Entolium orbiculare* (Sowerby) - DHONDT, p. 850.1984 *Entolium orbiculare* (Sowerby) - MAREK *et al.*, p. 92, pl. 30, fig. 1.*Material*: Two incomplete specimens from Orosei, lowermost Hauterivian (n. 286, 365).*Dimensions* (mm): n. 365: H = 8.5; L = 8.2; n. 286: H = 12; L = 13. The specimens are relatively small for the species.*Discussion*: As can be seen in the synonymy given above, *E. orbiculare* has been restudied recently by several authors. The Sardinian specimens bring no further new information.*Distribution*: Recent authors (JOHNSON, 1984 and KELLY, 1984) have extended the stratigraphical range of *E. orbiculare* downwards into the Oxfordian. The youngest *E. orbiculare* specimens were recorded by DHONDT (1971) from the *Actinocamax plenus* Zone, Late Cenomanian. Thus *E. orbiculare* could be an example of an unusually long ranging species. On the other hand this long range could only demonstrate that *E. orbiculare* has so few characteristics that it is difficult to differentiate it from other species in the same genus. Oxfordian-latest Cenomanian: north Temperate Realm (including Northern Canada, Alaska, Northern Siberia, Greenland), northern margin of the Tethys, SE Africa. JOHNSON (1984) indicated a "boreal" distribution for the Late Jurassic (Text-fig. 12).

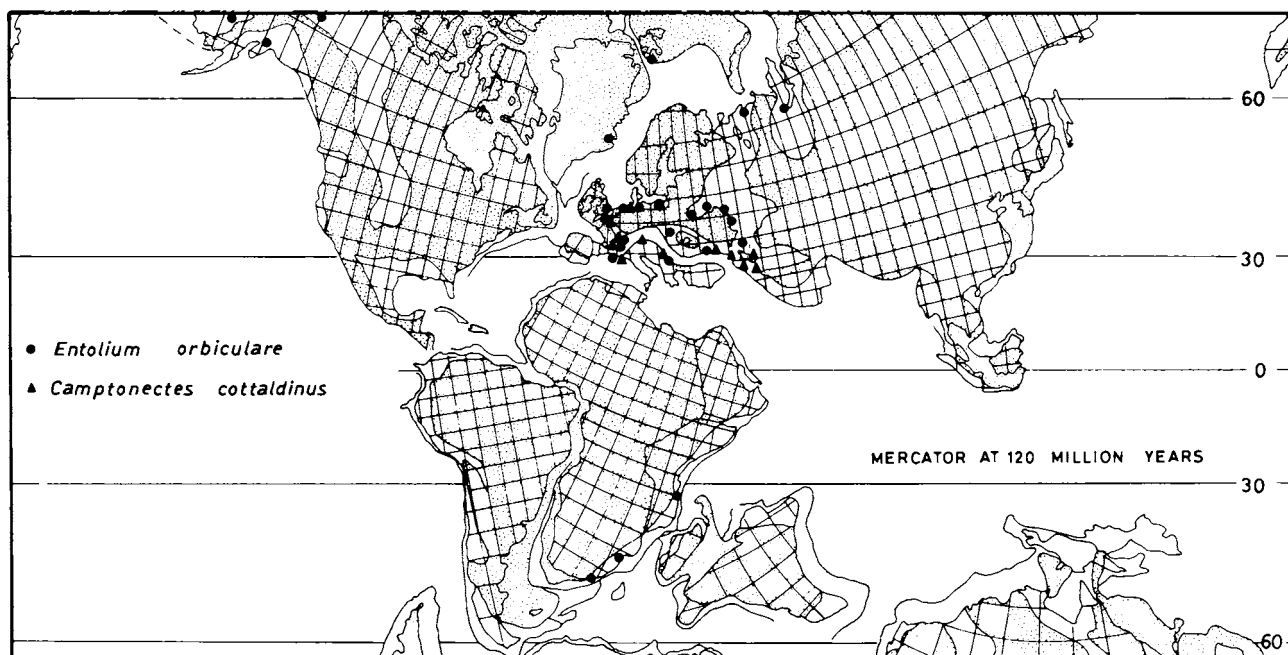


FIG. 12

Camptonectes cottaldinus (D'ORBIGNY, 1847)

Pl. 6, figs. 1 - 3; text-fig. 12

- v + 1847 *Pecten Cottaldinus*, d'Orbigny - D'ORBIGNY, p. 590, pl. 431, figs. 7-11.
- v . 1902 *Pecten* (*Camptonectes*) *Cottaldinus*, d'Orbigny - WOODS, p. 156, pl. 29, figs. 1-3 (*cum syn.*).
- ? 1907 *Pecten* cf. *crassitesta* Roem. - DENINGER, p. 469.
- v . 1907 *Pecten Cottaldi* d'Orb. - KARAKASCH, p. 192.
- 1960 *Camptonectes cottaldinus* Orbigny - MUROMTSIEVA, JANIN, p. 188, pl. 8, figs. 13-16.
- v . 1961 *Camptonectes cottaldinus* (Orbigny) - PROZOROVSKII, p. 117, pl. 8, figs. 5-8.
- v . 1966 *Camptonectes cottaldinus* (Orbigny) - BOGDANOVA, p. 78, pl. 8, fig. 8.
- 1968 *Camptonectes cottaldinus* (D'Orb.) - KEMPER, pl. 17, fig. 3.
- v . 1972 *Camptonectes* (*Camptonectes*) *cottaldinus* A. d'Orbigny - DHONDT, p. 6, pl. 2, fig. 2 (*cum syn.*).
- 1974 *Camptonectes cottaldinus* (d'Orbigny) - DIMITROVA, p. 71, pl. 37, figs. 3, 4.

Material: Eight somewhat deformed valves from the Upper Valanginian at Su Praicargiu (Lanaitto) (n. 153, 218) and from the Lower Hauterivian at Sa Oche (Lanaitto) (n. 175, 238, 776, 780, etc.).

Dimensions (mm):

n.	H	L
238	21	19
780	27.5	25
153	32	33

Discussion: The Sardinian specimens though slightly deformed and of relatively small size are in agreement with previous descriptions. The com-marginal lines and diverging camptonectid striae are clearly visible on most specimens.

It is assumed that DENINGER's record of *Pecten crassitesta* ROEMER [= *Maclearnia cincta* (Sowerby)], restricted to cold temperate seas of Neocomian age] actually refers to *C. cottaldinus*, since among the rich material from the Lower Cretaceous of Eastern Sardinia no specimen resembling *M. cincta* was ever found, but numerous smaller camptonectids occur.

Distribution: Valanginian - Aptian, north Temperate and Tethyan Realms: S. England, France, Germany, Switzerland, Sardinia, Austria, Bulgaria, USSR (Crimea, Caucasus, Central Asia) (Text-fig. 12).

Chlamys? archiaciana (D'ORBIGNY, 1847)

Pl. 6, figs. 4-6; text-fig. 13

- v + 1847 *Pecten Archiaciana*, d'Orbigny - D'ORBIGNY, p. 583, pl. 429, figs. 7-10.
- v . 1926 *Pecten Archiaci* d'Orb. - RENNGARTEN, p. 54.
- v . 1926 *Pecten khobensis* Karak. - RENNGARTEN, p. 55 [non KARAKASCH, 1907 = *Mimachlamys robinaldina* (D'ORBIGNY, 1847)].
- v . 1960 *Chlamys archiacianus* Orbigny - MUROMTSIEVA, JANIN, p. 188, pl. 9, fig. 7.
- v ? 1961 *Chlamys archiaci* (Orbigny) - PROZOROVSKII, p. 115, pl. 8, fig. 3.
- v . 1973a *Chlamys? archiaciana* (A. d'Orbigny) - DHONDT, p. 42, pl. 9, fig. 2 (*cum syn.*).

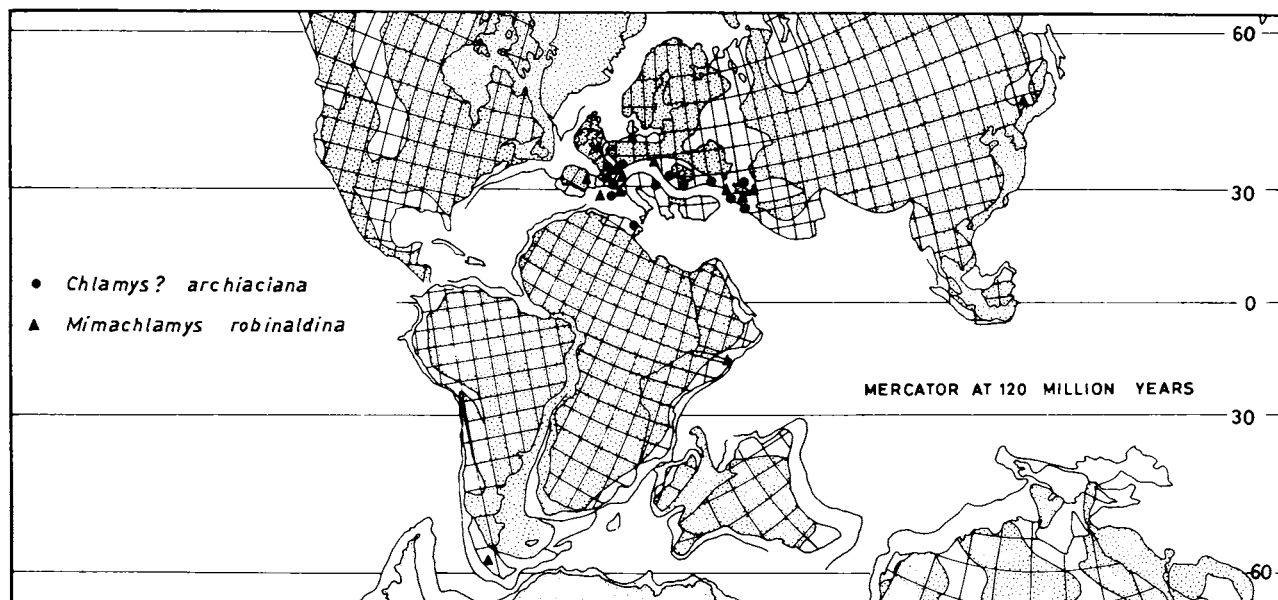


FIG. 13

. 1974 *Chlamys* (*Chlamys*) *archiacianus* (d'Orbigny) - DIMITROVA, p. 72, pl. 37, fig. 7.

1980 *Chlamys* (*Chlamys*) cf. *archiaciana* (d'Orbigny) - MONGIN, p. 12.

Material: Eight somewhat deformed bivalved and univalved specimens from the lowermost Hauterivian at Orosei (n. 52,288), Sa Oche (n. 477,775, etc) and Su Praicargiu (n. 151) (Lanaitto).

Dimensions (mm):

n.	H	L	B	UA	R
288	33	(29.5)	—	—	29 (LV?)
789	38	(31.0)	9	79°	22 (RV), 20 (LV)
151	—	—	—	—	> 19 (LV?)
775	(41)	(39.5)	—	—	22 (LV)
785	—	—	—	—	(19)

Discussion: The shell on n. 151 (Su Praicargiu) clearly shows the typical rib pattern of *Chlamys? archiaciana*. The rib number varies: some ribs divide, hence the variability in their number counted at the margin of the valves. When present, the commarginal lines form scale-like structures at the intersection points with the ribs. Rib number, shape, umbonal angle are also similar to the specimens described by previous authors.

Distribution: Valanginian to Aptian, but mainly Hauterivian: SE and Paris Basin in France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Central Asia). ? Berriasian of Tunisia (Text-fig. 13).

Chlamys? cf. elongata (LAMARCK, 1819)

Pl. 6, fig. 7

One left valve from the Lower Hauterivian of Monte Tundu (Dorgali) (n. 360) has a shell shape, a rib number and rib distribution similar to that of *Chlamys? elongata* (LAMARCK, 1819) (see WOODS,

1902, p. 170, pl. 31, figs. 10-13; pl. 32, figs. 1-3). It lacks the rib ornamentation, hence a definite identification is impossible.

Mimachlamys robinaldina (D'ORBIGNY, 1847)

Pl. 6, fig. 8; pl. 12, fig. 2a; text-fig. 13

v + 1847 *Pecten Robinaldinus*, d'Orbigny - D'ORBIGNY, p. 587, pl. 431, figs. 1-4.

v . 1902 *Pecten* (*Chlamys*) *Robinaldinus*, d'Orbigny-WOODS, p. 181, pl. 34, figs. 7-12; pl. 35, figs. 1-10 (*cum syn.*).

v . 1907 *Pecten khobensis* nov. sp. - KARAKASCH, p. 192, pl. 18, fig. 13.

1962 *Chlamys* (*Chlamys*) *robinaldina* (d'Orbigny) - KRIMHOLZ, p. 38, pl. 46, fig. 3.

v . 1966 *Chlamys robinaldinus* (Orbigny) - BOGDANOVA, p. 73, pl. 8, figs. 3, 4.

v . 1973a *Mimachlamys robinaldina* (A. d'Orbigny) - DHONDT, p. 56, pl. 7, fig. 2 (*cum syn.*).

1975 *Chlamys robinaldina* (d'Orbigny) - FÖRSTER, p. 26.

v . 1977 *Chlamys* (*Chlamys*) *galliennei* (Orbigny) - SOBETSKI, p. 40, pl. 3, fig. 1.

1979a *Chlamys dutemplei* (d'Orb.) - MONGIN, p. 415.

. 1981 *Chlamys* (*Chlamys*) *robinaldina* (d'Orbigny) - TZANKOV in TZANKOV *et al.*, p. 104, pl. 46, figs. 1-3.

v . 1984 *Mimachlamys robinaldina* (d'Orbigny) - DHONDT, p. 851.

Material: Eight slightly deformed specimens with partial shell preservation from the Lower Hauterivian at Orosei, Sa Oche and Su Praicargiu (Lanaitto).

Dimensions (mm): n. 786, from Sa Oche: H = 49; L = (42).

Discussion: The shell fragments on the Sardinian specimens show the typical *Mimachlamys robinaldina* ornamentation of narrow irregular radial ribs covered with small scales. The camptonectid striae in the intercostal intervals cannot be seen because of the poor preservation.

Distribution: Known from the Valanginian to the latest Cenomanian in the Temperate and Tethyan Realms from England to Japan: S. England, France, Belgium, Germany, Denmark, Austria, Czechoslovakia, Switzerland, Sardinia, Bulgaria, USSR (Moldavia, Crimea, Caucasus, W. Kazakhstan, Turkmenia), Somalia?, Mozambique, Japan, Argentina.

Genus *Euthymipecten* nov. gen.

Type species: *Pecten Astierianus* D'ORBIGNY, 1850.

Derivation of name: *Euthymi* and *pecten*; PICTET (1867) gave the first illustration of the type species under the name *Pecten Euthymi*.

Diagnosis: Large, suborbicular, compressed, nearly equivalve and almost equilateral pectinid. Right valve: slightly more convex than left valve; ornamentation consists of broad radial primary ribs, with intercalary irregular secondary and sometimes tertiary ribs; auricles unequal; anterior auricle elongated and with byssal notch; posterior auricle narrowly triangular. Left valve: generally only covered by narrow primary ribs; both auricles narrowly triangular. Shell relatively thin.

Discussion: Cretaceous pectinid genus, probably belonging to the subfamily Chlamydinae VON TEPPNER, 1922 because of the byssal notch.

Similar Mesozoic pectinid genera differ in some characteristics:

— Jurassic *Pseudopecten* BAYLE, 1878 superficially seems to have the same disc shape, but the rib arrangement is more regular and the shell is much heavier;

— *Eopecten* DOUVILLÉ, 1897 [= *Velata* QUENSTEDT, 1856 (*non* GRIFFITH and PIDGEON, 1834) = *Velopecten* PHILIPPI, 1899] is attached by the right valve but the ornamentation of both valves can be compared with *Euthymipecten*. In *Eopecten* the rib pattern is generally more intricate and the byssal notch is much more developed and functional at all stages.

From other Early Cretaceous pectinid genera *Euthymipecten* can be distinguished as follows:

— from *Chlamys* ROEDING, 1798 and *Mimachlamys* IREDALE, 1929 by the relatively smaller and more equal elongated auricles, by the less heavy shell and the more orbicular shape;

— from *Camptonectes* AGASSIZ in MEEK, 1864 by the shallower byssal notch, by the less heavy shell, by the presence of developed radial rib ornamentation;

— from *Propeamusium* DE GREGORIO, 1884 by the absence of internal ribs, and by the much larger shell and different shell structure;

— from *Neithea* DROUET, 1825 by the almost equi-valve shell and the regular ribpattern;

— from *Entolium* MEEK, 1865 by the presence of a byssal notch and of radial ornamentation;

— from *Aequipecten* FISCHER, 1887 (= *Microchlamys* SOBETSKI, 1977) by the absence of a functional byssal notch in adult stages and the generally larger size;

— from *Merklinia* SOBETSKI, 1960 by the much less intricate radial ornamentation, the relatively less convex valves, the presence of far fewer spines;

— from *Lyriochlamys* SOBETSKI, 1977 by the orbicular shape, the relatively small byssal notch and the radial ribs of varying order (*Lyriochlamys* is not clearly defined; the species which SOBETSKI listed as belonging to it do not seem to have much in common and some are only known as poorly preserved internal moulds. Therefore we compare *Euthymipecten* with the well known type species of *Lyriochlamys*: *Pecten fissicosta* ETHERIDGE, 1881 from the English Cenomanian).

Species included: the type species, *Pecten Astierianus* D'ORBIGNY, 1850 (see further), and *Pecten Beaveri* SOWERBY, 1817 from the Albian-Cenomanian. Both species have a relatively wide geographic distribution, but are restricted ecologically to fine grained deposits. No other species has been found which can be included in this new genus.

Age and geographic distribution: *Euthymipecten* seems to be restricted to the Cretaceous and possibly it does not extend beyond the Cenomanian. Geographically it occurs mainly in Temperate climatic zones, but generally in fine-grained deposits such as Gault clays. It represents a group of pectinids which lived not in littoral waters, but in somewhat deeper seas.

Euthymipecten astierianus (D'ORBIGNY, 1850)

Pl. 6, figs. 14a-16b

v + 1850 *Pecten Astierianus*, d'Orb. - D'ORBIGNY, p. 83, n. 392.

v . 1867 *Pecten Euthymi*, Pictet-PICTET, p. 96, pl. 21, figs. 1-3.

1871 *Pecten Astierianus*, d'Orb. - PICTET et CAMPICHE, p. 210.

? 1924 *Prospondylus Euthymi* Pictet - GILLET, p. 56.

? 1930 *Pecten Euthymi* Pictet - ROCH, p. 277.

v . 1934-1935 *Pecten Astierianus* d'Orb. - COTTREAU, p. 68, 1 text-fig. (sub *Prospondylus Euthymi* Pictet), pl. 73, fig. 3.

? 1972 *Prospondylus euthymi* Pictet - BESAIRIE, pp. 361 and 362.

- 1974 *Eopecten euthymi* (Pictet) - DIMITROVA, p. 78, pl. 39, fig. 2.
 1979b *Eopecten euthymi* (Pictet) - MONGIN, p. 2.
 1980 *Eopecten asterianus* (d'Orbigny) - MONGIN, p. 212.
 1986 *Prospondylus euthymi* - LE HÉGARAT in GALBRUN *et al.*, p. 579.

Material: Sardinia: one bivalved incomplete specimen with shell preservation from chalky marls at Orosei (n. 287), early Late Valanginian age.

France: Berrias, Ardèche (PICTET coll., MG n. 8783; COQUAND coll., MAFI K 10259), Berriasian; Clumans, Alpes-de-Haute-Provence (COQUAND coll., MAFI K 11129), Berriasian?; Ginestous, Hérault (COQUAND coll., MAFI); Saint-Auban, Alpes Maritimes (D'ORBIGNY coll., MNHN 5132), Berriasian? Valanginian?; Castellane, Alpes-de-Haute-Provence (D'ORBIGNY coll., MNHN 5132), Berriasian?; "Basses-Alpes", Alpes-de-Haute-Provence (PICTET coll., MG 8789), Berriasian?

Switzerland: different localities in Justistal, Thuner See (PICTET coll., MG 8784-8788, 8790).

Dimensions (mm):

n.	H	L	B	R	Valve	UA	Coll.
287	(70)	(70)	18	17	LV	—	Padua
5132	>73	—	—	18	RV	—	MNHN
5132	83	68.5	—	16	RV	100°	MNHN
8783	(60.6)	(57.2)	—	16	?	—	MG
K10259	(52)	(54)	—	19	RV	105°	MAFI
K10259	63.5	(63.7)	—	18	LV	111°	MAFI
K11129	62.2	64.7	—	22	LV	120°	MAFI
—	(56.5)	(58)	—	18	RV	107°	MAFI
—	(37.3)	(34.0)	—	(15)	?	(97°)	MAFI
—	(63)	(67)	—	18	LV	102°	MAFI
—	(62)	(58)	—	18	?	—	MAFI
8789	(75)	71	—	16	LV	—	MG
8789	(75)	—	—	18	RV	—	MG
8789	65	61	—	15	LV?	—	MG
8789	65	61	—	17	RV	—	MG
8789	(61.5)	—	—	15	LV	—	MG
8789	(61.5)	—	—	18	RV	—	MG
8784	72	—	—	(20)	RV	—	MG
8785	—	64	—	17	RV	—	MG
8786	(58)	63.7	—	21	LV	—	MG
8787	(67.8)	65	—	20	RV	—	MG
8790	72	(72)	—	17	RV?	—	MG

Description: Right valve suborbicular, covered with 16 to 21 primary radial ribs and several irregular secondary intercalary ribs; fine commarginal ornamentation forms spine-like structures at the intersection with primary and secondary radial ribs; anterior auricle elongate and with well developed byssal sinus, posterior auricle smaller and with almost right angle, both covered with strong com-

marginal lines which follow the exterior margins; less developed radial lines can also be seen.

Left valve somewhat more flattened than the right, mainly bearing only narrow radial ribs, also 16 to 21 in number, divided by broad interspaces; towards the margin rare intercalary ribs are present; anterior auricle with acute outer angle and covered with radial and commarginal lines, posterior auricle somewhat smaller.

Discussion: Already in 1871 PICTET and CAMPICHE placed the species *Pecten Euthymi* PICTET, 1867 in the synonymy of *P. Astierianus* D'ORBIGNY, 1850. Both taxa show the same ornamentation (COTTREAU, 1934-35) and are based on incomplete specimens, yet they agree in all details. The only specimen figured in literature with more or less complete auricles is in COTTREAU (1934, text-fig. on p. 69). Complete auricles are preserved on specimens in the COQUAND coll. (MAFI), and they prove beyond doubt that the auricle reconstruction made by PICTET (1867, pl. 21, figs. 1a, 1b) is inaccurate.

The generic attribution of *Pecten Astierianus* has been discussed by GILLET (1924), who placed it in *Prospondylus* ZIMMERMANN, 1886. According to NEWELL in MOORE (1969) this genus is synonymous with *Pseudomonotis* VON BEYRICH, 1852 and is restricted to the Palaeozoic. MONGIN (1980) rediscussed the problem, but did not come to any new conclusions and accepted the generic interpretation previously proposed by GILLET. *Euthymipecten astierianus* is obviously a pectinid which was generally free living in adult stages. On none of the specimens is there any trace of attachment on the right valve near the umbo. Only occasional byssal attachment could have existed for *E. astierianus* in adult stages. This is why *E. astierianus* does not belong to the genus *Eopecten*. In conclusion it cannot be included in the genera suggested by earlier authors: GILLET, COTTREAU, DIMITROVA and MONGIN (see synonymy).

E. astierianus show definite similarities with the congeneric Albian-Cenomanian "*Pecten (Aequipecten) beaveri*" SOWERBY, 1817 figured and described in WOODS (1902, p. 188, pl. 38): suborbicular valves and numerous straight ribs, primary, secondary and in *E. beaveri* even frequently tertiary. Both species seem to have lived in very fine grained sediments as we can ascertain from finding *E. beaveri* in the Gault clays or in the Lower Chalk, and *E. astierianus* in the "lithographic" limestone at Berrias, or in chalky marls in Eastern Sardinia.

Distribution: *Pecten Astierianus* was originally described from beds dated as "Néocomien A" at Castellane (Alpes-de-Haute-Provence) and at Saint-Auban (Alpes-Maritimes). *P. Euthymi* was

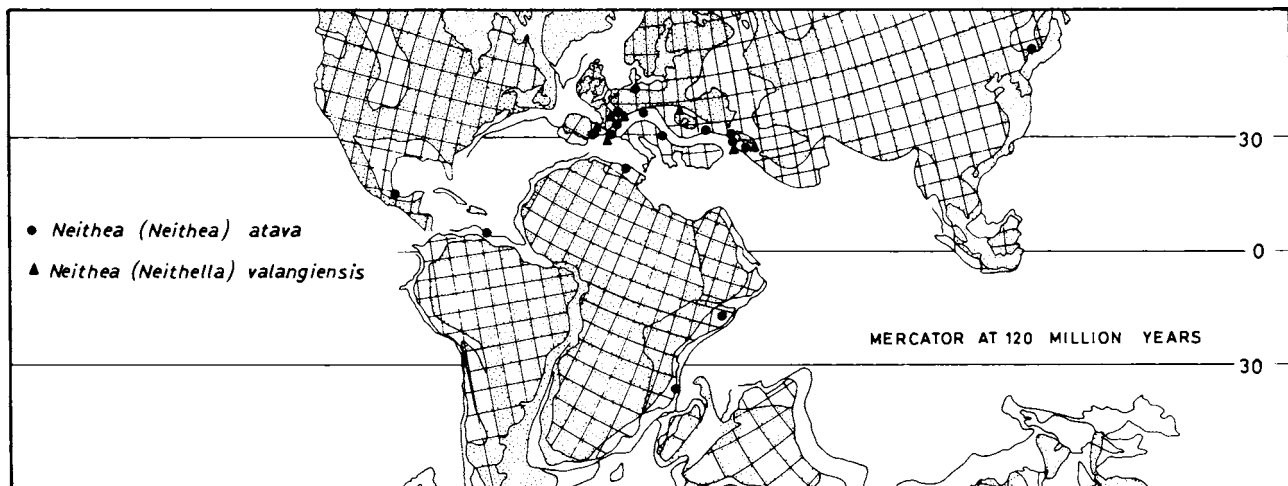


FIG. 14

described by PICTET from Berrias (Ardèche), without statement about the precise level at which the specimens were collected. LE HÉGARAT in BUSNARDO *et al.*, 1965, LE HÉGARAT, 1980 and in GALBRUN *et al.*, 1986, indicated "*Prospandylus euthymi*" as occurring in the Callisto Subzone (i.e. uppermost Berriasian) in the type-section of the Berriasian.

Since the original descriptions (as *P. Astierianus* and *P. Euthymi*) the species has been recorded from the following regions (taking into consideration only undoubted occurrences): Berriasian of the Ardèche (France), of Juststal (Thuner See, Switzerland), Valanginian of the Alpes-Maritimes and Alpes-de-Haute-Provence (France), Sardinia, Bulgaria, Morocco. The stratigraphic range of *E. astierianus* seems therefore to be restricted to the (Late?) Berriasian - Valanginian interval. The original specimens of *P. Astierianus* came from localities which do not contradict a Berriasian - Valanginian age.

The stratigraphic distribution indicated by GILLET (1924) (Tithonian-Gargasian) seems unconfirmed. Probably she had included longer ranging *Eopecten* species in her interpretation of "*Prospandylus euthymi*".

BESAIRIE (1972), in fossil-lists, mentioned occurrences of "*Prospandylus euthymi*" from the uppermost Aptian (Clansayesian) of Madagascar. They seem doubtful and disagree with other definite occurrences.

Neithea (Neithea) atava (ROEMER, 1839)

Pl. 6, figs. 10-12; text-fig. 14

- v + 1839 *Pecten atavus* Nob. - ROEMER, p. 29, pl. 18, fig. 21.
- v . 1847 *Janira atava*, d'Orbigny - D'ORBIGNY, p. 627, pl. 442, figs. 1-3,5
- v . 1847 *Janira neocomiensis*, d'Orbigny - D'ORBIGNY, p. 629, pl. 442, figs. 4,6-9.

- . 1859 *Janira Atava* D'Orb. - VILANOVA, pl. 3, fig. 21.
- . 1907 *Vola atava* Röm. - KARAKASCH, p. 189, pl. 23, fig. 29.
- v ? 1926 *Neithea atava* Roemer - RENNIGARTEN, p. 55.
- . 1955 *Neithea atava* Röm. - ERISTAVI, p. 22.
- . 1957 *Neithea (Neitheops) atava* (Roemer) - ALENCÁSTER, p. 12, pl. 2, figs. 5-7.
- . 1960 *Neithea atava* Roemer - MUROMTSIEVA, JANIN, p. 190, pl. 11, figs. 4-6.
- . 1965 *Neithea atava* Roemer - KOTETISHVILI, p. 48, pl. 2, figs. 5, 6.
- v . 1966 *Neithea atava* (Roemer) - BOGDANOVA, p. 85, pl. 9, fig. 3.
- ? 1969 *Neithea atava* (Goldf.) - PECORINI, p. 2.
- v . 1970 *Neithea atava* Roemer - KOTETISHVILI, p. 50, pl. 2, fig. 3.
- v . 1973b *Neithea (Neithea) atava* (F.A. Roemer) - DHONDT, p. 40, pl. 1, fig. 2, (cum syn.).
- . 1974 *Neithea (Neitheops) atava* (Römer) - DIMITROVA, p. 77, pl. 41, figs. 3-5.
- . 1975 *Neithea (Neithea) atava* (Römer) - HAYAMI, p. 74.
- v . 1977 *Neithea (Neithea) atava* (Roemer) - HAYAMI and NODA, p. 40, pl. 5, figs. 4, 5; pl. 6, figs. 1, 2 (cum syn.).
- . 1980 *Neithea atava* Roemer - FISCHER, p. 214, pl. 99, figs. 5-7.

Material: One flat and two convex valves, from Sa Oche (Lanaitto), Lower Hauterivian (n. 763, 774) and from the Orudè area (Dorgali), Lower-Middle Hauterivian (n. 631).

Dimensions (mm): n. 763: H = 30; L = (20).

Discussion: The Sardinian specimens show the typical rib structure of *N. atava*. None of the collected specimens reach the dimensions recorded



FIG. 15

from other Tethyan regions [Japan, Georgia (USSR), Ethiopia, Tanzania].

Distribution: Berriasian?, Valanginian - Aptian, southern part of the north Temperate Realm and Tethys: France (Paris Basin and SE), Germany, Switzerland, Sardinia, Spain, Bulgaria, USSR (Crimea, Caucasus, Central Asia), Japan, Ethiopia, Tanzania, Algeria, Mexico and Trinidad (Text-fig. 14).

Neithea (*Neithella*) *valangiensis* (Pictet and Campiche, 1870)

Pl. 6, fig. 13; text-fig. 14

- ? 1859 *Janira Neocomiensis* D'Orb. - VILANOVA, pl. 2, fig. 18 [non D'ORBIGNY, 1847 = *Neithea* (N.) *atava* (ROEMER, 1839)].
- v + 1870 *Janira valangiensis* Pictet et Campiche - PICTET et CAMPICHE, p. 242, pl. 181, figs. 1-3.
- 1949 *Neithea* (*Janira*) *valanginiensis* (Pict. et Camp.) - KOKOSZYNSKA, p. 58, pl. 5, figs. 15, 18.
- ? 1960 *Neithea valangiensis* Pictet et Campiche - MUROMTSIEVA, JANIN, p. 190, pl. 11, figs. 1-3.
- ? 1965 *Neithea valangiensis* Pictet et Campiche - KOTETISHVILI, p. 47, pl. 2, fig. 4.
- v . 1966 *Neithea* cf. *valangiensis* (Pictet et Campiche) - BOGDANOVA, p. 84, pl. 9, figs. 1, 2.
- v . 1973b *Neithea* (*Neithella*) *valangiensis* (F.J. Pictet et G. Campiche) - DHONDT, p. 70 (*cum syn.*).

Material: Five incomplete specimens: from Orosei, lowermost Hauterivian (n. 802, 839, 840), and from Su Praicargiu (n. 160), Sa Oche (n. 762) (Lanaitto), Lower Hauterivian.

Discussion: The specimens show well developed, regularly arranged commarginal growth lines; on somewhat eroded valves also the smaller intercalary ribs are visible. The valves are not very oblique and have a very narrow umbo.

Distribution: Valanginian - Hauterivian, from Spain, SE France, Switzerland, Sardinia, Poland, USSR (Crimea, Caucasus, Kopet Dag) (Text-fig. 14).

Fam. PLICATULIDAE

Plicatula placunaea LAMARCK, 1819

Pl. 7, figs. 1-3; text-fig. 15

- + 1819 *Plicatula placunaea* - LAMARCK, p. 186, n° 8.
- . 1842 *Plicatula Placunaea* Lam. - LEYMERIE, p. 27, pl. 13, fig. 2.
- . 1847 *Plicatula placunaea*, Lamarck - D'ORBIGNY, p. 682, pl. 462, figs. 11-18.
- 1853 *Plicatula placunaea*, Lam. - DE VERNEUIL et COLLOMB, p. 165, pl. 3, fig. 15.
- 1853 *Plicatula placunaea* Lamarck - PICTET et ROUX, p. 518, pl. 47, fig. 5 (sub *P. strigilis*).
- . 1859 *Plicatula Placunaea* Lamarck - VILANOVA, pl. 2, fig. 16.
- 1865 *Plicatula placunaea*, Lamarck - COQUAND, p. 348.
- 1871 *Plicatula placunaea*, Lamarck - PICTET et CAMPICHE, p. 268.
- 1900 *Plicatula placunaea* Lamarck - WOLLEMAN, p. 23.
- . 1901 *Plicatula placunaea*, Lamarck - WOODS, p. 134, pl. 25, figs. 1-4.
- 1907 *Plicatula placunaea* Lam. - KARAKASCH, p. 184, pl. 28, fig. 17.
- 1922 *Plicatula placunaea* Lk. - GILLET, p. 97.
- 1924 *Plicatula placunaea* Lk. - GILLET, p. 57, text-fig. 35, pl. 1, fig. 7.
- 1951 *Plicatula placunaea* Lamarck - GIGOUT, p. 354.
- 1960 *Plicatula placunaea* Lamarck - MUROMTSIEVA, JANIN, p. 196, pl. 14, figs. 2-4.
- 1965 *Plicatula placunaea* Lamarck - KOTETISHVILI, p. 54, pl. 4, fig. 3.
- . 1974 *Plicatula placunaea* Lamarck - DIMITROVA, p. 84, pl. 43, figs. 7-9.
- 1980 *Plicatula placunaea* Lamarck - FISCHER, p. 214, pl. 101, figs. 9, 10.

Material: Thirteen left valves from Orosei, uppermost Valanginian (n. 702, 704-709, etc.).

Dimensions (mm): n. 765: H = 17; L = (13); n. 704: H = 17; L = (14); n. 709: H = 23; L = (19).

Discussion: The preservation of the Sardinian specimens is not perfect but allows to state with reasonable certainty that they belong to *P. placunaea* as figured and described by previous authors. The rib number (primary ribs) is around 10 - 12.

Distribution: *P. placunaea* has been recorded as early as the Valanginian but occurs more commonly in the Aptian: S. England, Germany, Switzerland, Spain, France, Sardinia, Bulgaria, USSR (Crimea, Caucasus), Morocco (Text-fig. 15).

Fam. SPONDYLIDAE

Spondylus gibbosus D'ORBIGNY, 1847.

Text-fig. 11

- + 1847 *Spondylus gibbosus*, d'Orbigny - D'ORBIGNY, p. 658, pl. 452, figs. 1-6.
- . 1853 *Spondylus Brunneri* Pictet et Roux - PICTET et ROUX, p. 514, pl. 47, figs. 1, 2.
- . 1870 *Spondylus gibbosus*, d'Orbigny - PICTET et CAMPICHE, p. 257, pl. 182, figs. 1-4.
- 1889 *Spondylus* cf. *gibbosus* d'Orb. - TOULA, p. 80, pl. 5, fig. 7.
- . 1901 *Spondylus gibbosus*, d'Orbigny-WOODS, p. 117, pl. 20, figs. 5-11.
- ? 1949 *Spondylus gibbosus* d'Orb. - KOKOSZYNSKA, p. 59, pl. 5, fig. 19.
- . 1965 *Spondylus gibbosus* d'Orbigny - KOTETISHVILI, p. 51, pl. 3, fig. 2.
- . 1968 *Spondylus gibbosus* Orbigny - PASTERNAK in PASTERNAK *et al.*, p. 185, pl. 38, figs. 4-6.
- . 1974 *Spondylus (Spondylus) gibbosus* d'Orbigny - DIMITROVA, p. 86, pl. 43, fig. 11.

Material: One small phosphatised left valve from Orosei (n. 46), Clansayesian (uppermost Aptian).

Discussion: The smooth auricles, the umbonal angle etc. agree with earlier descriptions; 30 - 32 ribs are present, but the small size of the valve induces that intercalary ribs cannot be seen. The specimen agrees best with fig. 4 on pl. 182 of PICTET and CAMPICHE, 1870.

Distribution: Aptian - Albion: S. England, France, Switzerland, Sardinia, Bulgaria, Poland, USSR (Western Ukraine, Caucasus).

Spondylus roemeri DESHAYES in LEYMERIE, 1842

Pl. 7, figs. 15-18; text-fig. 15

- ? 1842 *Spondylus latus*, Leym. - LEYMERIE, p. 10, pl. 6, fig. 7 (non *Spondylus latus* SOWERBY, 1815).

- + 1842 *Spondylus Roemeri*, Desh. - LEYMERIE, p. 10, pl. 6, figs. 8-10.
- . 1847 *Spondylus Roemeri*, Deshayes - D'ORBIGNY, p. 655, pl. 451, figs. 1-6.
- . 1861 *Spondylus Roemeri*, Deshayes - DE LORRIOL, p. 107, pl. 14, figs. 14, 15.
- 1870 *Spondylus Roemeri*, Deshayes - PICTET et CAMPICHE, p. 256.
- 1896 *Spondylus Roemeri* Desh. - WOLLMANN, p. 834.
- 1900 *Spondylus Roemeri* Deshayes - WOLLMANN, p. 20.
- . 1901 *Spondylus Roemeri*, Deshayes - WOODS, p. 116, pl. 20, fig. 4.
- 1905 *Spondylus* cf. *Roemeri* Deshayes - HARBORT, p. 41, pl. 5, fig. 1.
- 1907 *Spondylus Römeri* Desh. - KARAKASCH, p. 183.
- 1922 *Spondylus Roemeri* Desh. - GILLET, p. 97.
- ? 1954 *Spondylus* sp. - COX, p. 628, pl. 66, fig. 6.
- 1960 *Spondylus roemeri* Deshayes - MURROMTSIEVA, JANIN, p. 195, pl. 13, figs. 1-4.
- 1974 *Spondylus (Spondylus) roemeri* Deshayes - DIMITROVA, p. 85, pl. 38, figs. 3-5; pl. 43, fig. 12.

Material: Four specimens (two with shell, one composite and one internal mould) from Orosei, Lower Hauterivian (n. 275, 697) and from Su Praicargiu (Lanaitto), uppermost Valanginian (n. 148, 154).

Dimensions (mm):

n.	H	L	B'
154	51	49	—
148	59	66	—
275	(63)	(52)	(29)

Discussion: The Sardinian specimens agree well in shape and ornamentation with those described by previous authors, but are somewhat larger.

Distribution: Valanginian-Hauterivian to Aptian: S. England, Germany, SE France, Switzerland, Sardinia, Bulgaria, USSR (Crimea), ?Trinidad (Text-fig. 15).

Fam. LIMIDAE

Acesta dorbignyana (MATHÉRON, 1843)

Pl. 7, fig. 8; text-fig. 16

- + 1843 *Lima d'orbignyana* Math. - MATHÉRON, p. 182, pl. 29, figs. 3, 4.
- 1847 *Lima Orbignyana*, Mathéron - D'ORBIGNY, p. 530, pl. 415, figs. 1 - 4.
- v . 1869 *Lima Orbignyana*, Mathéron - PICTET et CAMPICHE, p. 126, pl. 161, fig. 4.
- v . 1904 *Lima (Plagiostoma)*, sp. cf. *Orbignyana*, Matheron - WOODS, p. 12, pl. 3, fig. 10.



FIG. 16

- 1922 *Lima* (*Mantellum*) *Orbignyana* Math.-GILLET, p. 96.
 1924 *Lima Orbignyana* d'Orb. - GILLET, p. 62.
 v . 1960 *Lima orbignyana* Matheron - MUROMT-SIEVA, JANIN, p. 193, pl. 12, fig. 6.
 v . 1966 *Lima orbignyana* Matheron - BOGDANOVA, p. 95, pl. 10, figs. 4, 5.
 1974 *Plagiostoma orbignyana* (Matheron) - DIMITROVA, p. 92, pl. 44, fig. 15.

Material: One incomplete but well preserved left valve from Su Praicargiu (Lanaitto), uppermost Valanginian (n. 182).

Dimensions (mm): H = (32); L = (29).

Description: The ribs are separated by narrow, probably punctated grooves. The anterior auricle is well preserved and covered with radial ribs which follow the ornamentation pattern of the shell. Where the upper layer of the shell is peeling off the remaining ribs seem narrower and less smooth than on the shell surface.

Generic attribution: Previous authors have suggested that *Lima d'orbignyana* belonged to the genus *Plagiostoma* SOWERBY, 1814. If one follows the *Treatise* (MOORE, 1969) this genus is characterised by generally ovate shells, on which length exceeds height, and which have a smooth surface. *L. d'orbignyana* specimens are higher than long and are covered with shallow but definite ribs. This makes the species more like *Acesta* than like *Plagiostoma*, and explains the generic assignment used here.

Distribution: Valanginian to Aptian: S. England, France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus) (Text-fig. 16).

Acesta subovalis (SOWERBY, 1836)

Pl. 7, fig. 10; text-fig. 17

- v + 1836 *Lima ? subovalis* - SOWERBY in FITTON, pp. 342, 359, pl. 17, fig. 21.

1847 *Lima subovalis* Sow. Var. *allongée* - D'ARCHIAC, p. 309.

- v . 1847 *Lima ornata*, d'Orbigny - D'ORBIGNY, p. 551, pl. 421, figs. 6-10.
 v . 1867 *Lima ornata* d'Orbigny - GUÉRANGER, p. 19, pl. 24, figs. 7, 12.
 v . 1872 *Lima ornata* d'Orb. - GEINITZ, p. 205, pl. 42, figs. 16, 17.
 1877 *Lima Rauliniana*, D'Orb. - JUKES-BROWNE, p. 502, pl. 21, fig. 9.
 v . 1904 *Lima subovalis*, Sowerby - WOODS, p. 5, pl. 2, figs. 3-7 (*cum syn.*).
 1930 *Lima* aff. *subovalis* Sow. - PASSENDORFER, p. 584, pl. 1, fig. 11.
 1948 *Lima subovalis* Sow. - TAVANI, p. 104, pl. 1, fig. 12.
 1956 *Lima subovalis* Sow. - TRÖGER, p. 42.
 1959 *Lima* (*Ctenoides?*) *subovalis* Sowerby - FRENEIX, p. 224.
 . 1965 *Lima subovalis* Sowerby - CIEŚLINSKI, p. 28, pl. 2, fig. 2.
 v . 1977 *Lima* (*Lima*) *subovalis* Sowerby - SOBETSKI, p. 94, pl. 6, fig. 12.

Material: One incomplete right valve from Orosei, Upper Albian, n. 62, H = (23) mm.

Discussion: The shell ornamentation on the Sardinian specimens shows the typical narrow ribs with small scales described by previous authors.

Generic attribution: *Lima ? subovalis* SOWERBY is characterised, as far as we have been able to ascertain, by the presence of one well developed auricle rather than two as would be necessary to confirm the tentative assignment of FRENEIX (1959). It has a well developed radial ornamentation but one which never reaches the strong development typical for *Lima* (*Lima*), and therefore the assignment suggested by SOBETSKI seems unlikely. The shallow ribs and the relatively thin shell of *L. subovalis* are closer to the characteristics of *Acesta* as defined in the *Treatise* (MOORE, 1969).

Distribution: Albian and Cenomanian, only rarely recorded outside Europe: S. England, Germany, Belgium (coll. IRScNB), France, Sardinia, Poland, USSR (Moldavia), Somalia (Text-fig. 17).

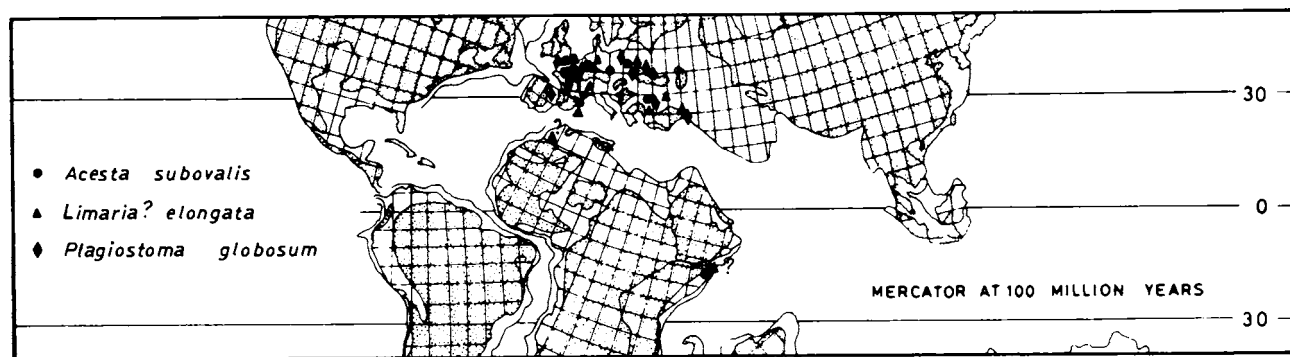


FIG. 17

Acesta cf. *subrigida* (ROEMER, 1836)

Pl. 7, fig. 19

One bivalved internal mould from Sa Oche, Lower Hauterivian (n. 676), has the general shape of an *Acesta* and could possibly be referred to *Acesta subrigida* (ROEMER, 1836) (as figured in WOODS, 1904, p. 10, text-figs. 1, 2). The preservation does not allow a definite specific assignment.

Dimensions (mm): H = (90); B = 37.

Ctenoides ? *undatus* (DESHAYES in LEYMERIE, 1842)
Text-fig. 16

- + 1842 *Lima undata* Desh. - LEYMERIE, p. 10, pl. 8, fig. 8.
- ? 1842 *Lima comata* Desh. - LEYMERIE, p. 10, pl. 8, fig. 7.
- . 1847 *Lima undata*, Deshayes - D'ORBIGNY, p. 528, pl. 414, figs. 9-12.
- . 1861 *Lima undata*, Deshayes - DE LORIO, p. 98, pl. 12, figs. 7, 8.
- v . 1869 *Lima undata*, Deshayes - PICTET et CAMPICHE, p. 133, pl. 162, fig. 1.
- v . 1897 *Lima* (*Acesta*) *undata*, Deshayes - KARAKASCH, p. 38, pl. 1, fig. 7.
- 1900 *Lima undata* Deshayes - WOLLEMAN, p. 29.
- v ? 1907 *Lima undata* Desh. aff. - KARAKASCH, p. 187.
- 1922 *Lima* (*Mantellum*) *undata* Desh. - GILLET, p. 95.
- v ? 1960 *Lima undata* Deshayes - MUROMTSIEVA, JANIN, p. 193, pl. 12, fig. 7.
- ? 1974 *Ctenoides undatus* (Deshayes) - DIMITROVA, p. 88, pl. 44, fig. 5.

Material: Three incomplete right valves from Sa Oche (Lanaitto), Lower Hauterivian (n. 779, 781, 784).

Dimensions (mm): n. 784: H = (39); L = (34); UA = 78°.

Discussion: *Ctenoides* ? *undatus* is very similar to *Acesta longa* (ROEMER, 1836) (figured and described in WOODS, 1904, p. 25, pl. 5, figs. 8-12) for the general shape and ornamentation. The differ-

ence seems to lie in the development of the scales, which are larger in *Ct.* ? *undatus* than in *A. longa*. The generic assignment is not certain because no specimens with complete umbonal parts are available.

Distribution: ?Valanginian, Hauterivian - Aptian (?), Temperate and Tethyan Realms: France (Paris Basin and SE), Sardinia, Germany, Switzerland, Bulgaria, USSR (Crimea, Caucasus) (Text-fig. 16).

Limaria ? *dubisiensis* (PICTET and CAMPICHE, 1869)
Pl. 7, figs. 4, 5; text-fig. 16

- v ? 1847 *Lima expansa*, Forbes - D'ORBIGNY, p. 533, pl. 415, figs. 9-12 [*non* FORBES, 1845 = *L. parallela* (SOWERBY, 1812)].
- v + 1869 *Lima dubisiensis*, Pictet et Campiche - PICTET et CAMPICHE, p. 124, pl. 161, figs. 2, 3.
- 1900 *Lima dubisiensis* Pictet et Campiche - WOLLEMAN, p. 27.
- 1922 *Lima dubisiensis* P. et Camp. - GILLET, p. 95.
- v . 1926 *Lima dubisiensis* Pictet et Camp. - RENNGARTEN, p. 53, pl. 2, figs. 3, 4.
- 1955 *Lima dubisiensis* Pict. et Camp. - ERISTAVI, p. 19.
- 1957 *Lima dubisiensis* Pict. et Camp. - ERISTAVI, p. 42.
- v . 1960 *Lima dubisiensis* Pictet et Campiche - MUROMTSIEVA, JANIN, p. 192, pl. 12, fig. 1.
- 1961 *Lima* cf. *dubisiensis* Pictet et Campiche - PROZOROVSKII, p. 119, pl. 8, fig. 9.
- v . 1961 *Lima* (*Plagiostoma*) *dubisiensis* Pictet et Campiche - BOGDANOVA, p. 136, pl. 1, figs. 10-12.
- 1966 *Lima dubisiensis* Pictet et Campiche - BOGDANOVA, p. 89.
- v . 1966 *Lima* cf. *carteroniana* Orbigny - BOGDANOVA, p. 90, pl. 10, figs. 6, 7.
- v . 1984 *Limaria dubisiensis* (Pictet and Campiche) - DHONDT, p. 854.

Material: Four incomplete specimens with partial shell preservation from Orosei (n. 304, 364) and Su

Praicargiu (Lanaitto) (n. 166, 170), uppermost Valanginian.

Discussion: The Sardinian specimens are poorly preserved but show sufficient ornamentation to permit identification. *Lima Carteroniana* D'ORBIGNY, 1847 from the Neocomian of France seems closely related, but has relatively more ribs.

Distribution: ? Berriasian, Valanginian - Hauterivian, ? Barremian: France, Germany, Switzerland, Sardinia, USSR (Crimea, Caucasus, Turkmenia) (Text-fig. 16).

Limaria ? *elongata* (SOWERBY, 1827)

Pl. 7, fig. 9; text-fig. 17

v + 1827 *Plagiostoma elongata* - SOWERBY, p. 113, pl. 559, fig. 2.

v . 1847 *Lima parallela*, d'Orbigny - D'ORBIGNY, p. 539, pl. 416, figs. 11-14 [non *Lima parallela* SOWERBY, 1912].

v ? 1847 *Lima Astieriana*, d'Orbigny - d'ORBIGNY, p. 549, pl. 420, figs. 4-7.

v . 1852 *Lima Itieriana* Pictet et Roux - PICTET et ROUX, p. 484, pl. 40, fig. 5.

v . 1869 *Lima Itieriana*, Pictet et Roux - PICTET et CAMPICHE, p. 156, pl. 166, figs. 4, 5.

v . 1904 *Lima (Mantellum) gaultina* nom. nov. - WOODS, p. 31, pl. 5, figs. 16-20 (*cum syn.*)

v . 1904 *Lima (Mantellum) elongata* (Sowerby) - WOODS, p. 34, pl. 6, figs. 5-7 (*cum syn.*).

1930 *Lima Itieriana* Pict. et Roux - PASSENDORFER, p. 584.

v . 1939 *Lima (Mantellum) gaultina* Woods - MARLIÈRE, p. 201.

? 1948 *Lima itieriana* Pictet et Roux - TAVANI, p. 104.

? 1948 *Lima* cfr. *gaultina* Woods - TAVANI, p. 105.

? 1951 *Lima* cf. *Itieriana* Pictet et Roux - GIGOUT, p. 373.

1955 *Lima (Mantellum) gaultina* Woods - ERISTAVI, p. 20, pl. 1, fig. 9.

v . 1960 *Lima gaultina* Woods - MUROMTSIEVA, JANIN, p. 194, pl. 12, fig. 9.

v . 1961 *Lima (Mantellum) gaultina* Woods - SOBETSKI, p. 60, pl. 6, figs. 15, 16.

. 1965 *Lima elongata* Sowerby - CIESLIŃSKI, p. 28, pl. 2, fig. 3.

v . 1968 *Lima (Mantellum) gaultina* Woods - PASTERNAK in PASTERNAK *et al.*, p. 181, pl. 37, fig. 9.

1968 *Lima (Mantellum) gaultina* Woods - JORDAN & SCHMID, p. 63.

non 1974 *Pseudolimea elongata* (Sow.) - OEKENTORP & SIEGFRIED, p. 105, pl. 13, fig. 5.

v . 1977 *Pseudolimea gaultina* (Woods) - SOBETSKI, p. 116, pl. 7, fig. 11.

1979a *Pseudolimea parallela* (d'Orb.) - MONGIN, p. 416.

Material: One almost complete left valve from the Upper Albian at Orosei, n. 50.

Dimensions (mm): H = (35); L = (30); R = 19.

Discussion: The specimen agrees with the description of *Lima gaultina* as given by WOODS (1904). *L. elongata* and *L. gaultina* are stated to be different by their rib shape, one having more rounded or at least undivided ribs, the other having sometimes "serate" ribs. The differences are probably due only to preservation; the discussions in literature concerning "rounded" versus "sharp" rib summits generally indicated "steinkern" versus "shell" preservation. Most of the English "Gault" specimens miss the exterior shell layer and as a result some finer rib details can no longer be seen, whereas the specimens from the Chalk have retained complete shells, and more ornamentation details remain visible. The first were described as *L. gaultina* and the second as *L. elongata*.

Lima Astieriana D'ORBIGNY, 1847 is based only on moulds, and is therefore described as having rounded ribs.

PERVINQUIÈRE (1912, from the Cenomanian of Tunisia), TREVISAN (1937, from the Cenomanian of Sicily), NALDINI (1949, from the Cenomanian of Libya) described under the name *Lima itieriana* a taxon with consistently more ribs than are present on the European specimens of *L. elongata*. *Lima numidica* PÉRON (1890) was erected for North African specimens similar to *L. elongata*, but with more ribs. Hence, it seems preferable to retain the name *numidica* for specimens from North Africa and Sicily. The specimens from Somalia described by TAVANI (1948) as *Lima itieriana* and *Lima* cfr. *gaultina* could belong to *L. numidica* but from the descriptions it is not possible to have a precise idea of their morphology.

Generic attribution: Most authors previously placed limid species characterised by an oblique shell shape and by well developed radial ornamentation in the genus (or subgenus) *Mantellum* ROEDING, 1798. In the *Treatise* (MOORE, 1969) *Mantellum* was synonymized with *Lima* BRUGUIÈRE, 1797. The species group from the Cretaceous strata has generally more numerous but less pronounced and less regular ribs than can be seen on *Lima lima* (LINNÉ), type species of the genus *Lima*. The same species group is on average more oblique, somewhat larger and covered with less well defined ribs than the genus *Pseudolimea* ARKELL in DOUGLAS and ARKELL, 1932. This species group is in fact

closest to *Limaria* LINK, 1807 (= *Mantellum* MOERCH, non ROEDING), type species *Lima inflata*. The difference is that it is difficult to ascertain whether the Cretaceous species group has gaping shells. This is why tentatively *Lima elongata* has been assigned to *Limaria*.

Distribution: Albian and Cenomanian. Albian: England, Germany, Poland, France, Switzerland, Sardinia, USSR (Crimea, Ukraine, Georgia), ?Morocco. Cenomanian: England, Belgium, France, ?USSR (Moldavia), ?Somalia (Text-fig. 17).

Plagiostoma globosum (SOWERBY, 1836)

Pl. 7, figs. 6, 7; text-fig. 17

- + 1836 *Lucina*? *globosa* - SOWERBY in FITTON, p. 335, pl. 11, fig. 2.
- v . 1847 *Lima semiornata*, d'Orbigny - D'ORBIGNY, p. 555, pl. 422, figs. 1-3.
- ? 1847 *Lima albensis*, d'Orbigny - D'ORBIGNY, p. 541, pl. 416, figs. 15, 16.
- 1885 *Radula* (*Plagiostoma*) *semiornata* d'Orb. - NOETLING, p. 15, pl. 2, fig. 4.
- v . 1904 *Lima* (*Plagiostoma*) *semiornata*, d'Orbigny - WOODS, p. 14, pl. 3, figs. 14 - 16; pl. 4, fig. 1.
- v . 1904 *Lima* (*Plagiostoma*) *globosa* (Sowerby) - WOODS, p. 16, pl. 4, figs. 4-6.
- 1930 *Lima globosa* Sow. - PASSENDORFER, p. 585.
- v . 1939 *Lima* (*Plagiostoma*) *semiornata* d'Orbigny - MARLIÈRE, p. 89, pl. 5, fig. 13.
- 1959 *Lima* (*Plagiostoma*) *semi-ornata* (d'Orbigny) - FRENEIX, p. 219.
- v . 1961 *Lima* (*Plagiostoma*) *semiornata* Orbigny - SOBETSKI, p. 59, pl. 6, figs. 13, 14.
- . 1965 *Lima* (*Plagiostoma*) *globosa* (Sowerby) - CIEŚLIŃSKI, p. 28, pl. 3, fig. 1.
- v . 1968 *Lima* (*Plagiostoma*) *hoperi sowerbyi* (Geinitz) - PASTERNAK in PASTERNAK *et al.*, p. 180, pl. 37, fig. 6 (non *Lima Sowerbyi* GEINITZ, 1850 = *Plagiostoma Hoperi* SOWERBY, 1822).
- 1977 *Lima semiornata* d'Orbigny - KOTETISHVILI, p. 24, pl. 3, fig. 2.
- v . 1977 *Plagiostoma semiornatum* (Orbigny) - SOBETSKI, p. 98, pl. 6, fig. 15.
- 1979a "*Lima*" *albensis* - MONGIN, p. 420.
- 1984 *Plagiostoma semiornatum* (D'Orbigny) - DHONDT, p. 855.

Material: Two right valves (internal moulds with shell fragments) from the Upper Albian of Orosei (n. 129, 130).

Dimensions (mm):

- n. 130: H=16.5 L=(16.7) UA=118°
- n. 129: H=19.0 L= 18.8 UA=125°

Discussion: The descriptions of *Plagiostoma globosum* and *P. semiornatum* by WOODS (1904) and other authors do not indicate major differences between the two taxa, beyond the former being "inflated" and the latter being "compressed". Many specimens cannot easily assigned to "*globosum*" or to "*semiornatum*" because they are intermediate between the two. This proves the two taxa represent extreme examples of variability within one species, and that the inflation cannot be considered as a diagnostic characteristic for the species. Stratigraphically both taxa have similar ranges. Hence, *P. globosum* (SOWERBY) and *P. semiornatum* (D'ORBIGNY) are considered as synonymous.

Distribution: Middle Albian to Upper Cenomanian, north Temperate and northern Tethyan Realms: S. England, Belgium, Spain, W. France, Sardinia, Poland, USSR (Ukraine, Moldavia, Caucasus) (Text-fig. 17).

Fam. GRYPHAEDAE

Aetostreon latissimum (LAMARCK, 1801)

Pl. 8, figs. 1a-7; pl. 9, figs. 1-6; text-fig. 18

- + 1801 *Gryphaea latissima* - LAMARCK, p. 399.
- 1819 *Gryphaea latissima* - LAMARCK, p. 199.
- 1821 *Gryphaea Couloni*, Def. - DEFRANCE, p. 534.
- . 1822 *Gryphaea sinuata* - SOWERBY, p. 43, pl. 336.
- . 1822 *Gryphea Aquila*, A. Br. - BRONGNIART in CUVIER et BRONGNIART, pp. 96, 399, pl. 9, fig. 11.
- v . 1833 *Exogyra Aquila* Nobis - GOLDFUSS, p. 36, pl. 87, fig. 3.
- . 1842 *Exogyra sinuata* Auct. - LEYMERIE, pp. 16, 17 (var. *Latissima*: pl. 12, fig. 1; var. *Elongata*: pl. 12, fig. 2).
- . 1842 *Exogyra subsinuata* Leym. - LEYMERIE, pp. 16, 17 (var. *Subsinuata*: pl. 12, fig. 3; var. *Dorsata*: pl. 12, fig. 4; var. *Falci-formis*: pl. 12, fig. 5; var. *Aquilina* Bourguet: pl. 12, figs. 6, 7).
- . 1847 *Ostrea Couloni*, d'Orbigny - D'ORBIGNY, p. 698, pl. 466, figs. 1-4; pl. 467, figs. 1-3.
- . 1847 *Ostrea aquila*, d'Orbigny - D'ORBIGNY, p. 706, pl. 470, figs. 1-4.
- . 1853 *Ostrea aquila* d'Orbigny - PICTET et ROUX, p. 520, pl. 48, figs. 1, 2.
- . 1858 *Ostrea Couloni*, (Defrance) d'Orbigny - PICTET et RENEVIER, p. 138.
- . 1859 *Ostrea Couloni* D'Orb. - VILANOVA, pl. 3, fig. 24.
- 1861 *Ostrea Couloni* (Defrance), d'Orbigny - DE LORIO, p. 110.
- . 1865 *Ostrea aquila*, Orbigny - COQUAND, p. 350.

- . 1869 *Ostrea Aquila* Orbigny - COQUAND, p. 158, pl. 61, figs. 4-9.
- . 1869 *Ostrea Couloni*, Orbigny - COQUAND, p. 180, pl. 65, fig. 10; pl. 71, figs. 8-10; pl. 74, figs. 1-5; pl. 75, figs. 1-6, 22.
- . 1871 *Ostrea Couloni*, (Defrance) d'Orbigny - PICTET et CAMPICHE, p. 287, pl. 187, figs. 1-3; pl. 188, figs. 1, 2; ? pl. 192, fig. 1.
- . 1878 *Aetostreon latissimum* Lamarck sp. - BAYLE, pl. 139, figs. 1-3.
- 1889 *Ostrea Couloni* Defr. (var. *aquila*) - TOULA, p. 81.
- 1890 *Ostrea Aquila* Orb. - TOULA, p. 340
- . 1890 *Ostrea (Exogyra) Haueri* n.sp. - TOULA, p. 340, pl. 5, fig. 3.
- 1896 *Exogyra Couloni* Defrance - WOLLEMAN, p. 831.
- v . 1897 *Ostrea Couloni*, (Defrance) d'Orbigny - KARAKASCH, p. 34, pl. 1, fig. 3; pl. 3, figs. 10-11.
- . 1900 *Exogyra Couloni* Defrance - WOLLEMAN, p. 8, pl. 1, fig. 1.
- 1900 *Exogyra Couloni* Defr. - BURCKHARDT, p. 18, pl. 21, figs. 7, 8; pl. 22, fig. 3.
- 1900 *Exogyra aquila* Brongniart - BURCKHARDT, p. 19, pl. 22, fig. 1.
- . 1903 *Gryphoea Couloni* Defrance - BIGOT, 3 figs.
- non 1905 *Exogyra Couloni* (Defr.) Pictet et Campiche - DACQUÉ, p. 14, pl. 2, figs. 6-8 (= *Ceratostreon* sp.).
- v . 1907 *Ostrea (Exogyra) Couloni* d'Orb. - KARAKASCH, p. 180.
- . 1907 *Exogyra Couloni* Defr. - DENINGER, p. 468.
- . 1910 *Gryphaea latissima* Lamarck - PERVINQUIÈRE, 8 figs.
- 1912 *Exogyra latissima* Lamarck - PERVINQUIÈRE, p. 176.
- v . 1912 *Exogyra sinuata* (Sowerby) - WOODS, p. 395, text-figs. 194-214; ? pl. 41, fig. 13.
- . 1914 *Exogyra Couloni* Defr. - LANGE, p. 217, pl. 16, fig. 7; pl. 18, figs. 2-4.
- 1922 *Exogyra latissima* Lk. - GILLET, p. 102.
- 1924 *Exogyra latissima* Lk. - GILLET, p. 69.
- v . 1926 *Exogyra latissima* Lamarck, forma *typica* - RENNGARTEN, p. 60, pl. 3, fig. 7; pl. 4, fig. 1.
- v . 1926 *Exogyra subsinuata* Leymerie, forma *typica* - RENNGARTEN, p. 61, pl. 4, fig. 4; pl. 5, fig. 1.
- v . 1926 *Exogyra subsinuata* Leym. var. *falciformis* Leym. - RENNGARTEN, p. 62, pl. 4, fig. 5; pl. 6, fig. 1.
- v ? 1926 *Exogyra aquilina* Leymerie var. *Lamarcki* var. n. - RENNGARTEN, p. 63, pl. 6, fig. 2; pl. 7, fig. 1.
- ? 1931 *Exogyra couloni* d'Orbigny var. *leufuensis* n. var. - WEAVER, p. 228, pl. 19, figs. 93a, b.
- . 1931 *Exogyra couloni* (Defrance) d'Orbigny - WEAVER, p. 229, pl. 19, figs. 88-91 (*cum syn.*).
- . 1948 *Exogyra latissima* Lmk. - TAVANI, p. 109, pl. 6, figs. 1, 2, 7; pl. 7, figs. 6, 10; pl. 8, fig. 3.
- 1948 *Exogyra Couloni* Defrance sp. - CHARLES, p. 13.
- ? 1948 *Exogyra Coquandi* nov. sp. - CHARLES, p. 14, pl. 1, figs. 1, 2.
- . 1948 *Exogyra latissima* Lamk. - FABRE in COLLIGNON, p. 57.
- 1951 *Exogyra couloni* d'Orbigny - GIGOUT, p. 354.
- 1954 *Exogyra latissima* (Lamarck) - COX, p. 629.
- v . 1957 *Exogyra subsinuata* Leym. - ERISTAVI, p. 44.
- v . 1957 *Exogyra subsinuata* Leym. aff. var. *falciformis* Leym. - ERISTAVI, p. 44.
- 1957 *Exogyra subsinuata* Leym. var. *crimica* nov. var. - ERISTAVI, p. 44, pl. 2, fig. 1.
- 1957 *Exogyra* aff. *subsinuata* Leym. - ERISTAVI, p. 44.
- v . 1960 *Amphidonta subsinuata* Leymerie - MUROMTSIEVA, JANIN, p. 199, pl. 16, figs. 1-4.
- v . 1960 *Amphidonta latissima* Lamarck - MUROMTSIEVA, JANIN, p. 200, pl. 17, figs. 1-3.
- v . 1961 *Exogyra subsinuata* Leymerie - PROZOROVSKII, p. 124, pl. 9, fig. 3.
- v . 1961 *Exogyra falciformis* Leymerie - PROZOROVSKII, p. 125, pl. 10, fig. 1; pl. 11, fig. 1.
- v . 1961 *Exogyra latissima* (Lamarck) - PROZOROVSKII, p. 126, pl. 12, fig. 1; pl. 13, fig. 3.
- . 1962 *Exogyra latissima* (Lamarck) - BRITISH MUSEUM, p. 152, pl. 54, fig. 4.
- . 1968 *Exogyra couloni* Defr. - KEMPER, p. 30, etc., pl. 2, fig. 4; pl. 18, fig. 10.
- v . 1970 *Amphidonta subsinuata* Leym. - KOTETISHVILI, p. 53, pl. 2, fig. 9.
- . 1971 *Aetostreon latissimum* (Lamarck) - STENZEL in MOORE, p. N1117, fig. J92(1).
- 1974 *Exogyra couloni* (Defrance) - OEKENTORP & SIEGFRIED, p. 151, pl. 13, fig. 7.
- 1975 *Aetostreon latissimum* (Lamarck) - PUGACZEWSKA, p. 51, pl. 7, fig. 1; pl. 8, figs. 1-7; pl. 9, figs. 1-4.
- ? 1980 *Aetostreon couloni* (Defrance) (juvenis et varietas) - MONGIN, p. 126.
- . 1980 *Aetostreon latissimum* Lamarck - FISCHER, p. 216, pl. 101, figs. 1, 2.

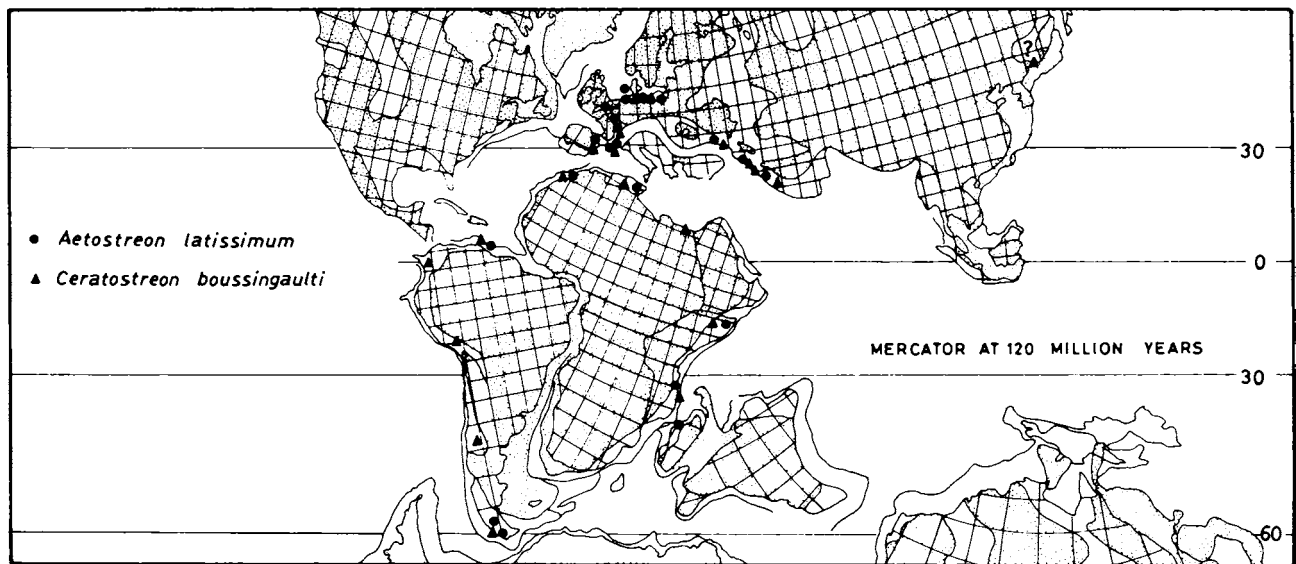


FIG. 18

- . 1982 *Aetostreon latissimum* Lamarck - STÜHMER, SPAETH, SCHMID, p. 52, pl. 6, fig. 2; pl. 7, figs. 1, 2; pl. 8, fig. 1.
- . 1984 *Aetostreon couloni* (sensu D'Orbigny) - DHONDT, p. 856.
- . 1984 *Aetostreon latissimum* (Lamarck) - DHONDT, p. 856.

Material: *Aetostreon latissimum* is the most frequently occurring bivalve species in the Lower Cretaceous of Eastern Sardinia. Numerous specimens are found at all localities in the marly uppermost Valanginian and Lower Hauterivian deposits (more than one hundred specimens available). Some beds of that age contain almost no other species. *A. latissimum* occurs also throughout the calcareous Upper Hauterivian and Lower Barremian but not commonly and the specimens are somewhat smaller and wider than in older strata. The outer shell layers are often silicified with beekite (Pl. 8, figs. 4,5; pl. 9, figs. 2,3). Collected specimens are frequently incomplete; hence, it seems pointless to measure them, but as indication a large specimen (n. 481, Sa Oche) easily reaches $H > 150$ mm.

Discussion: *A. latissimum* has been so often and extensively discussed and interpreted in so many ways since more than 150 years that it seems completely useless to continue the discussion of its exact identity. To give an idea of the complexity of the problem and to explain our concept of the species it suffices to read through the long but nevertheless incomplete synonymy list which we have given. This makes obvious that our concept of *A. latissimum* assumes a particularly broad variability suggested by the study of "populations" rather than of

single specimens. Therefore we consider the numerous names used in literature as representing only morphotypes without taxonomic or stratigraphic value. All things considered, our interpretation is not very far from that (excluding the adopted specific name) which arises from careful reading of the text of PICTET and CAMPICHE (1871, pp. 287 - 294). In fact as is the case in Switzerland (PICTET and ROUX, 1853; PICTET and CAMPICHE, 1871), in N. Germany, etc. (WOLLEMAN, 1900; WOODS, 1912) also in Sardinia, particularly in the Lower Hauterivian, different morphotypes occur together. A way to explain the broad variability of *A. latissimum* could be to assume that it was induced by environmental factors, especially the nature of the substrate on which the specimens lived and the space available when they formed "banks". A possible confirmation of the connection between the shape of the shell and the substrate can be suggested by the prevailing morphotypes in the different Sardinian deposits. In the Upper Valanginian and Lower Hauterivian marly sediments most *A. latissimum* specimens have a very convex left valve, a strongly developed keel and a steep posterior side. In the Upper Hauterivian -Lower Barremian when the substratum was calcareous the prevailing morphotype had a less strongly developed keel and somewhat less convex left valve.

Distribution: *A. latissimum* is very widely distributed in Temperate and Tethyan Realms, South America (Argentina, Chile, Colombia), Africa (N. Africa, Somaliland, Madagascar, Tanzania), Eurasia [England, Germany, Spain, France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Turkmenia)]. Valanginian to Aptian (Text-fig. 18).

Ceratostreon boussingaulti (D'ORBIGNY, 1842)

Pl. 7, figs. 11a, 11b; text-fig. 18

- + 1842 *Exogyra Boussingaultii*, d'Orb. - D'ORBIGNY, p. 91, pl. 18, fig. 20; pl. 20, figs. 8, 9.
- p . 1847 *Ostrea Boussingaultii*, d'Orbigny - D'ORBIGNY, p. 702, pl. 468, figs. 1-3 [non figs. 6-9 = *Ceratostreon tuberculiferum* (KOCH and DUNKER, 1837)].
- non 1858 *Ostrea Boussingaulti* - PICTET et RENÉVIER, p. 140, pl. 19, fig. 5.
- non 1861 *Ostrea Boussingaultii*, d'Orbigny - DE LORIOI, p. 111, pl. 14, figs. 8, 9 [= *Ceratostreon tuberculiferum* (KOCH and DUNKER, 1837)].
- ? 1865 *Ostrea Boussingaulti*, Orbigny - COQUAND, p. 352.
- non 1868 *Ostrea Boussingaulti*, d'Orbigny - DE LORIOI, p. 50, pl. 3, figs. 14-16 [= *Ceratostreon tuberculiferum* (KOCH and DUNKER, 1837)].
- p . 1869 *Ostrea Boussingaultii*, d'Orbigny - DE LORIOI in DE LORIOI et GILLIERON, p. 26, pl. 2, fig. 1 [non pl. 1, fig. 23 and pl. 2, figs. 2-4 = *Ceratostreon tuberculiferum* (KOCH and DUNKER, 1837)].
- p . 1869 *Ostrea Boussingaulti*, Orbigny - COQUAND, p. 161, pl. 64, figs. 4-10; pl. 74, figs. 16-18, ? pl. 64, figs. 14-18; ? pl. 65, fig. 7 [non pl. 64, figs. 11-13 = *C. tuberculiferum* (KOCH and DUNKER, 1887); nec pl. 64, figs. 19, 20 = *Ilymatogyra pellicoi* (DE VERNEUIL and COLLOMB, 1853); nec pl. 74, figs. 19, 20 = *Ceratostreon gurgyacensis* (COTTEAU, 1853)].
- 1869 *Ostrea Minos*, H. Coquand - COQUAND, p. 183, pl. 64, figs. 1-3; pl. 73, figs. 5-9; pl. 74, figs. 14, 15.
- . 1871 *Ostrea Minos*, Coquand - PICTET et CAMPICHE, p. 278, pl. 185, figs. 1-4.
- ? 1900 *Ostrea Minos* Coqu. - MÜLLER, p. 548, pl. 23, fig. 1.
- 1900 *Ostrea Minos* Coquand - WOLLEMAN, p. 15, pl. 1, fig. 2.
- v . 1907 *Ostrea (Exogyra) Minos* Coq. - KARAKASCH, p. 181, pl. 18, figs. 1, 3, 4, 5, 7, 8; pl. 21, fig. 28 (first four of upper row).
- ? 1907 *Ostrea minos* Coqu. - HAUPT, p. 210, pl. 8, fig. 4.
- 1910 *Ostrea (Exogyra) Minos* Coqu. - KRENKEL, p. 206, pl. 20, fig. 4; pl. 21, fig. 7.
- 1912 *Exogyra Boussingaulti* d'Orbigny - PERVINQUIÈRE, p. 188.
- ? 1916 *Exogyra Boussingaulti* d'Orbigny - DOUVILLÉ, p. 171, pl. 21, fig. 16.
- ? 1921 *Exogyra Boussingaulti*, var. *Minos* Coq. - GILLET, p. 23, pl. 2, figs. 13, 14.
- v ? 1926 *Exogyra* cf. *Minos* Coq. - RENNGARTEN, p. 59.
- 1931 *Ostrea minos* Coquand - WEAVER, p. 222, pl. 18, figs. 82, 83.
- ? 1934 *Exogyra yabei* nov. sp. - NAGAO, p. 202, pl. 25, fig. 7; pl. 26, fig. 1; pl. 27, fig. 1; pl. 28, figs. 1, 2; pl. 29, figs. 1, 14.
- 1948 *Exogyra Minos* (Coquand) - TAVANI, p. 111, pl. 5, figs. 3, 5, 6.
- 1951 *Exogyra boussingaulti* d'Orbigny - GIGOUT, p. 354.
- . 1954 *Exogyra minos* (Coquand) - COX, p. 630, pl. 65, fig. 5; pl. 66, fig. 2.
- 1956 *Exogyra minos* Coquand - BENAVIDES-CÁCERES, p. 375.
- 1956 *Exogyra boussingaulti* d'Orbigny - BENAVIDES-CÁCERES, p. 375.
- v . 1960 *Exogyra minos* Coquand - MUROMT-SIEVA, JANIN, p. 199, pl. 15, figs. 2-5.
- v ? 1965a *Amphidonta (Ceratostreon) yabei* (Nagao) - HAYAMI, p. 345, pl. 49, fig. 12; pl. 50, figs. 3-6.
- 1975 *Ceratostreon minos* (Coquand) - PUGACZEWSKA, p. 54, pl. 10, figs. 1-8; pl. 11, figs. 1-14; pl. 16, fig. 6.
- v . 1980 *Ceratostreon ? fragilis* Bogdanova, sp. nov. - BOGDANOVA, p. 26, pl. 9, figs. 5-7.
- 1980 *Ceratostreon minos* (Coquand) - MONGIN, p. 125, text-fig. 3.
- . 1983 *Ceratostreon minos* (Coquand) - BOGDANOVA in LUPPOV *et al.*, p. 84, pl. 15, figs. 5-7; pl. 16, figs. 4-10; pl. 17, figs. 1-13; pl. 18, figs. 1-3.

Material: One poorly preserved specimen from Carchinarzos (Monte Albo) (n. 340) and two from Sa Oche (Lanaitto) (n. 263, 476), Lower Hauterivian.

Dimensions (mm): H of best preserved specimen = (67).

Discussion: The Sardinian specimens agree with the descriptions given by previous authors.

The differences stated as existing between *Exogyra Boussingaulti* D'ORBIGNY and *Ostrea Minos* COQUAND are not really founded. The specimens from Colombia, which were described by D'ORBIGNY (1842) under the name *Boussingaulti*, were considered by later authors (mainly in publications on South American material) as being identical with European specimens for which the name *minos* had been erected by COQUAND (1869). Thus *minos* becomes a junior synonym of *boussingaulti*.

Exogyra yabei NAGAO, 1934 from the Aptian-Albian of Japan seems similar to *Ceratostreon boussingaulti*, but the preservation of the Japanese specimens, mainly right valves, is not totally satisfactory. Hence, the query.

C. ? fragilis BOGDANOVA, 1980, from the Lower Valanginian of Mangyschlack, shows according to its author only shallow plications, and relatively few of those. This does not allow a specific distinction from *C. boussingaulti*. The relatively small size of *C. ? fragilis* might be environmentally induced.

C. boussingaulti is the oldest in a series of similar species: *C. boussingaulti* (Valanginian - Aptian, Albian?); *C. flabellatum* (GOLDFUSS, 1835) (Albian - Cenomanian); *C. pliciferum* (DUJARDIN, 1837) (Turonian - Maastrichtian). MORONI and RICCO, 1968 (p. 54) stated that *C. boussingaulti* is synonymous with *C. flabellatum*, which they consider as a long ranging species. They base their opinion on TREVISAN (1937), who founded his views on a partial misinterpretation of PÉRON (1890-1891, pp. 128-129). There is no doubt that *C. flabellatum* and *C. boussingaulti* are closely related, but the Early Cretaceous *C. boussingaulti*, despite what MORONI and RICCO stated, is consistently covered with fewer and somewhat broader generally undivided plications.

Distribution: Berriasian?, Valanginian - Aptian, Albian?: South America (Argentina, ?Chile, Peru, Colombia, Trinidad), Africa (Morocco, Tunisia, ?Egypt, Somalia, ?Tanzania), Eurasia [Germany, Poland, Switzerland, Spain, France, Sardinia, USSR (Crimea, Caucasus, Mangyschlack), ?Japan] (Text-fig. 18).

Ceratostreon cf. *tuberculiferum* (KOCH and DUNKER, 1837)

Two small, smooth exogyrine valves with a well developed carina and incompletely preserved shell without strong ornamentation from the uppermost Valanginian of Su Praicargiu (n. 877, 879) are close to *Ceratostreon tuberculiferum* (KOCH and DUNKER, 1837) (figured in WOODS, 1913, pl. 61, figs. 7-11) because of the general shape, size etc. However, the preservation does not allow a definite identification.

Fam. OSTREIDAE

Rastellum "rectangulare" (ROEMER, 1839)

Pl. 7, figs. 12a-13

This group of oysters is in need of revision. The criteria used by the various authors for distinction between the many Cretaceous *Rastellum* "species" described (as "*Alectryonia*", "*Lopha*", "*Arctostrea*") are vague and do not take into consideration specific variability. Traditionally the Early Cretaceous specimens have been named *R. rectangulare* (ROE-

MER, 1839), and this is also done here, but it is understood that no precise diagnosis of the species can be given at this point.

In Eastern Sardinia *Rastellum* specimens have been found frequently; they are particularly abundant in the marly beds of latest Valanginian - earliest Hauterivian age of Carchinarzos (M. Albo) (n. 330, 341), Orosei (n. 108, 270, etc.), Sa Oche (n. 179, 524, etc.), Su Praicargiu (n. 171, 878, etc.) and Pischina Urtaddala (Gorropu) (n. 155, etc.).

Distribution: *Rastellum "rectangulare"* is very widely recorded from Valanginian to Aptian in England, Germany, France, Switzerland, Spain, Romania, Bulgaria, USSR (Crimea, Caucasus, Central Asia).

Subcl. PALAEOHETERODONTA

Fam. TRIGONIIDAE

Trigonia (Trigonia) carinata AGASSIZ, 1840

Pl. 10, figs. 1-6; text-fig. 19

- + 1840 *Trigonia carinata* Ag. - AGASSIZ, p. 43, pl. 7, figs. 7-10.
- 1840 *Trigonia sulcata* Ag. - AGASSIZ, p. 44, pl. 8, figs. 5-11; pl. 11, fig. 16 (non *Trigonia sulcata* GOLDFUSS in DECHEN in DE LA BECHE, 1832).
- 1842 *Trigonia harpa*, Desh. - LEYMERIE, p. 8, pl. 9, fig. 7.
- 1843 *Trigonia harpa*, Leymerie - MATHÉRON, p. 166, pl. 22, figs. 1-4.
- . 1844 *Trigonia carinata*, Agassiz - D'ORBIGNY, p. 132, pl. 286, figs. 1 - 7.
- . 1859 *Trigonia Carinata* Agas. - VILANOVA, pl. 3, fig. 19.
- 1865 *Trigonia carinata*, Agassiz - COQUAND, p. 325.
- 1866 *Trigonia carinata*, Agassiz - PICTET et CAMPICHE, p. 365 (*cum syn.*).
- . 1877 *Trigonia carinata*, Ag. - LYCETT, p. 179, pl. 35, figs. 3-6.
- 1897 *Trigonia carinata*, Agassiz - KARAKASCH, p. 65, pl. 3, fig. 3.
- 1900 *Trigonia carinata* Agassiz - WOLLMANN, p. 86, pl. 4, figs. 6, 7.
- 1900 *Trigonia carinata* Ag. - BURCKHARDT, p. 22, pl. 25, figs. 6-8.
- 1900 *Trigonia carinata*, Agassiz - WOODS, p. 90.
- . 1903 *Trigonia carinata*, Ag. - BURCKHARDT, p. 75, pl. 13, fig. 6; pl. 14, fig. 3.
- 1912 *Trigonia carinata* Agassiz - PERVINQUIÈRE, p. 217.
- . 1922 *Trigonia carinata* Ag. - GILLET, p. 53, pl. 2, fig. 9.
- 1924 *Trigonia carinata* Agassiz - GILLET, p. 78, text-fig. 38.

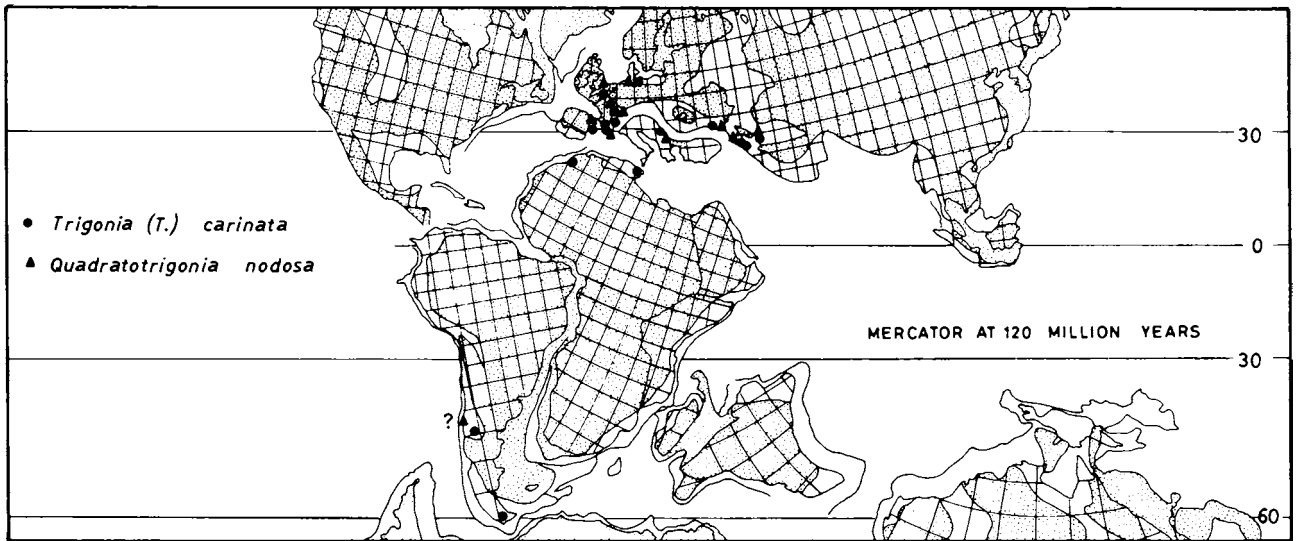


FIG. 19

- ? 1931 *Trigonina carinata* Agassiz - WEAVER, p. 263, pl. 26, figs. 137-141; pl. 27, figs. 147-149.
- . 1944 *Trigonina carinata* Ag. - LAMBERT, p. 386, pl. 8, fig. 5.
- 1949 *Trigonina carinata* Agassiz - MORDVILKO *et al.*, p. 131, pl. 23, fig. 1.
- 1951 *Trigonina carinata* Agassiz - GIGOUT, p. 353.
- 1957 *Trigonina carinata* Agass. - ERISTAVI, p. 38.
- . 1958 *Trigonina (Trigonina) carinata* Agassiz subspecies *caspia* Saveliev subsp. n. - SAVELIEV, p. 194, pl. 1, figs. 1-3; pl. 2, fig. 1.
- . 1960 *Trigonina carinata* Agassiz - MUROMT-SIEVA, JANIN, p. 205, pl. 19, figs. 1, 2.
- . 1974 *Trigonina (Trigonina) carinata* Agassiz - DIMITROVA, p. 93, pl. 45, figs. 2, 3 (*cum syn.*).
- . 1980 *Trigonina carinata* Agassiz - FISCHER, p. 216, pl. 101, fig. 7.

Material: *Trigonina carinata* occurs very abundantly (more than 60 specimens collected) in the Lower Hauterivian of the Lanaitto area (n. 533-575, etc.). It is also present in the Lower Hauterivian of the Carchinarzos (M. Albo) (n. 337) and Orudè (Dorgali) (n. 833) areas.

Dimensions (mm): On a large specimen $H > 60$.

Discussion: The preservation of the Sardinian specimens varies; all transitions are found between 1) smooth internal moulds with muscle scar imprints (Pl. 10, fig. 6), 2) smooth internal moulds with muscle scars and commarginal ornamentation (Pl. 10, figs. 4, 5) and 3) composite moulds with an exact reproduction of the external ornamentation but no muscle scars, a strong carina delimiting the anterior

from the posterior part, and the posterior area bearing radial ribs as well as commarginal ornamentation. (Pl. 10, figs. 1 - 3).

The species is well known and has been discussed and illustrated by previous authors; the Sardinian specimens agree perfectly with their descriptions.

Distribution: Valanginian - Aptian: S. England, Germany, Spain, SE France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Mangyschlack), Tunisia, Morocco, Argentina (Text-fig. 19).

Quadratotrigenia nodosa (SOWERBY, 1826)

Pl. 9, figs. 7, 8; text-fig. 19

- + 1826 *Trigonina nodosa* - SOWERBY, p. 7, pl. 507, fig. 1.
- . 1840 *Trigonina cincta* Ag. - AGASSIZ, p. 27, pl. 7, figs. 21-23; pl. 8, figs. 2-4.
- . 1844 *Trigonina rudis*, Parkinson - D'ORBIGNY, p. 137, pl. 289, figs. 1-5 (*non* PARKINSON, 1811).
- ? 1852 *Trigonina nodosa* Sowerby - PICTET *et* ROUX, p. 454, pl. 35, fig. 5.
- ? 1858 *Trigonina daedalea*, Parkinson - PICTET, *et* RENEVIER, p. 92, pl. 12, fig. 1.
- . 1858 *Trigonina nodosa*, J. SOWERBY - PICTET *et* RENEVIER, p. 94, pl. 12, fig. 2.
- 1865 *Trigonina nodosa*, J. Sowerby - COQUAND, p. 323.
- . 1869 *Trigonina cincta*, Agassiz - PICTET *et* CAMPICHE, p. 368.
- . 1875 *Trigonina nodosa* Sow.-LYCETT, p. 106, pl. 25, figs. 1, 2; pl. 37, figs. 5, 6.
- . 1875 *Trigonina nodosa* Sow. Var. *Orbignyana* - LYCETT, p. 107, pl. 24, figs. 1-3.
- 1897 *Trigonina nodosa*, Sowerby - KARAKASCH, p. 67.
- . 1900 *Trigonina nodosa* Sowerby - WOLLEMAN, p. 90, pl. 4, fig. 8.
- 1900 *Trigonina nodosa*, Sowerby - WOODS, p. 78 (*cum syn.*).

- 1900 *Trigonia* aff. *nodosa* Sow. - BURCKHARDT, p. 22, pl. 25, figs. 4, 5.
- 1920 *Trigonia nodosa* Sow. et var. - GILLET, p. 153, etc., pl. 7, figs. 1, 2.
- 1921 *Trigonia nodosa* Sow. var. *Orbignyana* Lycett - GILLET, p. 11, pl. 11, fig. 5.
- 1922 *Trigonia nodosa* Sow. - GILLET, p. 52.
- 1924 *Trigonia nodosa* Sow. - GILLET, p. 94, text-fig. 50.
- 1924 *Trigonia nodosa* variété *Orbignyana* Lyc. - GILLET, p. 94.
- ? 1948 *Trigonia cincta* Agassiz - CHARLES, p. 22.
- 1949 *Trigonia nodosa* Sowerby var. *karakaschi* Mordvilko - MORDVILKO *et al.*, p. 129, pl. 24, fig. 1.
- 1958 *Quadratotrighonia* (*Quadratotrighonia*) *nodosa* (Sowerby) - SAVELIEV, p. 253, pl. 23, figs. 1, 2.
- 1958 *Quadratotrighonia* (*Quadratotrighonia*) *nodosa* (Sowerby) var. *orbignyana* (Lycett) - SAVELIEV, p. 257, pl. 25, fig. 1.
- 1960 *Quadratotrighonia nodosa* Sowerby - MURMONTSEVA, JANIN, p. 206, pl. 20, figs. 1-3.
- 1969 *Yaadia* (*Quadratotrighonia*) *nodosa* (Sowerby) - COX in MOORE, p. N487, text-fig. D74(3).
- 1974 *Quadratotrighonia* (*Quadratotrighonia*) *nodosa nodosa* Sowerby - DIMITROVA, p. 99, pl. 47, figs. 3, 4.
- 1974 *Quadratotrighonia* (*Quadratotrighonia*) *nodosa orbignyana* (Lycett) - DIMITROVA, p. 100, pl. 47, fig. 6.

Material: Unlike *Trigonia carinata*, *Quadratotrighonia nodosa* is rare in the Lower Hauterivian deposits of the Lanaitto area; at Sa Oche 2 incomplete composite moulds (one left and one right valve, n. 193 and 245) have been collected.

Discussion: The Sardinian specimens agree with descriptions and figures of the authors listed above. Eastern European palaeontologists continue to subdivide *Q. nodosa* into infraspecific groups. Concerning the "differences" between *Q. nodosa* and *Q. nodosa orbignyana*, we have the impression that no changes have taken place which cannot be explained by ecophenotypic variability. There might be an evolutionary change in time: the *orbignyana* morphotype co-occurs with the *nodosa* morphotype more often in younger strata, which means towards the end of the range of the species. In how far this varying morphology is evolutionary and not sediment-related remains to be proved.

Generic attribution: *Trigonia nodosa* SOWERBY is the type species of *Quadratotrighonia* DIETRICH, 1933, which is considered by COX in MOORE (1969) as subgenus of *Yaadia* CRICKMAY, 1930. SAUL (1978)

interpreted *Yaadia* differently from COX in MOORE, and considered the genus as being restricted to North America. Her opinion seems founded and we have followed it; therefore we consider *Quadratotrighonia* as an independent genus.

Distribution: Valanginian-Aptian: Southern England, France, Germany, Spain, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus), ? Argentina (Text-fig. 19).

Pterotrighonia sp.

One internal mould of a right valve from the Upper Berriasian-Lower Valanginian of the Sa Oche area (n. 209). It could be a specimen of *Pterotrighonia caudata* (AGASSIZ, 1840) (known from the Valanginian to Aptian) but the preserved ornamentation is too faint for a specific identification.

Subcl. HETERODONTA

Fam. LUCINIDAE

"*Lucina*" *valdensis* PICTET and CAMPICHE, 1866
Pl. 11, fig. 9

+ 1866 *Lucina valdensis*, Pictet et Campiche -
PICTET et CAMPICHE, p. 288, pl. 122, fig. 7.
1924 *Phacoides valdensis*, Pict. et Camp. -
GILLET, p. 121.

Material: One incomplete composite mould of a left valve from the Gargasian (Upper Aptian) of Orosei (n. 758).

Dimensions (mm): H = (17); L = (20).

Discussion: The only specimen agrees with the description and figure of PICTET and CAMPICHE (1866) for the shell shape as well as for the ornamentation (strong commarginal ribs, elevated above the shell surface and separated by much wider intervals).

The preservation of the specimen from Sardinia (and of the species as described by previous authors) does not allow certainty as to its generic attribution. Hence the use of inverted commas to indicate the lack of certainty; the normal use would require a questionmark, but in this case we prefer an informal mark to indicate even greater uncertainty.

Distribution: This species seems rare; it has previously only been recorded from Aptian of Switzerland. It occurs in beds of similar age in Sardinia.

"*Lucina*" sp.

One bivalved internal mould (n. 876: H = 22; L = 25; B = 13.5 mm) has been collected from the Berriasian of Sos Tinzosos (Lanaitto). It shows the pallial line and muscle scars clearly. It cannot be attributed to any of the taxa previously described in literature. The nearest is "*Lucina*" *germani* PICTET

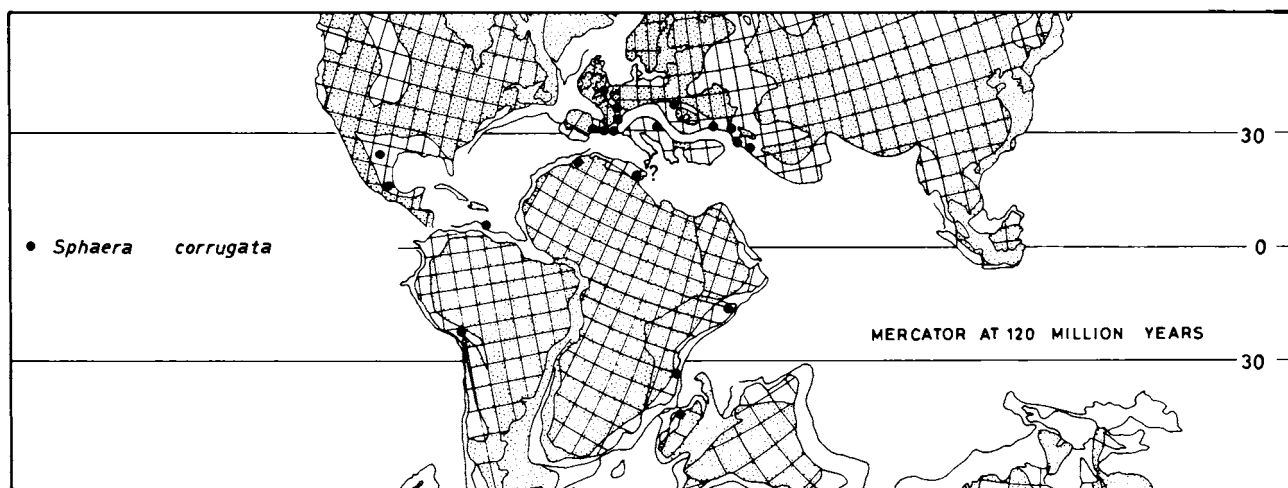


FIG. 20

and CAMPICHE, 1866, pl. 122, fig. 5, from the Valanginian of Nozeroy (Switzerland), which, however, is much larger and somewhat less inflated.

Fam. MACTROMYIDAE

Thetis minor SOWERBY, 1826.

Pl. 7, fig. 14

- + 1826 *Thetis minor* - SOWERBY, p. 21, pl. 513, figs. 5, 6.
- . 1846 *Thetis laevigata*, d'Orbigny - D'ORBIGNY, p. 452, pl. 387, figs. 1 - 3 (not the synonymy!).
- non 1846 *Thetis minor*, Sowerby - D'ORBIGNY, p. 453, pl. 387, figs. 4-7 (= *Thetis genevensis* PICTET and ROUX, 1852).
- . 1865 *Thetis minor*, Sowerby - PICTET et CAMPICHE, p. 202, pl. 112, fig. 4.
- . 1865 *Thetis laevigata*, d'Orbigny - PICTET et CAMPICHE, p. 203, pl. 112, figs. 2, 3.
- . 1884 *Thetis minor* Sow. - WEERTH, p. 41, pl. 9, figs. 5, 6.
- 1897 *Thetis minor*, Sowerby - KARAKASCH, p. 79.
- . 1898 *Thetis laevigata*, d'Orbigny - SKEAT and MADSEN, p. 176, pl. 7, figs. 7-9.
- . 1900 *Thetis minor* Sowerby - WOLLEMAN, p. 118.
- . 1907 *Thetironia minor* (Sowerby) - WOODS, p. 167, pl. 25, fig. 15; pl. 26, figs. 1-8.
- 1922 *Thetironia minor* Sow. - GILLET, p. 71.
- 1924 *Thetironia minor* Sow. - GILLET, p. 116, text-fig. 73.
- ? 1955 *Thetironia minor* Sow. - ERISTAVI, p. 20.
- ? 1957 *Thetironia minor* Sow. - ERISTAVI, p. 42.

1960 *Thetironia minor* Sowerby - MUROMT-SIEVA, JANIN, p. 213, pl. 25, figs. 5a, b.

1973 *Thetironia minor* Sowerby - GLAZUNOVA p. 65, pl. 36, figs. 1, 2.

? 1979a *Thetis minor* - MONGIN, p. 420.

One internal mould of a left valve from Sa Oche, Lower Hauterivian (n. 725, H = 16.1; L = 17; B' = 6.4 mm) is similar to descriptions and figures in PICTET and CAMPICHE (1865) and WOODS (1907). The specimen is relatively small, but the shape is identical, yet there are no clearly visible traces of the typical pallial line.

Discussion: Generally *Thetis minor* has been recorded from Aptian deposits. However, WEERTH (1884) and WOLLEMAN (1900) already described it from Neocomian strata. DE LORIO (1861) erected a Neocomian *Thetis* species, *T. Renevieri*, which does not seem very different, but the Sardinian specimen has the umbo more centrally placed than is the case on the figures available of *T. Renevieri*. It does not seem impossible that further study would prove both taxa to be conspecific. In Russian literature *Thetis minor* from the Aptian - Albian is cited with many "varr." (subsp.?) (such as *minor minor*, *minor nolani*, *minor transversa*, etc.) by MORDVILKO *et al.* (1949), RENNGARTEN (1926) and others. It is extremely difficult to assess the exact meaning of these different "varr.". Often they seem to refer only to somewhat deformed specimens. We considered it preferable not to use them without more information.

Distribution: Hauterivian - Aptian, ? Albian: England, France, Sardinia, Germany, USSR (Russian Platform, ? Crimea, Caucasus, Kopet Dag, Mangyshlack). Recorded from boulders in Denmark.

Fam. FIMBRIIDAE

Sphaera corrugata SOWERBY, 1822.

Pl. 10, figs. 7 - 10; text-fig. 20

- + 1822 *Sphaera corrugata* - SOWERBY, p. 42, pl. 335.
- . 1842 *Venus cordiformis* Desh. - LEYMERIE, p. 5, pl. 5, fig. 8.
- . 1843 *Cardium Galloprovinciale* Math. - MATHÉRON, p. 155, pl. 17, figs. 1-4.
- v . 1844 *Corbis cordiformis*, d'Orbigny - D'ORBIGNY, p. 111, pl. 279, figs. 1-6.
- . 1856 *Corbis corrugata* (Sow.), Forbes - PICTET et RENEVIER, p. 76, pl. 8, fig. 3.
- . 1859 *Corbis Cordiformis* D'Orb. - VILANOVA, pl. 3, fig. 13.
- 1861 *Corbis corrugata* (Sow.), Forbes - DE LORIO, p. 80.
- 1865 *Corbis corrugata*, Forbes - COQUAND, p. 306.
- . 1866 *Fimbria corrugata*, (Sow.) Pictet et Campiche - PICTET et CAMPICHE, p. 279.
- ? 1882 *Corbis globosa* n. sp. - SEGUENZA, p. 91, pl. 11, fig. 4.
- . 1892 *Corbis* aff. *cordiformis* d'Orb. - VANKOV, p. 88, pl. 4, figs. 1,2.
- . 1892 *Corbis Uhligi* nov. spec. - VANKOV, p. 89, pl. 4, fig. 3.
- . 1897 *Sphaera corrugata*, Sowerby - KARAKASCH, p. 71, pl. 2, fig. 1.
- . 1900 *Fimbria (Sphaera) cordiformis* d'Orb. sp. - MÜLLER, p. 554, pl. 21, fig. 7.
- 1907 *Sphaera corrugata* Sow. - KARAKASCH, p. 197.
- v . 1907 *Sphaera corrugata*, Sowerby-WOODS, p. 157, text-fig. 26, pl. 24, fig. 24; pl. 25, figs. 1, 2.
- . 1913 *Corbis (Sphaera) cordiformis* (Desh.) Leymerie - ROLLIER, p. 246.
- . 1913 *Corbis (Sphaera) corrugata* J. Sow. - ROLLIER, p. 246, pl. 16, fig. 4.
- . 1914 *Sphaera cordiformis* d'Orb. - LANGE, p. 246, pl. 22, figs. 1, 2.
- 1916 *Sphaera corrugata* Sowerby - DOUVILLÉ, p. 160, pl. 20, figs. 8, 9.
- . 1921 *Corbis (Sphaera) corrugata* Sow. - GILLET, p. 14, pl. 1, fig. 15.
- . 1922 *Corbis (Sphaera) corrugata* Sow. - GILLET, p. 66, pl. 3, figs. 8 - 10.
- 1933 *Corbis (Sphaera) corrugata* Sow. - DIETRICH, p. 49.
- ? 1937 *Corbis (Sphaera) globosa* Seg. - TREVISAN, p. 100, pl. 7, figs. 8, 9.
- 1948 *Corbis corrugata* Sowerby sp. - CHARLES, p. 25.
- . 1948 *Corbis (Sphaera) corrugata* Sow. - TAVANI, p. 139, pl. 10, fig. 2.
- . 1948 *Sphaera cordiformis* Leym. - FABRE in COLLIGNON, p. 60, pl. 1, fig. 4.
- 1949 *Sphaera* aff. *corrugata* Sow. - KOKOSZYNSKA, p. 70.
- . 1949 *Sphaera corrugata* Sowerby - MORDVILKO *et al.*, p. 134, pl. 26, fig. 4; pl. 27, fig. 1.
- 1951 *Sphaera corrugata* Sowerby - GIGOUT, p. 353.
- . 1954 *Sphaera corrugata* J. Sowerby - COX, p. 633, pl. 65, fig. 7.
- 1956 *Corbis (Sphaera) corrugata* Sowerby - BENAVIDES-CÁCERES, p. 380.
- 1957 *Corbis ("Sphaera") corrugata* (Sowerby) - ALENCÁSTER, p. 17, pl. 4, figs. 1-3.
- . 1960 *Sphaera corrugata* Sowerby - MUROMTSIEVA, JANIN, p. 214, pl. 25, figs. 8, 9.
- . 1961 *Sphaera corrugata* Sowerby - PROSOROVSKII, p. 144, pl. 15, fig. 4; pl. 16, figs. 1,2.
- . 1962 *Sphaera corrugata* Sowerby - PIRIATINSKY *et al.* in KRIMHOLZ, p. 57, pl. 9, fig. 3.
- . 1974 *Sphaera corrugata* Sowerby - DIMITROVA, p. 101, pl. 48, figs. 3, 4.
- . 1980 *Sphaera corrugata* Sowerby - FISCHER, p. 216, pl. 101, fig. 3.
- ? 1985 *Sphaera corrugata* Sowerby - MONGIN, p. 74.

Material: Twenty two specimens (usually as internal and composite moulds; some retain the shell) from the Lower Hauterivian at Carchinarzos (M. Albo) (n. 346), Orosei (279, 654), Sa Oche (184, 644, 652, 671, 795, 800, etc.).

Dimensions (mm):

n.	H	L	B
795 (int. mould)	(49)	59	46
671 (int. mould)	61	64	50
644 (with shell)	70	(75)	31'
184 (int. mould)	71	76	27'

Discussion: The Sardinian specimens bring no new information on this well-known species.

TREVISAN (1937) stressed that *Corbis globosa* SEGUENZA, 1882, from the Cenomanian in "African facies" of Sicily, is very similar to *Sphaera corrugata* and might even possibly be identical with it. The *Sph. corrugata* specimen described by MONGIN (1985) from Albian beds does not have all the characteristics of the species; hence, the query.

Distribution: Valanginian - Aptian (? Cenomanian): England, Spain, SE France, Sardinia, Sicily?, Germany, Poland, Bulgaria, USSR (Crimea, Caucasus, Turkmenia, Central Asia), Madagascar, Tanza-

nia (Tendaguru), Somalia, Egypt, Morocco, Mexico, Trinidad, Peru (Text-fig. 20).

Fam ASTARTIDAE

Astarte (Astarte) numismalis D'ORBIGNY, 1844

Pl. 11, fig. 1

- . 1842 *Astarte laticosta* Desh. - LEYMERIE, p. 4, pl. 4, figs. 4, 5 (non *A. laticosta* DESHAYES, 1839).
- + 1844 *Astarte numismalis*, d'Orbigny - D'ORBIGNY, p. 63, pl. 262, figs. 4-6.
- . 1844 *Astarte striato-costata*, d'Orbigny - D'ORBIGNY, p. 64, pl. 262, figs. 7-9 (non *A. striato-costata* ROEMER, 1836).
- 1845 *Venus* (?) [*striato-costata*] - FORBES, p. 241.
- . 1850 *Astarte subcostata* d'Orb. - D'ORBIGNY, p. 77.
- . 1856 *Astarte laticosta*, Desh. - PICTET et RENEVIER, p. 88, pl. 10, fig. 2.
- 1865 *Astarte laticosta*, Deshayes - COQUAND, p. 316.
- . 1865 *Astarte Leymerii* - ZITTEL, p. 156.
- . 1866 *Astarte subcostata*, d'Orbigny - PICTET et CAMPICHE, p. 307.
- . 1866 *Astarte numismalis*, d'Orb. - PICTET et CAMPICHE, p. 309.
- . 1897 *Astarte numismalis*, d'Orbigny - KARAKASCH, p. 70, pl. 1, fig. 23.
- . 1898 *Astarte numismalis*, d'Orbigny - SKEAT and MADSEN, p. 174, pl. 6, fig. 15.
- ? 1900 *Astarte Leymerii* Desh. - MÜLLER, p. 552, pl. 22, figs. 4, 5.
- 1900 *Astarte numismalis* d'Orbigny - WOLLMANN, p. 97.
- 1905 *Astarte subcostata* d'Orb. - HARBORT, p. 60, pl. 4, fig. 6.
- . 1906 *Astarte subcostata*, d'Orbigny - WOODS, p. 109, pl. 14, figs. 29-36.
- . 1921 *Astarte subcostata* d'Orb. - GILLET, p. 13, pl. 1, figs. 11, 12.
- 1922 *Astarte numismalis* d'Orb. - GILLET, p. 62.
- . 1922 *Astarte subcostata* d'Orb. - GILLET, p. 62.
- 1924 *Astarte subcostata* d'Orb. - GILLET, p. 101, fig. 56.
- 1924 *Astarte numismalis* d'Orb. - GILLET, p. 103.
- . 1948 *Astarte subcostata* d'Orb. - TAVANI, p. 126, pl. 7, figs. 2, 3.
- 1949 *Astarte numismalis* d'Orb. - KOKOSZYNSKA, p. 65.
- . 1966 *Astarte striato-costata* Orbigny - BOGDANOVA, p. 110, pl. 9, fig. 16.
- 1974 *Astarte numismalis* d'Orbigny - DIMITROVA, p. 104.

1976 *Astarte subcostata* d'Orbigny - MAREK, RACZYNSKA, p. 552.

Material: Ten composite or external moulds from Orosei, lower Upper Valanginian (n. 801, a - d) and lowermost Hauterivian (n. 803, 803a); one doubtful composite mould from the Sa Oche area, Lower Hauterivian (n. 212).

Dimensions (mm): The largest specimen, n. 801a: H = 7.3; L = 8.

Description: Shell small, relatively convex, subtriangular, moderately inequilateral. Antero-dorsal margin concave, anterior and ventral margins rounded. Ornamentation consists of 7-8 prominent commarginal ribs, with intercalary riblets on well preserved specimens.

Discussion: The figures of various authors quoted above show differences which are probably due to intraspecific variability and to changes in shape during ontogeny.

Depending to the state of preservation the Sardinian specimens agree with *Astarte subcostata* D'ORBIGNY, 1850 (= *laticosta* DESHAYES, 1842 and *striato-costata* D'ORBIGNY, 1844) when the intercalary commarginal riblets are still preserved, or with *A. numismalis* D'ORBIGNY, 1844 when the riblets are not preserved. The original figure of *A. numismalis* represents a poorly preserved specimen; the original specimens come from the same localities (Marolles and Saint-Sauveur) and are of the same stratigraphic age as the types of *A. striato-costata*. FORBES (1845) stated that English *Astarte* specimens, which were referred subsequently by WOODS (1906) to *A. subcostata* D'ORBIGNY, had been identified by D'ORBIGNY as representing *A. numismalis*. This proves that the two names proposed by D'ORBIGNY really refer to the same species; the oldest available name for this species is *A. numismalis*. DIMITROVA (1974) possibly unintentionally already expressed the same opinion: her very short synonymic list included *A. numismalis* D'ORBIGNY and "*A. laticosta* Desh." in PICTET and RENEVIER, 1856. This last taxon has generally (PICTET and CAMPICHE, 1866; WOODS, 1906; etc.) been considered as identical with *A. subcostata* D'ORBIGNY, 1850.

Distribution: Valanginian to Aptian, North Temperate and Tethyan Realms: England, Germany, Poland, France (Paris Basin and SE), Switzerland, Spain, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Central Asia), Algeria, Somalia, Tanzania. Recorded from boulders in Denmark.

Eriphyla gigantea (DESHAYES in LEYMERIE, 1842) Pl. 11, figs. 2 - 6; text-fig. 21

- + 1842 *Astarte gigantea*, Desh. - LEYMERIE, p. 5, pl. 4, fig. 3.

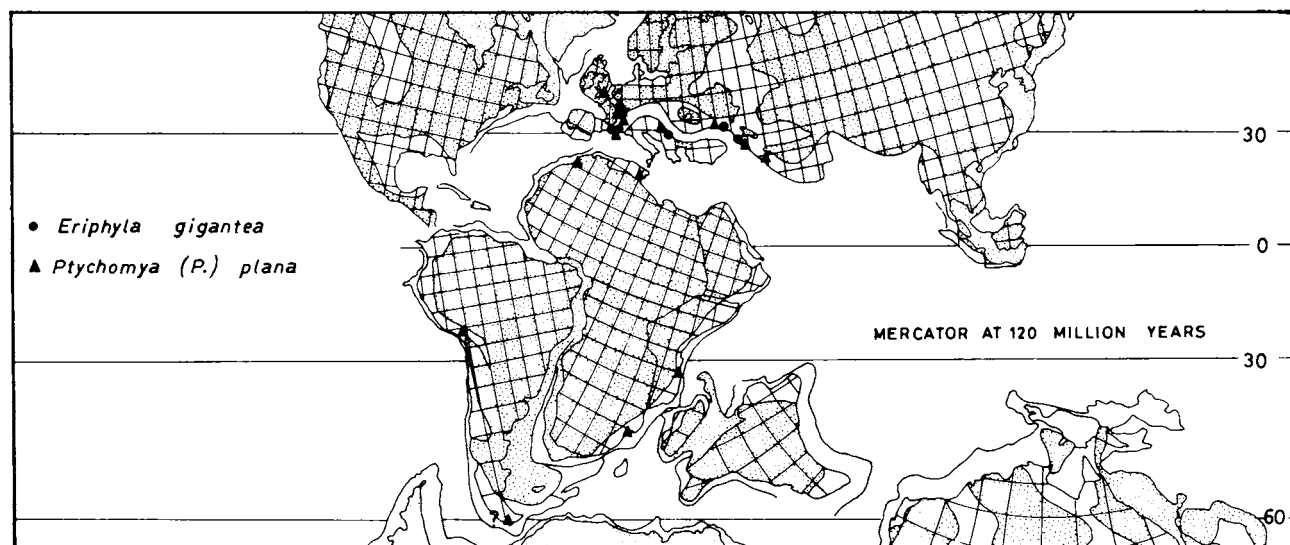


FIG. 21

- . 1843 *Venus Allaudiensis*, Math. - MATHÉRON, p. 149, pl. 15, figs. 1,2.
- . 1844 *Astarte gigantea*, Deshayes - D'ORBIGNY, p. 58, pl. 258, figs. 1-5.
- . 1866 *Astarte gigantea*, Leymerie - PICTET et CAMPICHE, p. 298, pl. 123, fig. 1.
- . 1866 *Astarte helvetica*, Pictet et Campiche - PICTET et CAMPICHE, p. 299, pl. 123, fig. 2.
- 1922 *Astarte gigantea* Desh. in Leym. - GILLET, p. 64.
- 1948 *Astarte gigantea* Deshayes in Leymerie - CHARLES, p. 23.
- . 1960 *Astarte gigantea* Deshayes - MUROMT-SIEVA, JANIN, p. 210, pl. 23, fig. 1.
- non 1962 *Astarte (Tridonta) gigantea* (Deshayes) - ABBASS, p. 103, pl. 16, figs. 8, 10-12, 15.
- . 1974 *Astarte gigantea* Deshayes - DIMITROVA, p. 102, pl. 50, fig. 7.

Material: Specimens with shell, composite moulds, internal moulds from Carchinarzos (M.Albo) (n. 329, 354), Orosei (n. 656, 658, etc.), Orudè (n. 832), Sa Oche (frequent, more than 40 specimens), Su Praicargiu (n. 144), all from the Lower Hauterivian.

Dimensions (mm): Specimens from Sa Oche:

n.	H	L	B	H/L
190 (comp. mould)	70	91	28	0.77
191 (comp. mould)	71	87	30	0.82
832 (int. mould)	74	90	34	0.82
643 (int. mould)	81	89	35	0.91
679 (int. mould)	83	89	35	0.93
696 (comp. mould)	87	92	—	0.95
674 (int. mould)	89	97	37	0.92

Discussion: The ornamentation and general aspect of the Sardinian material agree with the figures of

previous authors, but the shell shape is more variable than has been indicated by them. Some specimens (n. 674, 696, etc.) are orbicular, but others (n. 190, 191 etc.) are more elongated, and closer to fig. 7 on pl. 50 in DIMITROVA (1974). On the measured specimens (N = 7) the ratio H/L varies from 0.77 to 0.95; deformation does not seem to occur. Different preservational states could be responsible for the "variability": internal moulds are more elongate and umbones are centrally located, whereas composite moulds are more orbicular and have recurved umbones.

It seems unlikely that specimens from the Maas-trichtian of Egypt with a length of only 22 mm, described as *Astarte gigantea* by ABBASS (1962), are referable to the species of DESHAYES.

Generic attribution: The specimens from Sardinia do not present well preserved hinges. The hinges of *A. gigantea* which are figured in literature are not perfect (f.i. D'ORBIGNY, 1844, p. 258, fig. 3). Yet, the hinges and the general shape of the valves indicate strong similarities with species such as *Astarte striata* SOWERBY, 1826 from the Albian of S. England, *A. obovata* SOWERBY, 1822 from the Aptian of S. England, *A. laevis* (PHILLIPS, 1829) from the lowermost Cretaceous of N. England [these three species were placed in *Eriphyla* by WOODS (1906)] or with *Eriphyla (E.) pulchella* HAYAMI, 1965 from the Albian of Japan (the Japanese *Eriphyla* species are smaller than the English species assigned to the same genus). On the base of these similarities it was decided to place *Astarte gigantea* in the genus *Eriphyla*.

Distribution: Hauterivian-?Barremian from France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus) (Text-fig. 21).

Ptychomya (*Ptychomya*) *plana* AGASSIZ, 1842

Pl. 11, figs. 7, 8; text-fig. 21

+ 1842 *Ptychomya plana* Ag. - AGASSIZ, pl. 11, figs. 3,4.

v . 1844 *Crassatella Robinaldina*, d'Orbigny - D'ORBIGNY, p. 75, pl. 264, figs. 10 - 13.

1845 *Ptychomya plana* - AGASSIZ, p. XVIII.

. 1857 *Crassatella Robinaldina*, d'Orbigny - PICTET et RENEVIER, p. 90, pl. 11, figs. 2, 3.

1861 *Crassatella neocomiensis*, de Loriol - DE LORIO, p. 71, pl. 9, figs. 1-4.

. 1866 *Ptychomya Robinaldina*, (d'Orbigny), Pictet et Campiche - PICTET et CAMPICHE, p. 352, pl. 127, figs. 2-6.

. 1866 *Ptychomya Germani*, Pictet et Campiche - PICTET et CAMPICHE, p. 354, pl. 127, figs. 7,8.

. 1866 *Ptychomya neocomiensis* (de Loriol), Pictet et Campiche - PICTET et CAMPICHE, p. 355, pl. 127, figs. 9-12.

. 1892 *Pholadomya Pilari* nov. spec. - VANKOV, p. 86, pl. 2, figs. 1,2.

. 1900 *Ptychomya Hauchecornei* n. sp. - MÜLLER, p. 556, pl. 22, figs. 6, 7.

. 1907 *Ptychomya Robinaldina* (d'Orbigny) - WOODS, p. 179, pl. 27, figs. 24-26.

? 1907 *Ptychomya Germani* P. et C. sp. - HAUPT, p. 219.

1912 *Ptychomya Robinaldina* d'Orbigny - PERVINQUIÈRE, p. 252.

. 1914 *Ptychomya Kitchini* nov. sp. - LANGE, p. 242, pl. 17, fig. 6.

1922 *Ptychomya Robinaldina* d'Orb. - GILLET, p. 75.

1922 *Ptychomya neocomiensis* de Lor. - GILLET, p. 75.

1924 *Ptychomya Robinaldina* d'Orb. - GILLET, p. 135, text-fig. 86.

1924 *Ptychomya Germani* Pict. et Camp. - GILLET, p. 135.

1924 *Ptychomya neocomiensis* de Loriol - GILLET, p. 136.

. 1933 *Ptychomya robinaldina* var. *hauchecornei* (Müll.) - DIETRICH, p. 53.

. 1936 *Ptychomya robinaldina* (d'Orbigny) - RENNIE, p. 383, pl. 49, figs. 1, 2.

? 1951 *Ptychomya robinaldina* d'Orb. - GIGOUT, p. 366, pl. 12, fig. 1.

1956 *Ptychomia robinaldina* d'Orbigny - BENAVIDES - CÁCERES, p. 380.

. 1960 *Ptychomya robinaldina* Orbigny - MURMONTSEVA, JANIN, p. 217, pl. 27, figs. 4, 5.

. 1968 *Ptychomya mordvilkae* Uрманова sp. nov. - Uрманова in BUZURUKOV *et al.*, p. 269, pl. 63, fig. 6.

. 1974 *Ptychomya robinaldina* (d'Orbigny) -

DIMITROVA, p. 113, pl. 53, figs. 1, 2.

Material: One bivalved internal mould (n. 862), two composite moulds (n. 259, 742) from Sa Oche (Lannaitto), Lower Hauterivian.

Dimensions (mm):

n.	H	L	B	R
742	27	33	—	—
862	30.5	43	16.5	—
259	—	> 60	—	> 45 at the margin

Discussion: Authors have distinguished European *Ptychomya* species using the number of ribs, the outline of the shell and the size, generally while having only a limited number of specimens at their disposal. WOODS (1907) suspected that *P. Robinaldina* and *P. neocomiensis* might be conspecific and drew attention to the variability in rib number induced by the divarication along a V or W line. Having at his disposal an enormous material WEAVER (1931, pp. 338-346) showed how variable in outline, rib number and proportions the species *P. koeneni* BEHRENDSEN from the Valanginian to Barremian of Argentina is. *P. koeneni* is certainly closely related to the European taxa discussed herein. Keeping in mind WEAVER's results, and being faced with the impossibility of logically distinguishing *robinaldina*, *germani* and *neocomiensis* from one another we conclude that they must fall within the specific variability of one species, for which, by the rules of the I.C.Z.N. the name *plana* must be used. The "different" outlines drawn by previous authors are partially artificial: f.i. the type of *P. Germani* is an incomplete specimen. The differences in rib numbers fall easily within the variability indicated by FRENEIX (1972) for *P. salvani* PALLA (Upper Albian-Middle Cenomanian of Tarfaya, Morocco): on p. 162 she stated "le nombre de côtes des flancs peut varier de 15 à 25 chez des adultes". Those are the only quantitative data available on rib numbers of *Ptychomya* in literature, and they represent almost the doubling of the rib number within one species. The *P. plana* specimens mentioned under different names in literature vary in size: the Aptian specimens are often large, and those from older strata are said to be smaller. This last statement has been partly induced by the small size of the D'ORBIGNY type-specimen of *P. Robinaldina*. The Sardinian material of undisputed Early Hauterivian age reaches the size of Aptian specimens mentioned in literature.

In our interpretation of *P. plana*, *P. mordvilkae* Uрманова, 1968 from the Aptian of Turkmenia (USSR) is easily included. The ornamentation of both taxa is identical and the figured specimen of *P. mordvilkae* is indeed somewhat more elongate, but not enough to warrant a specific distinction.



FIG. 22

We follow FRENEIX (1972) in placing *Ptychomya* in the Astartidae.

Distribution: Known from Valanginian to Aptian (? Albian): England, SE France, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Turkmenia), ?Japan, Tanzania (Tendaguru), Tunisia, ? Morocco, Peru, ? Argentina (Text-fig. 21).

Fam. CARDIIDAE

"*Cardium*" *gillieronii* PICTET and CAMPICHE, 1866
Pl. 12, fig. 7

+ 1866 *Cardium Gillieronii*, Pictet et Campiche -
PICTET et CAMPICHE, p. 252, pl. 119, fig.
2; pl. 120, figs. 1, 2.

Material: Two internal moulds from Sa Oche (Lanaitto), Lower Valanginian (n. 860, 861).

Dimensions (mm): n. 860, left valve: H = 46; L = 46; B' = 16.

Discussion: The Sardinian specimens despite slight deformation, show the characteristics of this rare species described by PICTET and CAMPICHE and originally also based on internal moulds. The incomplete hinge and lack of ornamentation do not allow precise generic attribution.

Distribution: Lower Valanginian of Sardinia, Valanginian of Western Switzerland.

"*Cardium*" sp.

Two moulds (internal for the major part, but partially composite) of medium-sized (L = ± 35 mm) cardiid specimens from the Upper Berriasian-lowermost Valanginian of Sos Tinzosos (Lanaitto) (n. 891, 895) with radial ribs, have been examined. Their general characteristics are insufficient for further description or attribution.

Integricardium deshayesianum (DE LORIO, 1861)
Pl. 12, figs. 1a-4b; text-fig. 22

+ 1861 *Cyprina Deshayesiana*, de Lorient - DE LORIO, p. 78, pl. 10, figs. 1, 2.

. 1865 *Cyprina Deshayesiana*, de Lorient - PICTET et CAMPICHE, p. 215, pl. 113, fig. 5.

1896 *Cyprina Deshayesiana* de Lorient - WOLLEMAN, p. 848.

1900 *Cyprina Deshayesiana* de Lorient - WOLLEMAN, p. 112.

1912 *Cardium (Integricardium) Deshayesianum* P. de Lorient - ROLLIER, p. 133, pl. 10, figs. 1, 2.

1924 *Cyprina Deshayesiana* de Lorient - GILLET, p. 130.

1957 *Cyprina deshayesiana* Lor. - ERISTAVI, p. 39.

. 1960 *Integricardium deshayesianum* Lorient - MUROMTSIEVA, JANIN, p. 216, pl. 26, fig. 8.

. 1967 *Cyprina deshayesiana* de Lorient - BRAMER, p. 100, pl. 4, figs. 1-5.

. 1974 *Integricardium deshayesianum* (Lorient) - DIMITROVA, p. 112, pl. 51, fig. 3.

Material: Univalved and bivalved internal moulds (one with shell fragments) from Orosei, lowermost Hauterivian (n. 273, 283) and from Sa Oche (Lanaitto), Lower Hauterivian (n. 250, 662, 664, 665, 667, 669).

Dimensions (mm):

n.	H	L	B	H/L	H/B
665	62	(70)	(27)'	(0.89)	—
664	64	74	25'	0.86	(1.28)
662	64	77	(47)	0.83	(1.36)
669	66	74	50	0.89	1.32
283	67	73	—	0.92	—
273	80	87	60	0.92	1.33

Discussion: Most Sardinian specimens agree well with the figures in PICTET and CAMPICHE 1865, especially pl. 113, fig. 5a, showing the strong muscle scars and a slight pallial line. The dimensions and the ratios of the shells agree with those given by DIMITROVA (1974). The small shell fragment on specimen n. 667 shows only commarginal growth lines.

Distribution: Valanginian - Hauterivian: France, Switzerland, Germany, Sardinia, Bulgaria, USSR (Crimea, Caucasus) (Text-fig. 22).

Pleuriocardia ? *rauliniana* (D'ORBIGNY, 1844)

Pl. 12, fig. 5

- + 1844 *Cardium Raulinianum*, d'Orbigny - D'ORBIGNY, p. 25, pl. 242, figs. 7 - 10.
- non 1852 *Cardium Raulinianum* d'Orbigny - PICTET et ROUX, p. 426, pl. 31, fig. 1 [= *P. constantii* (D'ORBIGNY, 1844)].
- 1866 *Cardium Raulinianum*, d'Orb. - PICTET et CAMPICHE, p. 268.
- 1979a "*Cardium*" *raulinianum* - MONGIN, p. 421.

Material: One left valve with partial shell preservation from Orosei, uppermost Albian (Vraconian) (n. 8).

Dimensions (mm): H = 12.7; L = 11.

Discussion: The valve is covered with narrow radial ribs on the posterior side (on the anterior side the shell is missing); towards the umbo the shell appears to be smooth. The rib number can be estimated at about 40. The spines in the intercalary intervals which D'ORBIGNY (1844) figured and mentioned cannot be seen on this specimen. At this point, not having seen the D'ORBIGNY original, it is impossible to judge whether his figure on pl. 242, fig. 10, is accurate: it gives the impression of being reconstructed.

The proportions of the specimens figured by PICTET and ROUX (1852) do not agree with the figures of D'ORBIGNY: height is far greater than the length and the umbo protudes further. The outline of the valves of *Cardium Raulinianum* D'ORBIGNY is orbicular, but that of *C. Raulinianum* in PICTET and ROUX is not. Therefore we refer the PICTET and ROUX specimens to *P. constantii* (D'ORBIGNY, 1844) which is of the same stratigraphic age and very similar.

For the generic assignment we tentatively follow the suggestion of SCOTT (1978).

Distribution: Upper Albian in France, Switzerland and Sardinia.

Pleuriocardia ? *voltzii* (LEYMERIE, 1842)

Pl. 12, fig. 6; text-fig. 22

- + 1842 *Cardium Voltzii*, Leym. - LEYMERIE, p. 6, pl. 7, fig. 3.
- . 1844 *Cardium Voltzii*, Leymerie - D'ORBIGNY, p. 21, pl. 241, figs. 1-4.
- . 1866 *Cardium Voltzi*, Leymerie - PICTET et CAMPICHE, p. 247, pl. 118, figs. 3, 4.
- ? 1896 *Cardium Voltzi* Leymerie - WOLLEMAN, p. 847.
- 1907 *Cardium voltzi* Leym. - KARAKASCH, p. 198.
- 1922 *Cardium Voltzi* Leym. - GILLET, p. 71.
- 1924 *Cardium Voltzi* Leym. - GILLET, p. 113.
- ? 1984 *Cardium voltzi* Leymerie - FRICOT *et al.*, p. 22, pl. 2, fig. 1.

Material: One composite mould of a left valve from Orosei, lowermost Hauterivian (n. 751).

Dimensions (mm): H = 29.2; L = 37; B' = (15).

Discussion: The shape of the Sardinian specimen agrees well with the figure in D'ORBIGNY (1844) and in PICTET and CAMPICHE (1866). For the generic attribution we tentatively follow SCOTT (1978).

Distribution: Hauterivian - ? Aptian from Germany, Switzerland, France, Sardinia, USSR (Crimea, Caucasus) (Text-fig. 22).

Protocardia impressa (DESHAYES in LEYMERIE, 1842)

Pl. 13, figs. 15-17b; text-fig. 22

- + 1842 *Cardium impressum*, Desh. - LEYMERIE, p. 6, pl. 8, figs. 1, 2 (varr. *major* et *minor*).
- . 1844 *Cardium impressum*, Deshayes - D'ORBIGNY, p. 20, pl. 240, figs. 1-4.
- v ? 1865-1866 *Cardium comes*, H. Coquand - COQUAND, p. 309 (1865), pl. 19, figs. 3, 4 (1866).
- . 1866 *Cardium impressum*, Leymerie - PICTET et CAMPICHE, p. 249, pl. 119, fig. 1.
- 1907 *Cardium impressum* Leym. - KARAKASCH, p. 199.
- 1912 *Cardium (Pterocardium) impressum* (Desh.) - ROLLIER, p. 141.
- . 1922 *Cardium (Protocardia) impressa* Desh. - GILLET, p. 69, pl. 4, fig. 1.
- p . 1960 *Protocardia anglica* Woods - MUROMT-SIEVA, JANIN, p. 215, pl. 26, figs. 1, 2 (*non* WOODS, 1908).
- . 1974 *Protocardia impressa* (Deshayes) - DIMITROVA, p. 107, pl. 48, fig. 2.

Material: Univalved and bivalved composite moulds from the uppermost Valanginian of Orosei (n. 281) and from the Lower Hauterivian of Sa Oche (Lanaïto) (n. 187, 251, 687, 690, 692).

Dimensions (mm):

n.	H	L	B
187	74	65	54
251	83	(71)	(35)'
690	85	(80)	—

Discussion: The Sardinian specimens agree with the description and figures in PICTET and CAMPICHE (1866), especially those referring to moulds. The radial "protocardiid" ribs are clearly visible on most specimens (Pl. 13, fig. 17b). The material described by COQUAND (1865) as *Cardium comes* from the Aptian of Spain shows strong similarities with *P. impressa*, but the preservation is different and thus it is not possible to be completely certain that both taxa are synonymous. If they are then it would mean that the stratigraphic range of *P. impressa* includes the Aptian.

Probably the occurrences of Hauterivian "*Protocardia anglica* WOODS" in MUROMTSIEVA and JANIN (1960) belong to *P. impressa*; *P. anglica* is generally only known from the Barremian ? - Aptian. Comparison with material of *P. anglica* WOODS (with shell preservation) is difficult, but the outline of the English Aptian specimens seems more quadrate than on the Hauterivian specimens from Southern Europe.

Distribution: Valanginian - Hauterivian (Barremian - Aptian?): France, Switzerland, Spain?, Sardinia, Bulgaria, USSR (Crimea) (Text-fig. 22).

Protocardia peregrina (D'ORBIGNY, 1850)

Pl. 12, figs. 8, 9; text-fig. 22

- . 1844 *Cardium peregrinorsum*, d'Orbigny - D'ORBIGNY, p. 16, pl. 239, figs. 1-3 (non D'ORBIGNY, 1842).
- + 1850 *Cardium peregrinum*, d'Orb. - D'ORBIGNY, p. 79, n° 304.
- . 1866 *Cardium peregrinum*, d'Orbigny - PICTET et CAMPICHE, p. 254, pl. 121, figs. 1, 2.
- 1897 *Cardium peregrinum*, d'Orbigny - KARAKASCH, p. 72, pl. 1, fig. 24.
- ? 1921 *Cardium* (*Protocardium*) *peregrinum* d'Orb. - GILLET, p. 15, pl. 2, fig. 3.
- 1922 *Protocardia peregrina* d'Orb. - GILLET, p. 70.
- 1924 *Protocardia peregrina* d'Orb. - GILLET, p. 111, text-fig. 70.
- 1927 *Protocardium peregrinum* d'Orb. - PČELINČEV, p. 146.
- ? 1984 *Cardium peregrinum* D'Orbigny - FRICOT *et al.*, p. 25.

Material: One bivalved specimen from Orosei, uppermost Valanginian (n. 2) and one composite mould of a right valve from Sa Oche (Lanaïtto), Lower Hauterivian (n. 739).

Dimensions (mm):

n.	H	L	B
739	15.3	15.0	—
2	16	15.7	12.2

Discussion: On one specimen (n. 739) radial ribs can be seen on the posterior side; on both specimens some plications made by the ribs at the pallial margin are visible.

According to FRENEIX (written communication) *Cardium peregrinorsum* D'ORBIGNY, 1842 from the Neocomian of Colombia is indeed different from *C. peregrinorsum* D'ORBIGNY, 1844 from the Neocomian of France: the two species are similar in shape, but one has 30 and the other only about 20 posterior radial ribs. Therefore the name from the *Prodrome* (D'ORBIGNY, 1850) must be retained. *Protocardia peregrinorsa* D'ORBIGNY, var. *orientalis* DOUVILLÉ, 1916 (p. 158, pl. 20, fig. 4) has about 40 ribs and belongs probably to a third species.

Distribution: Valanginian - Hauterivian, ? Barremian (Aptian citations probably refer to *Cardium subbillanum* LEYMERIE, 1842): France, Switzerland, Sardinia, USSR (Crimea, Caucasus) (Text-fig. 22).

Fam. ARCTICIDAE

Proveniella bernensis (LEYMERIE, 1842)

Pl. 13, figs. 2, 3; text-fig. 23

- + 1842 *Cyprina* ? *bernensis*, Leym. - LEYMERIE, p. 5, pl. 5, fig. 6.
- ? 1843 *Venus galloprovincialis*, math. - MATHÉRON, p. 150, pl. 15, figs. 3, 4.
- v . 1844 *Cyprina rostrata*, Fitton - D'ORBIGNY, p. 98, pl. 271, figs. 1-5 (non *Cyprina rostrata* SOWERBY in FITTON, 1836, p. 240, pl. 17, fig. 1).
- . 1861 *Cyprina Bernensis*, Leymerie - DE LORRIOL, p. 76, pl. 9, fig. 8.
- . 1865 *Cyprina bernensis*, Leymerie - PICTET et CAMPICHE, p. 212, pl. 113, figs. 1, 2.
- 1897 *Cyprina bernensis*, Leymerie - KARAKASCH, p. 74.
- 1907 *Cyprina bernensis* Leym - KARAKASCH, p. 199.
- 1912 *Cyprina Bernensis* Leymerie - PERVINQUIÈRE, p. 222.
- . 1922 *Cyprina bernensis* Leym. - GILLET, p. 72, pl. 4, figs. 2-4.
- . 1924 *Cyprina* s. str. *bernensis* Leymerie - GILLET, p. 127, text-fig. 79.
- 1948 *Cyprina bernensis* Leymerie - CHARLES, p. 23.
- 1957 *Cyprina bernensis* Leym. - ERISTAVI, p. 39.
- non 1973 *Cyprina* aff. *bernensis* Leymerie - GLAZUNOVA, p. 60, pl. 32, fig. 2.

Material: Three composite moulds from the Lower Hauterivian of Carchinarzos (M. Albo) (n. 328, 344) and Orosei (n. 767).

Dimensions (mm): n. 328: H = 30; L = 36.5.

Discussion: The Sardinian specimens agree well with the figures given by LEYMERIE (1842) and D'ORBIGNY (1844). Commarginal external lines are impressed on the internal moulds. The references indicating Barremian occurrences such as GLAZUNOVA (1973) seem to concern a species with a less recurved umbo.

Distribution: Valanginian-Hauterivian from France, Switzerland, Sardinia, Tunisia, USSR (Crimea, Caucasus) (Text-fig. 23).

Proveniella crassicornis (AGASSIZ, 1842)

Pl. 13, fig. 1

- p . 1842 *Ceromya crassicornis* Ag. - AGASSIZ, p. 36, pl. 8f, figs. 5-10 (non figs. 1-4).
- . 1852 *Isocardia crassicornis* d'Orbigny - PICTET et ROUX, p. 428, pl. 31, fig. 3.



FIG. 23

- . 1866 *Cyprina crassicornis*, (Agassiz) Pictet et Campiche - PICTET et CAMPICHE, p. 226, pl. 115, figs. 6-8.
- . 1930 *Cyprina crassicornis* d'Orb. - PASSENDORFER, p. 428.

Material: One left valve (internal mould with shell fragments) from the Upper Albian of Orosei (n. 46).

Dimensions (mm): H = 21; L = (20); B' = 9.6.

Discussion: The shell shape of *Proveniella crassicornis* changes during ontogeny; the Sardinian specimen is relatively small and therefore its umbo is not yet strongly recurved. The most similar figure is found in PICTET and ROUX, 1852, pl. 31, figs. 3b, c. The shell is only ornamented with commarginal growth lines. The mould is completely smooth if we exclude the slightly undulating commarginal growth lines near the ventral margin which could indicate growth stops. *P. crassicornis* is similar to *P. quadrata* (D'ORBIGNY, 1844) as described and figured in WOODS (1907, p. 146, pl. 23, figs. 6-9). However, as already stated by this last author, it is relatively higher and less inequilateral; at the same ontogenetic stage the umbones are more prominent in *P. crassicornis* and more recurved in *P. quadrata*.

Distribution: Upper Albian of France (Perte du Rhône), Switzerland, Sardinia, Poland.

Fam. VENERIDAE

Flaventia brongniartina (LEYMERIE, 1842)

Pl. 13, fig. 4; text-fig. 23

- + 1842 *Venus Brongniartina* Leym. - LEYMERIE, p. 5, pl. 5, fig. 7; pl. 7, fig. 1.
- . 1845 *Venus Brongniartina*, Leymerie - D'ORBIGNY, p. 432, pl. 382, figs. 3-6.
- 1850 *Venus sub-Brongniartina*, d'Orb. - D'ORBIGNY, p. 76, n° 247.
- . 1861 *Venus subbrongniartina*, d'Orbigny - DE LORIO, p. 60, pl. 7, figs. 4, 5.
- . 1865 *Venus subBrongniartina*, Leymerie - PICTET et CAMPICHE, p. 168, pl. 111, fig. 1.

- ? 1912 *Venus subbrongniartina* d'Orbigny - PERVINQUIÈRE, p. 273.
- ? 1916 *Meretrix (Flaventia) Brongniarti* Leymerie - DOUVILLÉ, p. 151, text-fig. 47, pl. 19, fig. 11 (non *Venus Brongniartii* PAYRAUDEAU, 1826, nec *Venus Brongniarti* ROEMER, 1836).
- 1922 *Meretrix (Flaventia) Brongniartina* Leym. - GILLET, p. 73, text-fig. 3.
- 1924 *Clementia (Flaventia) Brongniartina* Leymerie - GILLET, p. 134, text-fig. 83.
- ? 1956 *Meretrix (Flaventia) Brongniartina* Leymerie - MAHMOUD, p. 116, pl. 11, figs. 4-9.
- ? 1962 *Meretrix brongniartiana* (Leymerie) - ABBASS, p. 143, pl. 22, figs. 6-8, 10.
- . 1965 *Flaventia brongniarti* Leymerie - KOTETISHVILI, p. 66, pl. 5, fig. 10.
- . 1965 *Flaventia subbrongniarti* d'Orbigny - KOTETISHVILI, p. 67, pl. 5, fig. 11.
- 1983 *Flaventia brongniartina* Leymerie - FRICOT et al., p. 25.

Material: Internal moulds bivalved and univalved from Sa Oche (Lanaitto), Lower Hauterivian (n. 730, 742b, 743).

Dimensions (mm):

n.	H	L	B
742b	26	35	8'
730	27	(33)	(14)

Discussions: The nomenclature of *Flaventia brongniartina* is somewhat confused because D'ORBIGNY in 1850 unnecessarily introduced the name *sub-Brongniartina*. He had erroneously considered that the original name of the species *Venus Brongniartina* is a homonym of *V. Brongniartii* PAYRAUDEAU, 1826.

The Sardinian specimens closely resemble the description and the figure in PICTET and CAMPICHE (1865) for *Venus subBrongniartina* LEYMERIE, by which name the Swiss authors meant *Venus Brongniartina* LEYMERIE as can be understood from their synonymy.

The specimens which we studied do not show all the generic characteristics of *Flaventia*, but previous authors with better material at their disposal adopted this attribution.

Distribution: Valanginian - Aptian: France, Switzerland, Sardinia, USSR (Georgia), ?Egypt, ?Tunisia (Text-fig. 23).

"Venus" cornueliana D'ORBIGNY, 1845.

Pl. 13, fig. 8

+ 1845 *Venus Cornueliana*, d'Orbigny - D'ORBIGNY, p. 436, pl. 383, figs. 10-13.

. 1861 *Venus Cornueliana*, d'Orbigny - DE LORIO, p. 61, pl. 7, figs. 6, 7.

. 1865 *Venus Cornueliana*, d'Orbigny - PICTET et CAMPICHE, p. 173, pl. 111, fig. 3.

1922 *Meretrix Cornueliana* d'Orb. - GILLET, p. 74.

Material: Four bivalved internal moulds of Early Hauterivian age from Carchinarzos (M. Albo) (n. 338, 339), Orosei (n. 843), Sa Oche (Lanaïto) (n. 716).

Dimensions (mm): n. 339: H = 23.3; L = 31.3; B = 13.

Discussion: Precise generic attribution is impossible because *"Venus" cornueliana* is only known from internal moulds; therefore the usage of D'ORBIGNY is continued. We accept the interpretation of PICTET and CAMPICHE (1865) concerning the distinction between *V. Cornueliana* and *V. Robinaldina* D'ORBIGNY, 1845 based on the shape of the anterior and posterior margins.

Distribution: only recorded from the Hauterivian of France, Switzerland and Sardinia.

"Venus" thurmanni DE LORIO, 1861

Pl. 13, figs. 5a, 5b

+ 1861 *Venus Thurmanni*, de Lorio - DE LORIO, p. 63, pl. 8, figs. 1, 2.

1865 *Venus Thurmanni*, de Lorio - PICTET et CAMPICHE, p. 174.

Material: One bivalved internal mould from Sa Oche (Lanaïto), Lower Hauterivian (n. 735).

Dimensions (mm): H = 24.2; L = 34.6; B = 16.2

Discussion: Similar to *"Venus" cornueliana* D'ORBIGNY, 1845 but less inequilateral and with a more elongated and narrow anterior part. The problem of generic attribution is the same as in *"V. cornueliana* (see above).

Distribution: Rarely recorded, until now only from the Hauterivian of E. France and Sardinia.

"Venus" vendoperana (LEYMERIE, 1842)

Pl. 13, figs. 6, 7; text-fig. 23

+ 1842 *Lucina vendoperana*, Leym. - LEYMERIE, p. 4, pl. 5, fig. 3.

. 1845 *Venus vendoperata* (sic) d'Orbigny -

D'ORBIGNY, p. 439, pl. 384, figs. 7-10 (sub *Venus neocomiensis*).

. 1855 *Venus vendoperana*, (Leym.) d'Orb. - PICTET et RENEVIER, p. 71, pl. 7, fig. 9.

. 1861 *Venus Vendoperana* (Leym.), d'Orbigny - DE LORIO, p. 64, pl. 8, fig. 3.

. 1865 *Venus vendoperana*, (Leym.) d'Orbigny - PICTET et CAMPICHE, p. 181, pl. 111, fig. 12.

1865 *Venus vendoperana*, Orbigny - COQUAND, p. 294.

non 1907 *Venus ? vendoperana* (Leym.) - COSSMANN in PELLAT et COSSMANN, p. 28, pl. 6, figs. 21, 22.

1921 *Meretrix vendoperata* (sic) d'Orb. - GILLET, p. 17.

1922 *Meretrix Vendoperata* (sic) d'Orb. - GILLET, p. 73.

. 1984 *Cyprimeria vendoperana* Leymerie - FRICOT *et al.*, p. 22, pl. 2, fig. 6.

Material: Two bivalved internal moulds from Sa Oche (Lanaïto), Lower Hauterivian (n. 727, 744).

Dimensions (mm):

n.	H	L	B
744	17.0	16.3	10.0
727	18.5	18.2	11.9

Discussion: The Sardinian specimens agree best with the figures of D'ORBIGNY and of PICTET and CAMPICHE. *"V." vendoperana* is considered specifically different from *"V." dupiniana* D'ORBIGNY, 1845 because it is more circular and relatively more convex. No certain generic attribution is possible for this species which is only known from internal moulds.

Distribution: Valanginian to Aptian, from E. France, Switzerland, Spain, Sardinia (Text-fig. 23).

Fam. GASTROCHAENIDAE

Gastrochaena cf. *brevis* PICTET and CAMPICHE, 1864 Pl. 13, fig. 19

+ 1864 *Gastrochaena brevis*, Pictet et Campiche - PICTET et CAMPICHE, p. 16, pl. 99, figs. 11, 12.

One specimen from Orosei, Upper Albian (n. 47). Only the infilling of the cavity constructed by the bivalve (maximal width = 10 mm) and a small shell fragment are present. The specific identification is based on the similarity with fig. 12 on pl. 99 in PICTET and CAMPICHE (1864). The type of *G. brevis* came from the Gault (= Upper Albian) of Switzerland.

Gastrochaena cf. *sinuosa* PICTET and CAMPICHE, 1864 Pl. 13, fig. 18

+ 1864 *Gastrochaena sinuosa*, Pictet et Campiche - PICTET et CAMPICHE, p. 9, pl. 99, fig. 1.

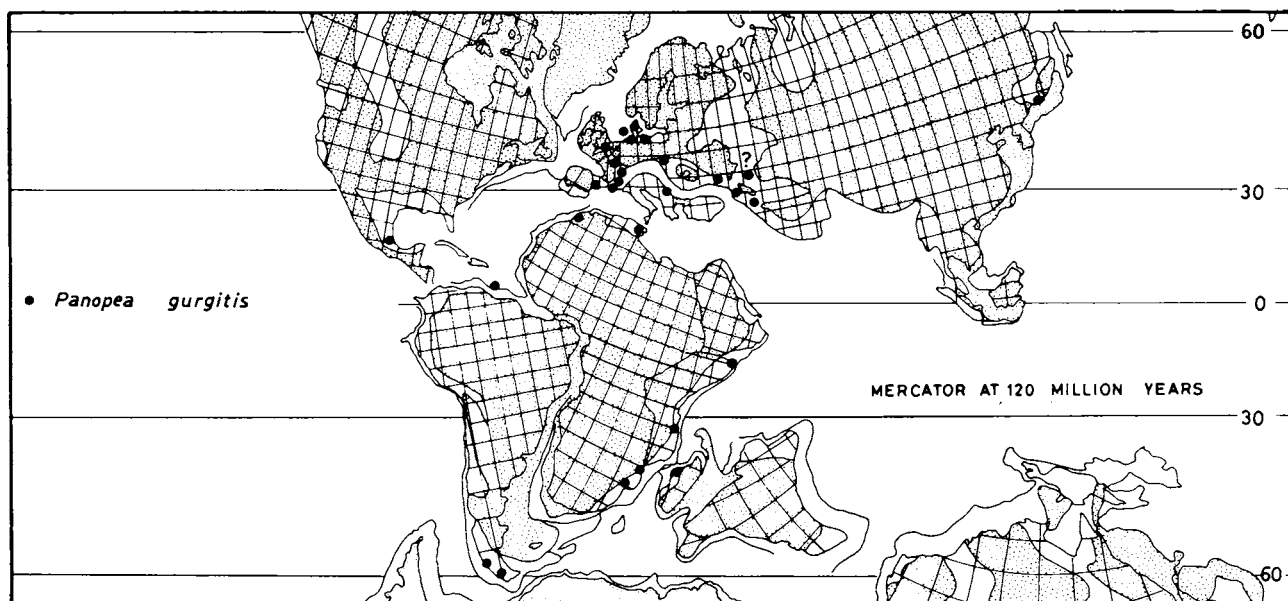


FIG. 24

One specimen from Orosei, uppermost Valanginian (n. 3). A pyriform tube (maximal width = 7 mm) similar to fig. 1e on pl. 99 in PICTET and CAMPICHE (1864) is the only material available from Sardinia. The type of *G. sinuosa* came from the Valanginian of Switzerland.

Fam. HIATELLIDAE

Panopea gurgitis (BRONGNIART in CUVIER, 1822)
Pl. 13, figs. 9-12; text-fig. 24

- v + 1822 *Lutraria? Gurgitis* A. Br. - BRONGNIART in CUVIER, p. 96 and 400, pl. 9, fig. 15.
- . 1823 *Mya plicata* - SOWERBY, p. 20, pl. 419, fig. 3.
- . 1842 *Pholadomya neocomensis*, Leym. - LEYMERIE, p. 3, pl. 3, fig. 4.
- . 1842 *Pholadomya Prevosti*, Desh. - LEYMERIE, p. 3, pl. 2, fig. 7.
- . 1842 *Pholadomya acutisulcata*, Desh. - LEYMERIE, p. 3, pl. 3, fig. 2.
- . 1843 *Lutraria sinuosa*, Math. - MATHÉRON, p. 138, pl. 13, figs. 5, 6.
- . 1843 *Lutraria Voltzii*, Math. - MATHÉRON, p. 139, pl. 12, figs. 2, 3.
- . 1843 *Lutraria rostrata*, Math. - MATHÉRON, p. 139, pl. 12, figs. 6, 7.
- . 1843 *Lutraria massiliensis*, Math. - MATHÉRON, p. 140, pl. 12, figs. 8, 9.
- . 1843 *Lutraria cuneata*, Math. - MATHÉRON, p. 140, pl. 12, figs. 4, 5.
- v . 1845 *Panopaea neocomiensis*, d'Orbigny - D'ORBIGNY, p. 329, pl. 353, figs. 3-8.
- . 1845 *Panopea Carteroni*, d'Orbigny - D'ORBIGNY, p. 332, pl. 355, figs. 1, 2.
- . 1845 *Panopaea rostrata*, d'Orbigny - D'OR-

BIGNY, p. 333, pl. 355, figs. 3, 4 (sub *P. arcuata* d'Orb.).

- v . 1845 *Panopaea recta*, d'Orbigny - D'ORBIGNY, p. 334, pl. 356, figs. 1, 2.
- v . 1845 *Panopaea Prevostii*, d'Orbigny - D'ORBIGNY, p. 334, pl. 356, figs. 3, 4.
- v . 1845 *Panopaea acutisulcata*, d'Orbigny - D'ORBIGNY, p. 336, pl. 357, figs. 1-3.
- . 1845 *Panopaea plicata*, d'Orbigny - D'ORBIGNY, p. 337, pl. 357, figs. 4, 5.
- . 1845 *Myopsis lateralis* Ag. - AGASSIZ, p. 259, pl. 32, figs. 6, 7.
- . 1845 *Myopsis attenuata* Ag. - AGASSIZ, p. 260, pl. 31, figs. 1-4.
- . 1845 *Myopsis curta* Ag. - AGASSIZ, p. 260, pl. 32, figs. 1-3.
- . 1845 *Myopsis lata* Ag. - AGASSIZ, p. 261, pl. 32, figs. 8, 9.
- . 1845 *Myopsis neocomensis* Ag. - AGASSIZ, p. 257, pl. 31, figs. 5-10.
- . 1845 *Myopsis arcuata* Ag. - AGASSIZ, p. 258, pl. 31, fig. 13.
- . 1845 *Myopsis unioïdes* Ag. - AGASSIZ, p. 258, pl. 31, figs. 11, 12.
- . 1852 *Panopaea acutisulcata* d'Orbigny - PICTET et ROUX, p. 397, pl. 28, fig. 1.
- . 1852 *Panopaea plicata* d'Orbigny - PICTET et ROUX, p. 399, pl. 28, fig. 2.
- . 1852 *Panopaea Rhodani* Pictet et Roux - PICTET et ROUX, p. 400, pl. 28, fig. 3.
- . 1855 *Panopaea neocomiensis* (Leym.) d'Orb. - PICTET et RENEVIER, p. 56, pl. 6, figs. 2, 3.
- . 1855 *Panopaea plicata*, (Sow.) Forbes - PICTET et RENEVIER, pp. 57, 175, pl. 6, figs. 4, 5.

- . 1861 *Panopaea arcuata*, Agassiz - DE LORIO, p. 52, pl. 6, figs. 1, 2.
- . 1861 *Panopaea rostrata* (Math.), d'Orbigny - DE LORIO, p. 54, pl. 6, fig. 3.
- . 1865 *Panopaea neocomiensis*, (Leym.) d'Orb. - PICTET et CAMPICHE, p. 49, pl. 100, figs. 10-12.
- . 1865 *Panopaea lateralis*, Agassiz - PICTET et CAMPICHE, p. 54, pl. 101, fig. 1.
- . 1865 *Panopaea Carteroni*, d'Orb. - PICTET et CAMPICHE, p. 56, pl. 101, fig. 2.
- . 1865 *Panopaea lata*, (Agassiz) d'Orb. - PICTET et CAMPICHE, p. 57, pl. 101, fig. 3; pl. 102, fig. 1.
- . 1865 *Panopaea attenuata*, (Agassiz) Tribolet - PICTET et CAMPICHE, p. 59, pl. 102, figs. 2, 3.
- 1865 ?*Panopaea curta*, (Agassiz) Tribolet - PICTET et CAMPICHE, p. 60, pl. 102, fig. 4.
- . 1865 *Panopaea cylindrica*, Pictet et Campiche - PICTET et CAMPICHE, p. 61, pl. 103, figs. 1, 2.
- v . 1865 *Panopea neocomiensis*, Orbigny - COQUAND, p. 278.
- v . 1865 *Panopea plicata*, Forbes - COQUAND, p. 278.
- 1869 *Panopaea neocomiensis* (Leym.) d'Orbigny - DE LORIO et GILLIERON, p. 10, pl. 1, fig. 10.
- . 1884 *Panopaea neocomiensis* d'Orb. - WEERTH, p. 37, pl. 8, fig. 7.
- . 1884 *Panopaea cylindrica* Pictet u. Camp. - WEERTH, p. 38, pl. 8, fig. 8.
- . 1884 *Panopaea Teutoburgiensis* n. sp. - WEERTH, p. 39, pl. 8, fig. 9.
- . 1897 *Panopaea neocomiensis*, (Leym.) d'Orbigny - KARAKASCH, p. 80, pl. 2, fig. 8.
- . 1898 *Pleuromya neocomiensis* Leymerie - SKEAT and MADSEN, p. 185, pl. 6, fig. 11.
- . 1900 *Panopaea neocomiensis* Leymerie - WOLLEMAN, p. 124.
- . 1900 *Panopaea Schröderi* n. sp. - WOLLEMAN, p. 126, pl. 5, fig. 7.
- ? 1900 *Panopaea Weinbaueri* n. sp. - WOLLEMAN, p. 129, pl. 6, fig. 2.
- . 1905 *Panopaea cylindrica* Pictet et Campiche - HARBORT, p. 75, pl. 5, fig. 4.
- ? 1907 *Glycimeris* (*Panopaea*) *Carteroni* d'Orb. sp. - HAUPT, p. 221.
- 1907 *Panopaea neocomiensis* (Leym.) d'Orb. - KARAKASCH, p. 202.
- . 1907 *Panopaea truncata* nov. sp. - KARAKASCH, p. 203, pl. 28, fig. 14.
- . 1909 *Panopea gurgitis* (Brongniart) - WOODS, p. 222, pl. 35, figs. 9-14; pl. 36, figs. 1-8.
- . 1912 *Panopea plicata* J. de C. Sowerby - PERVINQUIÈRE, p. 284, pl. 21, figs. 1-4.
- . 1914 *Panopaea gurgitis* Brongn. - LANGE, p. 257, pl. 22, figs. 7, 8.
- . 1922 *Panopaea plicata* Sow. - GILLET, p. 83, pl. 4, fig. 5.
- 1924 *Panopaea plicata* Sow. - GILLET, p. 142, text-fig. 89.
- . 1931 *Panopaea neocomiensis* (Leymerie) - WEAVER, p. 361, pl. 42, figs. 268 - 270.
- . 1933 *Panopaea gurgitis* (Brongn.) - DIETRICH, p. 56.
- . 1936 *Panope gurgitis* (Brongniart) - RENNIE, p. 385, pl. 50, figs. 1-10 (*cum syn.*).
- . 1947 *Panope Gurgitis* (Brongniart) - RENNIE, p. 29, pl. 4, figs. 39-45.
- . 1948 *Panopea plicata* Sowerby - CHARLES, p. 27, text-fig. 1.
- . 1948 *Panopea Prevosti* Deshayes sp. in Leymerie - CHARLES, p. 28, text-fig. 2.
- . 1948 *Panopaea rostrata* Math. - FABRE in COLLIGNON, p. 61, pl. 1, fig. 5.
- . 1948 *Panopea plicata* Sow. - TAVANI, p. 145, pl. 10, fig. 6.
- 1949 *Panopea plicata* Sow. - TAVANI, p. 9.
- 1949 *Panopea cf. gurgitis* Brongn. - KOKOSZYNSKA, p. 71.
- 1949 *Panopaea gurgitis* Brongt. - COLLIGNON, p. 24, pl. 3, fig. 7.
- 1949 *Panopaea Carteroni* d'Orb. - COLLIGNON, p. 24, pl. 3, fig. 8.
- . 1949 *Panopaea inaequalis* d'Orb. - COLLIGNON, p. 25, pl. 4, fig. 1.
- . 1949 *Panopaea triangula* nov. sp. - COLLIGNON, p. 25, pl. 4, fig. 2.
- . 1949 *Panopaea submandibula* nov. sp. - COLLIGNON, p. 26, pl. 4, fig. 3.
- . 1949 *Panopaea intermedia* nov. sp. - COLLIGNON, p. 27, pl. 4, fig. 4.
- 1949 *Panopaea gurgitis* Brongniart var. *plicata* Sowerby - MORDVILKO *et al.*, p. 142, pl. 29, fig. 1.
- 1951 *Panopea gurgitis* Brongniart - GIGOUT, p. 353.
- . 1954 *Panopea gurgitis* (Brongniart) - COX, p. 634, pl. 67, fig. 9.
- 1957 *Panopaea gurgitis* Brongn. var. *plicata* Sow. - ERISTAVI, p. 40.
- . 1960 *Panope neocomiensis* Leymerie - MUROMTSIEVA, JANIN, p. 219, pl. 27, fig. 9.
- . 1960 *Panope plicata* Sowerby - MUROMTSIEVA, JANIN, p. 219, pl. 27, figs. 10-12.
- 1961 *Panope cf. cylindrica* (Pictet et Campiche) - PROZOROVSKII, p. 147, pl. 17, fig. 3.
- . 1962 *Panopea gurgitis* (Brongniart) - BRITISH MUSEUM, p. 154, pl. 55, fig. 1.

- v . 1965 *Panopea (Myopsis) plicata* (Sowerby) - HAYAMI, p. 153, pl. 22, figs. 1 - 7 (*cum syn.*).
- . 1967 *Panopaea neocomiensis* Leymerie - BRAMER, p. 102, pl. 5, figs. 1-5, 9.
- . 1967 *Panopaea* sp. - BRAMER, p. 102, pl. 5, fig. 6.
- . 1967 *Panopaea cylindrica* Pictet und Campiche - BRAMER, p. 102, pl. 5, fig. 8.
- . 1968 *Panopaea dupiniana* d'Orbigny - KEMPER, p. 132, pl. 11, fig. 5.
- 1970 *Panope gurgitis* Brongniart - KOTETISHVILI, p. 56, pl. 3, fig. 8.
- . 1974 *Panopea neocomiensis* (Deshayes) - DIMITROVA, p. 114, pl. 53, figs. 3-5.
- . 1974 *Panopea cylindrica* Pictet et Campiche - DIMITROVA, p. 115, pl. 57, figs. 1, 2; pl. 58, fig. 5.
- . 1974 *Panopea carteroni* d'Orbigny - DIMITROVA, p. 115, pl. 56, fig. 2.
- ? 1974 *Panope gurgitis* (Brongniart) - KOCIUBYNSKI, SAVCZINSKAJA, p. 108, pl. 39, figs. 1-5.
- . 1980 *Panopea plicata* (Sowerby) - JANIN, p. 126, pl. 44, figs. 5-7.
- . 1980 *Panopea neocomiensis* Leymerie - FISCHER, p. 218, pl. 102, figs. 2, 3.
- 1982 *Panopaea neocomiensis* (Leymerie) - STÜHMER, SPAETH, SCHMID, p. 60, pl. 10, figs. 1-4.
- . 1984 *Panopea plicata* Sowerby - FRICOT *et al.*, p. 22, pl. 1, fig. 5.
- . 1984 *Panopea plicata* Sowerby var. *prevosti* Ley. - FRICOT *et al.*, p. 22, pl. 1, fig. 4.
- 1985 *Panopea plicata* Sowerby - MONGIN, p. 84.

Material: Mainly preserved as composite moulds, *P. gurgitis* is frequent in the Lower Hauterivian deposits with specimens usually in life position. About 70 specimens (n. 265, 266, 393-436, etc.) from Sa Oche (Lanaïto), 15 from Orosei (n. 382-392, etc.), 2 from Carchinarzos (M. Albo), one (n. 216) from Costas d'Ossu (Dorgali), all of Early Hauterivian age; two specimens with preserved shell, showing its extreme thinness from Sa Oche (n. 396, 722); one specimen (n. 336) from Lower Hauterivian included in Tertiary conglomerates from Monte Tintiri (Siniscola).

Dimensions (mm): Largest specimen, n. 429, from Sa Oche, Hauterivian: L = 73.

Discussion: The synonymy list given above may seem excessive. Yet, the extreme variability of *Panopea gurgitis* relative to the position and shape of the umbo, the convexity and gaping of the valves, their shape (elongated, rectangular, subquadrate

etc.) has been recognised by many authors such as PICTET and RENEVIER (1855, p. 56 and 175), WOLLEMAN (1900, p. 125), WOODS (1909, p. 222 etc.), PERVINQUIÈRE (1912, p. 285), GILLET (1922), CHARLES (1948). In a large series of specimens, such as available from E. Sardinia, most of the "taxa" of older authors can be found. Transitions between these "taxa" are always present. Therefore we consider the opinion of some previous authors, that there is one highly polymorphic species of *Panopea* occurring from the Neocomian to the Aptian (Albian?) as reasonable and this allows to introduce a further simplification in the nomenclature of Early Cretaceous panopeids. The broad variability is due: 1) to the natural variability of a biological species, 2) to plastic deformation occurring during and after fossilisation, known as "pelomorphosis" and facilitated by the very thin shell of Cretaceous *Panopea* and the marly nature of the sediment.

ROLLIER (1917, pp. 642-696) thoroughly discussed, also mathematically, the effects of the variously oriented compression on shells; on p. 655, fig. A, a very impressive figure of different possible shapes of *Pleuromya musculoides* v. SCHL. is given. A similar variability of shape due to compression can be easily imagined for Early Cretaceous *Panopea gurgitis*. At the same time REGINECK (1917), using the concept of ROLLIER, experimented with models to interpret the Jurassic *Pholadomya* species (another thin-shelled infaunal bivalve). CHARLES (1948) did similar work on the Neocomian *Panopea* "taxa" of MATHÉRON. They all reached the conclusion that extreme variability is connected with plastic deformation. By going further with compressional variability in mind we re-interpreted the various "taxa" existing in palaeontological literature on Early Cretaceous panopeids. We have come to the conclusion, in the same way as REGINECK did for Jurassic *Pholadomya*, that especially AGASSIZ's names do not represent true species, but merely refer to morphotypes. This equally applies to the names used by MATHÉRON and D'ORBIGNY. Possibly even the large specimens figured and described by D'ORBIGNY (1845) (f.i. as *P. Dupiniana*, *P. irregularis*) and by MAAS (1895) (f.i. as *P. carinata*, *P. Ewaldi*, *P. subhercynica*, *P. Zecki*) are also representatives of *P. gurgitis*. However, we have not included these taxa in the synonymy because we did not see the types, and the rich Sardinian material definitely does not include such large-sized specimens. KOCIUBINSKII and SAVCZINSKAJA (1974) described and figured as *gurgitis* a Cenomanian *Panopea* from the Donbass which bears as far as can be seen on the figures strong commarginal folds; it seems doubtful that those specimens effectively belong to *P. gurgitis*.

Distribution: Valanginian - Aptian (Albian?): England, France, Spain, Germany, Poland, Switzerland, Sardinia, Bulgaria, USSR (Crimea, Caucasus, Turkmenia), Japan, Madagascar, Mozambique, S. Africa, Tanzania (Tendaguru), Somalia, Tunisia, Morocco, Trinidad, Chile, Argentina; recorded from boulders in Denmark (Text-fig. 24).

Fam. REQUIENIIDAE

Matheronia (*Matheronia*) *rougonensis* MONGIN, 1953 ⁽¹⁾

Pl. 13, figs. 13, 14

+ 1953 *Matheronia rougonensis* Mongin - MONGIN in MONGIN et TROUVÉ, p. 231, figs. 3, 4; pl. 3, fig. 5.

. 1957 *Matheronia rougonensis* Mongin - MONGIN in MARIE et MONGIN, p. 419.

1971 *Matheronia Rougonensis* Mongin - MONGIN, p. 84.

. 1987 *Matheronia rougonensis* Mongin - CALZADA, p. 14, pl. 1, figs. 1-3.

Material: Nineteen specimens (n. 902-920) from uppermost Berriasian-lowermost Valanginian of Carchinarzos (M. Albo); three are conjoined clusters of two or more individuals. All are left valves only, albeit unbroken and in a range of sizes.

Description: The commissural rim of the left valve is subcircular, though slightly flattened anteriorly, with the widest diameter (approximately dorso-ventral) reaching 20 mm in the largest individual, or about 10 mm in most of the others. The spirogyrally coiled limb of the valve extends antero-dorsally well beyond the commissure, with a small part cutting back across the commissural plane. Up to 1 ½ whorls of coiling are shown in the larger specimens. The largest specimen thus measures 33 mm from the ventral edge of the valve margin to the dorsalmost extremity of the coiled umbo; in most of the other specimens this dimension measures around 20 mm. The flattened anterior face of the valve forms a broad sole for encrustation upon the sedimentary substratum, although xenomorphic growth was confined to the earlier-formed parts of this surface. Although this anterior flattening gives rise to a weakly salient edge around the outer flank of the coiled valve (somewhat exaggerated in some specimens by compactional crushing), there is no distinct carina.

The thin (~ 1 mm), greyish-brown outer shell layer is of fibrillar prismatic calcite. Most of this has spalled off, leaving a fine pattern of radial striations on the remaining shell surface. Where fragments of the entire outer shell layer remain, its outer surface

is poorly preserved due to the combined effects of boring and microstylolitic indentation of the surrounding sediment grains. The outer surface appears, however, to have been largely smooth, although a few individuals show some weakly developed, blunt radial ribbing, especially on the anterior flank. Otherwise, coarse lamellose commarginal growth rugae are present throughout.

The inner shell layers, now pale sparry calcite, are only patchily preserved, where originally thickest, e.g. within the umbo; the hinge and myophores were not observed in any of the specimens.

Discussion: The combination of a bi-minerallic shell, with a fibrillar prismatic calcite outer layer and (now recrystallised) originally aragonitic inner layers, with a spirogyrate shell growth form, and attachment to the substratum by the left valve, shows these specimens to be rudist bivalves, belonging either to the Diceratidae or to the Requieniidae (see SKELTON, 1978 for details). The latter family is more likely, in view of the virtually smooth outer shell surface and the coiling across the commissural plane of the extended umbo of the left valve (which implies a greatly reduced, more or less operculiform right valve). The lack of a carina allows rejection of several taxa (e.g. all *Toucasia* species, many species of *Matheronia* and, for that matter, the diceratid *Heterodicerias luci* DEFRANCE). The only likely contenders are species of *Requienia* and non-carinate species of *Matheronia*. From among these, by far the closest parallel seems to be with *M. rougonensis*, distinguishable by its relatively small size, rounded commissure (and hence absence of carina) and fairly thin shell wall (MONGIN, in MONGIN and TROUVÉ, 1953) though it is difficult to distinguish this species clearly from *M. jaccardi* (PICTET and CAMPICHE, 1869) which according to MONGIN has a thicker test. The Tithonian *M. salevensis* FAVRE, 1913 and the Valanginian *M. eurystoma* (PICTET and CAMPICHE, 1869), for example, are both somewhat larger and carinate. The lack of ribbing in the specimens considered here is somewhat problematical though, since MONGIN describes *M. rougonensis* as possessing some variable ribbing. Possibly this represents an environmentally modulated feature in this species. In the absence of information on the hinge and myophores of these specimens, the identifications given here must remain somewhat provisional, although the external similarities with MONGIN's species are striking.

It should be interesting to know whether the striking similarity with *M. rougonensis* of *Ostrea Ballaquensis* COQUAND, 1869 (p. 190, pl. 75, figs. 7-11) from Ballaigues, Vaud, "Infravalanginien", also figured and described in PICTET and CAMPICHE

⁽¹⁾ This species was studied and described jointly with Peter SKELTON.

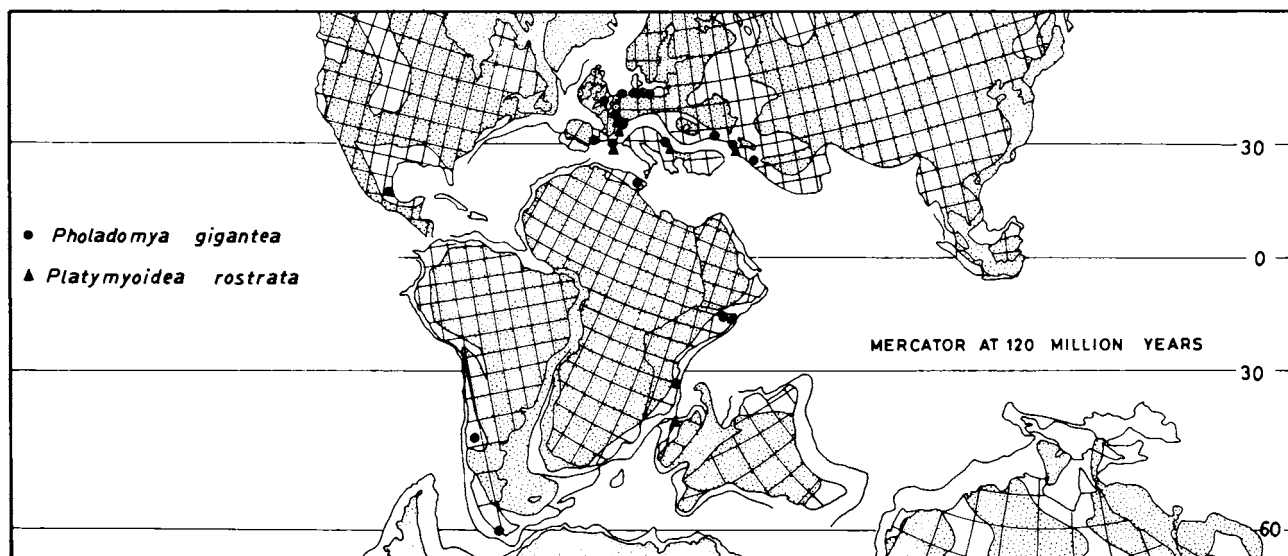


FIG. 25

(1871, p. 299, pl. 191, figs. 8 - 9) from beds of the same age at Le Locle, is merely accidental or indicates a close relationship. PICTET and CAMPICHE already expressed doubt as to the oyster relationship of this taxon.

Distribution: Berriasian and Lower Valanginian of SE France and Sardinia; Valanginian of Spain.

Subcl. ANOMALODESMATA

Fam. PHOLADOMYIDAE

Pholadomya gigantea (SOWERBY, 1836)

Pl. 13, fig. 20; text-fig. 25

- + 1836 *Pholas* ?? *giganteus* - SOWERBY in FITTON, p. 130 and 338, pl. 14, fig. 1.
- 1841 *Pholadomya elongata* Münster - GOLDFUSS, p. 270, pl. 157, fig. 3.
- ? 1842 *Pholadomya semicostata* Ag. - AGASSIZ, p. 51, pl. 2, figs. 1,2; pl. 3 (1), fig. 11.
- . 1842 *Pholadomya elongata* Müntst. - AGASSIZ, p. 57, pl. 1, figs. 16, 17.
- . 1842 *Pholadomya Scheuchzeri* Ag. - AGASSIZ, p. 58, pl. 2 (1), figs. 3-7; pl. 2 (2), fig. 7.
- . 1842 *Pholadomya Favrina* Ag. - AGASSIZ, p. 59, pl. 2 (1), figs. 1, 2.
- v . 1845 *Pholadomya elongata*, Munster - D'ORBIGNY, p. 350, pl. 362, figs. 1-3.
- . 1852 *Pholadomya Favrina* Agassiz - PICTET et ROUX, p. 403, pl. 29, fig. 1.
- ? 1852 *Pholadomya Genevensis* Pictet et Roux - PICTET et ROUX, p. 405, pl. 29, fig. 2.
- 1855 *Pholadomya elongata*, Münster - PICTET et RENEVIER, p. 61.
- 1855 *Pholadomya gigantea* (Sow.) Forbes, non d'Orb. - PICTET et RENEVIER, p. 175.
- . 1859 *Pholadomya Elongata* Münster - VILANOVA, pl. 3, fig. 16.
- 1861 *Pholadomya elongata*, Münster - DE LORIOL, p. 56.
- . 1864 *Pholadomya elongata*, Munster - PICTET et CAMPICHE, p. 74, pl. 104, figs. 1 - 4.
- . 1864 *Pholadomya semicostata*, Agassiz - PICTET et CAMPICHE, p. 77, pl. 105, figs. 1,2.
- v . 1865 *Pholadomya gigantea*, Forbes - COQUAND, p. 283.
- v . 1865-1866 *Pholadomya recurrens*, H. Coquand - COQUAND, p. 284 (1865), pl. 8, figs. 5, 6 (1866).
- . 1875 *Pholadomya gigantea*, Sow. sp. - MOESCH, p. 82, pl. 30, fig. 6; pl. 31, figs. 2-4.
- . 1884 *Pholadomya alternans* Roem. - WEERTH, p. 34, pl. 8, fig. 1; pl. 9, fig. 11.
- . 1884 *Pholadomya cf. gigantea* Sow. - WEERTH, p. 34, pl. 8, figs. 2, 3.
- . 1884 *Pholadomya Mörschi* n. sp. - WEERTH, p. 35, pl. 8, fig. 4.
- . 1895 *Pholadomya elongata* Müntst. - MAAS, p. 279, pl. 9, figs. 1, 2.
- . 1897 *Pholadomya elongata*, Munster - KARAKASCH, p. 81, pl. 2, fig. 9.
- . 1900 *Pholadomya gigantea* Sow. - BURCKHARDT, p. 23, pl. 23, figs. 5, 6.
- 1900 *Pholadomya elongata* Münster - WOLLEMAN, p. 133.
- . 1900 *Pholadomya alternans* A. Roemer - WOLLEMAN, p. 134, pl. 5, figs. 9-10; pl. 6, fig. 3.
- 1900 *Pholadomya Eberti* n. sp. - WOLLEMAN, p. 136, pl. 6, fig. 4.

- . 1900 *Pholadomya gigantea* Sow. sp. - MÜLLER, p. 557, pl. 21, fig. 1.
- . 1903 *Pholadomya gigantea* Sow. sp. - BURCKHARDT, p. 76, pl. 15, figs. 1, 2.
- . 1909 *Pholadomya gigantea* (Sowerby) - WOODS, p. 246, pl. 40, fig. 14; pl. 41, fig. 1.
- 1912 *Pholadomya elongata* Münster - PERVINQUIÈRE, p. 286.
- . 1914 *Pholadomya gigantea* Sow. - LANGE, p. 256, pl. 16, fig. 6.
- 1924 *Pholadomya gigantea* Sow. - GILLET, p. 145, text-fig. 90.
- . 1931 *Pholadomya gigantea* (Sowerby) - WEAVER, p. 313, pl. 36, figs. 209-211.
- ? 1931 *Pholadomya agrioensis* n. sp. - WEAVER, p. 316, pl. 36, figs. 205, 206.
- . 1933 *Pholadomya gigantea* (Sow.) - DIE-TRICH, p. 54.
- . 1935 *Pholadomya alternans* Roemer - COX, p. 203, pl. 23, fig. 5.
- 1948 *Pholadomya gigantea* Sow. - TAVANI, p. 148, pl. 10, fig. 12.
- 1949 *Pholadomya gigantea* Sowerby - MORDVILKO *et al.*, p. 142, pl. 29, fig. 9.
- . 1960 *Pholadomya gigantea* Sowerby - MUROMTSIEVA, JANIN, p. 221, pl. 28, figs. 5-7.
- 1961 *Pholadomya gigantea* (Sowerby) - PROZOROVSKII, p. 148, pl. 17, fig. 2.
- ? 1961 *Pholadomya semicostata* Agassiz - PROZOROVSKII, p. 149, pl. 17, fig. 1.
- 1967 *Pholadomya* cf. *gigantea* Sowerby - BRAMER, p. 106, pl. 7, figs. 1, 2, 4, 6-8.
- ? 1967 *Pholadomya alternans* A. Roemer - BRAMER, p. 106, pl. 7, figs. 3, 5.
- . 1974 *Pholadomya* (*Pholadomya*) *gigantea* (Sowerby) - DIMITROVA, p. 116, pl. 56, fig. 1; pl. 58, figs. 1, 2; pl. 59, fig. 1.
- 1974 *Pholadomya gigantea* (Sowerby) - OEKENTORP & SIEGFRIED, p. 162, pl. 18, fig. 2.
- . 1980 *Pholadomya gigantea* Sowerby - FISCHER, p. 218, pl. 102, fig. 4.

Material: Seven composite moulds from Orosei, lower Upper Valanginian (n. 285) and Lower Hauterivian (n. 844), Su Praicargiu, uppermost Valanginian (n. 132, 139, 199) and Sa Oche, Lower Hauterivian (n. 616, 808). Generally found in life position.

Dimensions (mm): n. 132: H = 31; L = 93, B = (35).

Discussion: This well known species has been figured somewhat differently (under various names) by AGASSIZ, PICTET and CAMPICHE, etc. This expresses the broad variability in shape and ornamentation (number and development of the ribs). The shape varies because *P. gigantea* is an infaunal thin-

shelled species and hence is subjected to "pelomorphosis" (see REGINECK, 1917). The ornamentation varies ontogenetically, is probably related to the nature of the substrate and depending on the preservation. In Sardinia the species shows a spectrum of different ornamentations which seem to vary with the sediment: in the chalky marls of Orosei, lower Upper Valanginian, *P. gigantea* has a more developed commarginal ornamentation; in the more marly uppermost Valanginian sediments of Su Praicargiu it has fine, but distant ribs; in the more calcareous sediments of Sa Oche it has less distant somewhat coarser ribs.

Generally young ontogenetic stages of *P. gigantea* have not been described. It is possible that among the many small pholadomyid taxa recorded from the Neocomian deposits at least some represent the young stages of *P. gigantea*; especially *P. semicostata* AGASSIZ has the necessary characteristics for this. *P. alternans* ROEMER, 1841, was not figured by the author; interpreting the original description is difficult. Therefore we prefer not to include *P. alternans* in synonymy because of insufficient information.

Distribution: ?Berriasian, Valanginian - Aptian of Temperate and Tethyan Realms: England, Spain, Sardinia, France, Germany, Switzerland, Bulgaria, USSR (Crimea, Central Asia), Tunisia, Somalia, Tanzania (Tendaguru), Argentina (Text-fig. 25).

Fam. LATERNULIDAE

Platymyoidea rostrata (AGASSIZ, 1842)

Pl. 13, fig. 21; text-fig. 25

- + 1842 *Platymya rostrata* Ag. - AGASSIZ, p. 182, pl. 10, figs. 11, 12.
- v . 1843 *Solen ? carinatus*, Math. - MATHÉRON, p. 133, pl. 11, figs. 1, 2.
- v . 1845 *Anatina Agassizii*, d'Orbigny - D'ORBIGNY, p. 369, figs. 1, 2.
- 1861 *Anatina Agassizii*, d'Orbigny - DE LORIOL, p. 57.
- . 1864 *Anatina Agassizii*, d'Orbigny - PICTET et CAMPICHE, p. 99, pl. 107, fig. 1.
- 1900 *Anatina Agassizi* d'Orbigny - WOLLEMAN, p. 138.
- 1921 *Platymya Agassizi* d'Orb. - GILLET, p. 18.
- 1948 *Platymya Agassizi* d'Orb. - TAVANI, p. 142, pl. 10, fig. 7.
- . 1949 *Anatina Agassizi* d'Orb. - COLLIGNON, p. 26, pl. 4, fig. 5.
- 1960 *Laternula agassizi* Orbigny - MUROMTSIEVA, JANIN, p. 221, pl. 29, figs. 4, 5.
- . 1969 *Platymyoidea rostrata* (Agassiz) - KEEN and COX in MOORE, p. N845, text-fig. F23(8).

. 1974 *Platymyoidea agassizi* (d'Orbigny) - DIMITROVA, p. 119, pl. 59, figs. 8, 9.

Material: One composite mould from Sa Oche (Lannaitto), Lower Hauterivian (n. 632).

Dimensions (mm): H = 40; L = (79); B = 31.

Discussion: The Sardinian specimen of this relatively rare species agrees well with the figures of previous authors, especially those of MUROMTSIEVA and JANIN (1960). The species is generally known as *Pl. agassizi*, as the result of an erroneous emendation by D'ORBIGNY.

Distribution: Valanginian - Barremian: France, Germany, Switzerland, Sardinia, Bulgaria, USSR (Caucasus), Somaliland, Madagascar (Text-fig. 25).

ACKNOWLEDGMENTS

One of us (I.D.) wishes to express his sincere gratitude to Director X. MISONNE and to the staff of the Palaeontology Department of the Institut Royal des Sciences Naturelles de Belgique for their hospitality. During the study leaves spent in Brussels in 1986 and 1987 the paper was written jointly by us.

For help during many seasons of field work sincere thanks go to F. MASSARI. P. SKELTON (Milton Keynes) kindly accepted to help in the study of the rudist species.

For permission to study collections in their care and/or discussions on aspects of this paper we are grateful to: T.N. BOGDANOVA (Leningrad), R.J. CLEEVELY (London), G. CSÁSZÁR (Budapest), D. DECROUEZ (Geneva), J.-C. FISCHER (Paris), S. FRENEIX (Paris), I. HAYAMI (Tokyo), W.J. KENNEDY (Oxford), E. KOTETISHVILI (Tbilisi), T. MATSUMOTO (Fukuoka), N.J. MORRIS (London), D.P. NAJDIN (Moscow), S.I. PASTERNAK (Lwow), H. REMY (Bonn), F. ROBĄSZYŃSKI (Mons), T.R. WALLER (Washington D.C.).

To C. ROSSI RONCHETTI (Milan) we would like to express our deep gratitude for her kind and thorough refereeing of this paper.

We are indebted to C. BROGIATO (Padua) for photography and mounting of the plates and to F. TODESCO (Padua) for the artwork.

REFERENCES

- ABBASS H.L., 1962 - *A monograph on the Egyptian Cretaceous pelecypods*. Geol. Mus. Cairo Monogr., v. 1, 224 pp., 24 pls., Cairo.
- ABDEL-GAWAD G.I., 1986 - *Maastrichtian non-cephalopod mollusks (Scaphopoda, Gastropoda and Bivalvia) of the Middle Vistula Valley, Central Poland*. Acta geol. pol., v. 36, pp. 69-224, 26 figs., 48 pls., Warszawa.
- ADKINS W.S., 1928 - *Handbook of Texas Cretaceous fossils*. Univ. Texas Bull., n. 2838, 303 pp., 37 pls., Austin.
- AGASSIZ L., 1840 - *Études critiques sur les Mollusques fossiles. Mémoire sur les Trigonies*. 58 pp., 8 pls., Neuchâtel.
- AGASSIZ L., 1842-1845 - *Études critiques sur les mollusques fossiles. Monographie des Myes*. 287 pp., 94 pls., Neuchâtel.
- AIRAGHI C., 1904 - *Inocerami del Veneto*. Boll. Soc. geol. ital., v. 23, pp. 178-198, 8 figs., 1 pl., Roma.
- ALENCÁSTER DE CSERNA G., 1957 - *Pelecípodos y Gasterópodos del Cretácico inferior de la Región de San Juan Raya-Zapotitlán, Estado de Puebla*. Paleont. mexic., v. 2, 47 pp., 2 figs., 1 tab., 7 pls., Mexico.
- AMÉDRO F., 1985 - *Géologie du Boulonnais. Le Crétacé inférieur*. Sci. et Nat., v. 3, pp. 66-74, 4 figs., 1 pl., Lille.
- ANDELCOVIĆ M., 1956 - *La constitution géologique et tectonique des montagnes de Gledići (Serbie centrale-Šumadija)*. Ann. géol. Pénins. Balcan., v. 24, pp. 31-184, 53 figs., 12 pls., Beograd.
- ANDERSON F.M., 1938 - *Lower Cretaceous deposits in California and Oregon*. Geol. Soc. Amer. Spec. Pap., n. 16, 339 pp., 83 pls., Baltimore.
- ARCHIAC A., d', 1837 - *Mémoire sur la formation crétacée du sud-ouest de la France*. Mém. Soc. géol. France, v. 2, pp. 157-193, 3 pls., Paris.
- ARCHIAC A., d', 1847 - *Rapport sur les fossiles du Tourtia*. Mém. Soc. géol. France, sér. 2, v. 2, pp. 291-351, 13 pls., Paris.
- BARRON E.J., HARRISON C.G.A., SLOAN J.L. & HAY W.W., 1981 - *Paleogeography, 180 million years ago to present*. Ecl. geol. Helv., v. 74, pp. 443-470, 1 fig., 3 tabs., 9 pls., Basle.
- BAYLE E., 1878 - *Fossiles principaux des terrains de la France*. Expl. carte géol. France, v. 4, Atlas, part 1, 79 pls., Paris.
- BENAVIDES-CÁCERES V.E., 1956 - *Cretaceous system in northern Peru*. Bull. Amer. Mus. Nat. Hist., v. 108, pp. 359-493, 58 figs., 36 pls., New York.
- BESAIRIE H., 1972 - *Géologie de Madagascar. I. Les terrains sédimentaires*. Ann. géol. Madagascar, v. 35, 463 pp., 89 pls., Tananarive.
- BIGOT A., 1903 - *Gryphoea Couloni DeFrance, 1821*. Palaeontologia Universalis, fiche 9, 2 pp., 3 figs., Paris.
- BOGDANOVA T.N., 1961 - *Pelecypods from the Valanginian of Kopet-Dag and their stratigraphic distribution*. Trudy VSEGEI, n. ser., v. 46, pp. 126-151, 2 figs., 3 pls., Gostoptechisdat, Leningrad [In Russian].
- BOGDANOVA T.N., 1966 - *Fauna from Neocomian of Kopet-Dag. Mollusca*. Trudy VSEGEI, n. ser., v. 130, pp. 70-116, 4 pls., Leningrad [In Russian].

- BOGDANOVA T.N., 1980 - *New Lower Cretaceous oysters from Mangyshlak*. New species of fossil plants and invertebrates of USSR, v. 5, pp. 26-28, 1 pl., Trudy paleont., Inst. Akad. Nauk SSSR, Nauka, Moskva [In Russian].
- BÖSE E., 1910 - *Monografía geológica y paleontológica del Cerro de Muleros cerca de ciudad Juárez, estado de Chihuahua y descripción de la fauna cretácea de la Encantada, placer de Guadalupe, estado del Chihuahua*. Bol. Inst. geol. México, v. 25, VI + 193 pp., 48 pls., México.
- BRAMER G., 1967 - *Muscheln im Gildehauser Sandstein*. Jb. Heimatver. Grafsch. Bentheim, pp. 91-107, 7 pls., Bentheim.
- BRIART A. et CORNET F.-L., 1868 - *Description minéralogique, géologique et paléontologique de la Meule de Bracquegnies*. Mém. couron. et Mém. savants étrang. Acad. r. Belg., v. 34, 92 pp., 8 pls., Bruxelles.
- BRITISH MUSEUM (NAT. HIST.), 1962 - *British Mesozoic Fossils*. 205 pp., 72 pls., London.
- BURCKHARDT C., 1900 - *Coupe géologique de la Cordillère entre Las Lajas et Curacautin*. Anal. Mus. La Plata, secc. geol. y miner., v. 3, 102 pp., 26 pls., La Plata.
- BURCKHARDT C., 1903 - *Beiträge zur Kenntnis der Jura- und Kreideformation der Cordillere. I-II*. Palaeontographica, v. 50, pp. 1-144, 16 pls., Stuttgart.
- BUSNARDO R., LE HEGARAT G. et MAGNÉ J., 1965 - *Le stratotype du Berriasien*. Mém. Bur. Rech. géol. min., v. 34, pp. 5-33, 3 figs., 9 tabs., Paris.
- BUSULINI A., DIENI I., MASSARI F., PEJOVIĆ D. et WIEDMANN J., 1984 - *Nouvelles données sur le Crétacé supérieur de la Sardaigne orientale*. Cret. Res., v. 5, pp. 243-258, 9 figs., London.
- BUVIGNIER A., 1852 - *Statistique géologique, minéralogique, minérallurgique et paléontologique du Département de la Meuse*. Atlas. 52 pp., 32 pls., Paris.
- BUZURUKOV D.D., KAKHANOVA L.P., URMANOVA S.K.H., 1968 - *New Lower Cretaceous and Eocene representatives of the Venerids in Central Asia*. New species of fossils plants and invertebrates of USSR, v. 2, pp. 266-270, 2 pls., Ministr. Geol., VSEGEI, Nedra, Moskva [In Russian].
- CALZADA S., 1907 - *Determinación específica de las Matheronia de Garraf (Barcelona)*. Trab. Mus. Geol. Semin. Barcelona, n. 122, pp. 14-15, 1 pl., Barcelona.
- CAMACHO H.H. y RICCARDI A.C., 1978 - *Megafauna*. VII Congr. Geol. Argent., Relat. geol. y Recurs. nat. Neuquen, 13 pp., 2 figs., 6 tabs., Neuquen.
- CASEY R., 1961 - *The stratigraphical palaeontology of the Lower Greensand*. Palaeontology, v. 3, pp. 487-621, 14 figs., 8 pls., London.
- CASEY R. and RAWSON P.F., 1973 - *A review of the boreal Lower Cretaceous*. Geol. Journ., Spec. Issue 5, pp. 415-430, Liverpool.
- CHABRIER G., 1968 - *Le synclinal crétacé de Gorropu (Sardaigne)*. C.R. Soc. géol. France, 1967, pp. 321-322, 1 fig., Paris.
- CHABRIER G., 1969 - *Sur la stratigraphie et la structure des monts d'Oliena (Sardaigne orientale)*. C.R. Soc. géol. France, 1969, pp. 218-220, 2 figs., Paris.
- CHARLES R., 1948 - *Note sur les fossiles hauteriviens du massif d'Allauch. II*. Mém. Soc. Étud. paléont. Paléothnogr. Provence, v. 1 (1), pp. 1-35, 3 figs., Marseille.
- CHOFFAT P. et LORIOU P., de, 1888 - *Matériaux pour l'étude stratigraphique et paléontologique de la Province d'Angola*. Mém. Soc. Phys. Hist. nat. Genève, v. 30 (2), 116 pp., 8 pls., Genève.
- CIEŚLIŃSKI S., 1960 - *Biostratigraphy and fauna of the Albien in Poland*. Inst. Geol. Prace, v. 30, pp. 5-30, 1 fig., 9 pls., Warszawa [In Polish].
- CIEŚLIŃSKI S., 1965 - *Stratigraphy and fauna of the Cenomanian in Poland (Excluding the Carpathians and Silesia)*. Inst. Geol. Biul., v. 192, pp. 5-55, 3 figs., 6 pls., Warszawa [In Polish].
- COLLETÉ C., DESTOMBES P., FRICOT C. et PIETRESON DE SAINT AUBIN J., 1982 - *Les fossiles de l'Albien de l'Aube*. Assoc. géol. auboise, 100 pp., 30 pls., Troyes.
- COLLIGNON M., 1948 - *Faune néocomienne des Couches à Criocères de Belohasifaka, Cercle de Sitampiky, Madagascar*. Ann. géol. Serv. Mines Madagascar, v. 15, pp. 53-85, 8 figs., 6 pls., Tananarive.
- COLLIGNON M., 1949 - *L'Albien d'Ambarimaninga*. Ann. géol. Serv. Mines Madagascar, v. 16, pp. 5-128, 29 figs., 22 pls., Tananarive.
- COQUAND H., 1862 - *Géologie et paléontologie de la région sud de la province de Constantine*. 320 pp., 31 pls., Marseille.
- COQUAND H., 1865-1866 - *Monographie paléontologique de l'étage Aptien de l'Espagne*. Mém. Soc. Émul. Provence, v. 3, pp. 191-411 (1865), 28 pls. (1866), Marseille.
- COQUAND H., 1869 - *Monographie du genre Ostrea, Terrain Crétacé*. 215 pp., 75 pls., Baillière, Paris.
- COQUAND H., 1880 - *Études supplémentaires sur la Paléontologie Algérienne, faisant suite à la description géologique et paléontologique de la région sud de la province de Constantine*. Bull. Acad. de Hippone, v. 15, 449 pp., Bône (Algérie).
- COTTEAU J., 1934-1935 - *Types du Prodrome de Paléontologie stratigraphique universelle de d'Orbigny. III*. Ann. Paléont., v. 23, pp. 45-80, 2 figs., 4 pls. (1934); v. 24, pp. 33-48, 3 pls. (1935), Paris.
- COX L.R., 1935 - *The Mesozoic Palaeontology of British Somaliland. IX. Cretaceous Gastropoda and Lamelibranchiata*. 7 pp., 2 pls., Cardiff.
- COX L.R., 1954 - *Lower Cretaceous Mollusca from Pointe-à-Pierre, Trinidad*. J. Paleont., v. 28, pp. 622-636, 3 pls., Tulsa.
- CROME J., 1980 - *The occurrence of the bivalve Inoceramus concentricus on Dundee Island, Joinville Island group*. Bull. br. antarct. Surv., v. 49, pp. 283-286, 2 figs., Cambridge.

- CRAVE J.A., 1982 - *Late Mesozoic bivalve biostratigraphy of the Antarctic Peninsula region*. J. geol. Soc. London, v. 139, pp. 771-778, 1 fig., 3 tabs., London.
- CRAVE J.A., 1983 - *Lower Cretaceous bivalve biostratigraphy of Antarctica*. Zitteliana, v. 10, pp. 399-406, 7 figs., 1 tab., München.
- CRAVE J.A., 1985 - *Lower Cretaceous inoceramid bivalves from the Antarctic Peninsula region*. Palaeontology, v. 28, pp. 475-525, 11 figs., 8 pls., London.
- CUVIER G. et BRONGNIART A., 1822 - *Description géologique des environs de Paris*. VIII+428 pp., 17 pls., Paris.
- DACQUÉ E., 1905 - *Beiträge zur Geologie des Somalilandes. I: Untere Kreide*. Beitr. Paläont. Geol. Österreich-Ungarns u. Orients, v. 17, pp. 7-20, 2 pls., Wien.
- DARTEVELLE E. et FRENEIX S., 1957 - *Mollusques fossiles du Crétacé de la Côte occidentale d'Afrique du Cameroun à l'Angola. III: Lamellibranches*. Ann. Mus. r. Congo belge Tervuren, Sci. géol., v. 20, 271 pp., 5 figs., 35 pls., Tervuren.
- DEFRANCE M., 1821 - *Dictionnaire des Sciences Naturelles*. 19^e. 540 pp., Strasbourg.
- DENINGER K., 1905 - *Die Jura- und Kreidebildungen in Nord- und Ostsardinien*. N. Jb. Min. Geol. Paläont., Beilbd. 20, pp. 436-444, Stuttgart.
- DENINGER K., 1907 - *Die mesozoischen Formationen auf Sardinien*. N. Jb. Min. Geol. Paläont., Beilbd. 23, pp. 435-473, 3 pls., Stuttgart.
- DESTOMBES P. et MONGIN D., 1976 - *L'Albien moyen de Courcelles (Aube)*. Bull. Inform. Géol. Bass. Paris, v. 13 (2), pp. 33-40, 2 pls., Paris.
- DHONDT A., 1971 - *Systematic revision of Entolium, Propeamussium (Amusiidae) and Syncyclonema (Pectinidae, Bivalvia, Mollusca) of the European Boreal Cretaceous*. Bull. Inst. r. Sci. nat. Belg., v. 47, n. 32, 95 pp., 4 pls., Bruxelles.
- DHONDT A.V., 1972 - *Systematic revision of the Chlamydinae (Pectinidae, Bivalvia, Mollusca) of the European Cretaceous. 1. Camptonectes*. Bull. Inst. r. Sci. nat. Belg., v. 48 (3), 60 pp., 2 pls., Bruxelles.
- DHONDT A.V., 1973a - *Systematic revision of the Chlamydinae (Pectinidae, Bivalvia, Mollusca) of the European Cretaceous. Part 3: Chlamys and Mima-chlamys*. Bull. Inst. r. Sci. nat. Belg., Sci. Terre, v. 49 (1), 134 pp., 2 figs., 9 pls., Bruxelles.
- DHONDT A.V., 1973b - *Systematic revision of the subfamily Neitheinae (Pectinidae, Bivalvia, Mollusca) of the European Cretaceous*. Mém. Inst. r. Sci. nat. Belg., n. 176, 101 pp., 5 pls., Bruxelles.
- DHONDT A.V., 1981 - *Répartition des Bivalves (sans Inocérames ou Rudistes) dans le Crétacé Moyen*. Cret. Res., v. 2, pp. 307-318, 6 tabs., London.
- DHONDT A.V., 1984 - *Some Spanish Cretaceous Bivalves*. Cuad. Geol. ibér., v. 8, pp. 847-865, 1 pl., Madrid.
- DHONDT A.V., 1987 - *Bivalves from the Hochmoos Formation (Gosau-Group, Oberösterreich, Austria)*. Ann. nathist. Mus. Wien, v. 88A, pp. 41-101, 2 figs., 6 pls., Wien.
- DIENI I. e MASSARI F., 1963 - *Il Cretaceo dei dintorni di Orosei (Sardegna)*. Accad. naz. Lincei, Rend. Cl. Sc. fis. mat. nat., ser. 8, v. 35, pp. 575-580, Roma.
- DIENI I. et MASSARI F., 1965 - *Le Crétacé inférieur d'Orosei (Sardaigne) et ses analogies avec celui du Sud-Est de la France*. Mém. Bur. Rech. géol. min., v. 34, pp. 795-799, Paris.
- DIENI I., MASSARI F., 1966 - *I foraminiferi del Valanginiano superiore di Orosei (Sardegna)*. Palaeontographia ital., v. 61, pp. 75-186, 3 figs., 10 pls., Pisa.
- DIENI I. and MASSARI F., 1985a - *Mesozoic of Eastern Sardinia*. In: CHERCHI A. (ed.), 19th European Micropaleontological Colloquium, Sardinia, October 1-10, 1985, Guidebook, pp. 66-78, 7 figs., Agip, Cagliari.
- DIENI I. & MASSARI F., 1985b - *Mesozoic of Lanaitto Valley-Oliena*. In: CHERCHI A. (ed.), 19th European Micropaleontological Colloquium, Sardinia, October 1-10, 1985, Guidebook, pp. 221-232, 3 figs., Cagliari.
- DIENI I., MIDDLEMISS F.A., OWEN E.F., 1975 - *The Lower Cretaceous Brachiopods of east-central Sardinia*. Boll. Soc. paleont. ital., v. 12, pp. 166-216, 18 figs., 7 pls., Modena.
- DIENI I., TURNŠEK D., 1980 - *Parkeria sphaerica Carter, 1877 (Hydrozoan) in the Vraconian (Lower Cretaceous) of Orosei (Sardinia)*. Boll. Soc. paleont. ital., v. 18, pp. 200-206, 3 figs., 1 pl., Modena.
- DIETRICH W.O., 1933 - *Zur Stratigraphie und Palaeontologie der Tendaguruschichten*. Palaeontographica, suppl. 7, ser. 2, part 2, pp. 1-86, 1 fig., 12 pls., Stuttgart.
- DIMITROVA N., 1969 - *Des représentants du genre Pinna dans le Hauterivien de la Bulgarie du nord-est*. Bull. geol. Inst. bulg. Acad. Sci., Paleont., v. 18, pp. 59-69, 7 pls., Sofia [In Bulgarian with French summary].
- DIMITROVA N., 1974 - *Les fossiles de Bulgarie. IV b, Crétacé inférieur (Gastropoda et Bivalvia)*. Acad. bulg. Sci., 258 pp., 59 pls., Sofia [In Bulgarian with French summary].
- DOUVILLÉ H., 1916 - *Les terrains secondaires dans le massif du Moghara, à l'Est de l'isthme de Suez, d'après les explorations de M. Couyat-Bartoux*. Mém. Acad. Sci. Inst. France, sér. 2, v. 54, 184 pp., 50 figs., 21 pls., Paris.
- EICHWALD VON E., 1866-1869 - *Lethaea Rossica ou Paléontologie de la Russie*. 2. XXXV + 1304 pp., 40 pls., Stuttgart.
- ERISTAVI M.S., 1955 - *Lower Cretaceous fauna of Georgia*. Akad. Nauk Gruz. SSR, Geol. Inst., Monogr. 6, 225 pp., 25 figs., 8 pls., Tbilisi [In Russian].

- ERISTAVI M.S., 1957 - *Comparison of Lower Cretaceous deposits of Georgia and Crimea*. Akad. Nauk Gruz. SSR, Geol. Inst., 83 pp., 18 figs., 4 pls., Moskva [In Russian].
- FERUGLIO E., 1936-1938 - *Palaeontographia patagonica*. I-II. Mem. Ist. Geol. r. Univ. Padova, v. 11, 192 pp., 20 pls. (I, 1936); v. 12, 192 pp., 10 figs., 4 tabs., 6 pls. (II, 1938), Padova.
- FISCHER J.-C., 1980 - *Fossiles de France et des régions limitrophes*. Guides Géol. rég., 444 pp., 1 fig., 195 pls., Masson ed., Paris.
- FITTON W.H., 1836 - *Observations on some of the strata between the Chalk and the Oxford Oolite in the South-east of England. Including: Appendix A, Descriptive notes respecting the shells figured in pls. 11-23, by J. De C. Sowerby*. Trans. Geol. Soc., ser. 2, v. 4, pp. 103-390, 13 pls., London.
- FORBES E., 1845 - *Catalogue of Lower Greensand fossils, in the Museum of the Geological Society, with notices of species new to Britain, contained in other collections*. Quart. J. geol. Soc. London, v. 1, pp. 237-250, 345-355, 5 pls., London.
- FORBES E., 1846 - *Report on the fossil invertebrata from Southern India, collected by Mr. Kaye and Mr. Cunliffe*. Trans. geol. Soc. London, ser. 2, v. 7, pp. 139-159, 13 pls., London.
- FÖRSTER R., 1975 - *Die geologische Entwicklung von Süd-Mozambique seit der Unterkreide und die Ammoniten-Fauna von Unterkreide und Cenoman*. Geol. Jb., Reihe B, v. 12, 324 pp., 81 figs., 17 pls., Hannover.
- FRECH F., 1902 - *Ueber Gervilleia*. Cbl. Mineral. Geol. Paläont., 1902, pp. 609-620, 10 figs., Stuttgart.
- FRENEIX S., 1959 - *Lamellibranches du Crétacé supérieur de France [Protobranches, Prionodontes, Dysodontes (Pars)]*. C.R. Congr. Soc. Savant. Paris et Département., Dijon 1959, Sect. Sci., Géol., pp. 175-248, Paris.
- FRENEIX S., 1972 - *Les Mollusques bivalves crétacés du Bassin côtier de Tarfaya (Maroc médional)*. Notes Mém. Serv. géol. Maroc, n. 228, pp. 49-255, 48 figs., 7 tabs., 18 pls., Rabat.
- FRICOT C., COLLETÉ C., DUBUS B., PIETRESON DE SAINT AUBIN J., 1984 - *Le Barrémien de l'Aube dans les travaux du canal d'amenée du barrage-réservoir Aube*. Ass. Géol. Aube Bull., 1983, pp. 16-31, 2 pls., Sainte-Savine.
- FÜRSICH F.T., 1982 - *Upper Jurassic bivalves from Milne Land, East Greenland*. Grøn. geol. Undersøg. Bull., v. 144, 126 pp., 43 figs., København.
- GALBRUN B., RASPLUS L. et LE HÉGARAT G., 1986 - *Données nouvelles sur le stratotype du Berriasien: corrélations entre magnétostratigraphie et biostratigraphie*. Bull. Soc. géol. France, sér. 8, v. 2, pp. 575-584, 6 figs., 1 tab., Paris.
- GARDNER J.S., 1884 - *British Cretaceous Nuculidae*. Quart. J. geol. Soc. London, v. 40, pp. 120-144, 3 pls., London.
- GEINITZ H.B., 1872-1875 - *Das Elbthalgebirge in Sachsen*. Palaeontographica, v. 20, 564 pp., 113 pls., Cassel.
- GIGOUT M., 1951 - *Études géologiques sur la Méséta marocaine occidentale (arrière-pays de Casablanca, Mazagan et Safi)*. Notes Mém. Serv. géol. Maroc, n. 86, 490 pp., 65 figs., 28 pls., Rabat.
- GILLET S., 1920 - *Revision du groupe de la Trigonina quadrata Ag.* Bull. Soc. géol. France, sér. 4, v. 20, pp. 153-157, 1 pl., Paris.
- GILLET S., 1921 - *Étude du Barrémien supérieur de Wassy (Haute-Marne)*. Bull. Soc. géol. France, sér. 4, v. 21 (1-3), pp. 3-47, 3 figs., 3 pls., Paris.
- GILLET S., 1922 - *Étude de la faune de lamellibranches du Calcaire à Spatangues (Hauteriviens supérieur)*. Bull. Soc. Sci. hist. nat. Yonne, v. 75, pp. 45-108, 3 figs., 5 pls., Auxerre.
- GILLET S., 1924-1925 - *Études sur les lamellibranches néocomiens*. Mém. Soc. géol. France, n. sér., vols. 1 (3-4) and 2(1), 339 pp., 95 figs., 2 pls., Paris.
- GLAZUNOVA A.E., 1972 - *Palaeontological basis of the stratigraphic subdivision of the Cretaceous deposits of Povolzhia. Upper Cretaceous*. Ministr. Geol. SSSR (VSEGEI), 203 pp., 58 pls., Nedra, Moskva [In Russian].
- GLAZUNOVA A.E., 1973 - *Palaeontological basis of the stratigraphic subdivision of the Cretaceous deposits of Povolzhia. Lower Cretaceous*. Ministr. Geol. SSR (VSEGEI), 324 pp., 56 figs., 123 pls., Nedra, Moskva [In Russian].
- GOLDFUSS A., 1833-1841 - *Petrefacta Germaniae. II*. 312 pp., 94 pls., Düsseldorf.
- GORTANI M., 1973 - *La fauna mesocretacea degli Strati di Graua*. In: *Missione geologica A.G.I.P. nella Danalia meridionale e sugli altipiani bararini (1936-1938)*. IV. Documentazione paleontologica. Parte seconda. Acc. naz. Lincei, pp. 3-99, 16 pls., Roma.
- GUÉRANGER E., 1867 - *Album paléontologique du Département de la Sarthe*. 20 pp., 25 pls., Le Mans.
- HÄGG R., 1954 - *Die Mollusken und Brachiopoden der schwedischen Kreide. 4. Die Mammillaten- und Mucronatenkreide des Ystadsgebietes*. Sveriges geol. Unders., ser. C, v. 47 (6), 72 pp., 9 pls., Stockholm.
- HARBORT E., 1905 - *Die Fauna der Schaumburg-Lippe'schen Kreidemulde*. Abh.k. preuss. geol. Landesanst., N.F., v. 45, 112 pp., 12 pls., Berlin.
- HAUPT O., 1907 - *Beiträge zur Fauna des oberen Malm und der unteren Kreide in der argentinischen Cordillere*. N. Jb. Min. Geol. Paläont., Beilbd. 23, pp. 187-236, 4 pls., Stuttgart.
- HAYAMI I., 1965a - *Lower Cretaceous marine Pelecypods of Japan. I*. Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., v. 15(2), pp. 221-349, 4 figs., 26 pls., Fukuoka.

- HAYAMI I., 1966 - *Lower Cretaceous marine Pelecypods of Japan. Ill.* Mem. Fac. Sci. Kyushu Univ., ser. D, Geol., v. 17(3), pp. 151-249, 11 figs., 5 pls., Fukuoka.
- HAYAMI I., 1975 - *A systematic survey of the Mesozoic Bivalvia from Japan.* Bull. Univ. Mus. Univ. Tokyo, v. 10, pp. 1-228, 10 pls., Tokyo.
- HAYAMI I. and NODA M., 1977 - *Notes on the morphology of Neithea (Cretaceous pectinids) with taxonomic revision of Japanese species.* Trans. Proc. palaeont. Soc. Japan, n. ser., v. 105, pp. 27-54, 5 figs., 2 pls., Tokyo.
- HAYAMI I. and OJI T., 1980 - *Early Cretaceous Bivalvia from the Choshi District, Chiba Prefecture, Japan.* Trans. Proc. palaeont. Soc. Japan, n. ser., v. 120, pp. 419-448, 3 pls., Tokyo.
- HEINZ R., 1932 - *Sur les Inocérames de Madagascar.* Ann. géol. Serv. Mines Madagascar, v. 2, pp. 55-61, Tananarive.
- IMLAY R.W., 1961 - *Characteristic Lower Cretaceous megafossils from northern Alaska.* U.S. geol. Surv. prof. Pap., n. 335, 74 pp., 1 fig., 20 pls., Washington.
- INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE, 1985 - *Third edition, adopted by the XX General Assembly of the International Union of Biological Sciences.* XX + 338 pp., Int. Trust Zool. Nom. and Univ. Calif. Press, London.
- JANIN B.T., 1980 - *Bivalve Molluscs.* In: CHERNOV V.G. et al., *Urgonian deposits of the Soviet Carpathians.* Akad. Nauk SSSR, M.O.I.P., pp. 120-132, 5 pls., Nauka, Moskva [In Russian].
- JOHNSON A.L.A., 1984 - *The palaeobiology of the bivalve families Pectinidae and Propeamussiidae in the Jurassic of Europe.* Zitteliana, v. 11, 235 pp., 213 figs., 4 tabs., 11 pls., München.
- JORDAN H. & SCHMID F., 1968 - *Zur Altersstellung und Gliederung des Flammenmergels (Oberalb) im Sackwald.* Geol. Jb., v. 85, pp. 55-66, 1 fig., Hannover.
- JUKES-BROWNE A.J., 1877 - *Supplementary notes on the fauna of the Cambridge Greensand.* Quart. J. geol. Soc. London, v. 33, pp. 485-504, 1 pl., London.
- JOUKOWSKY E. et FAVRE J., 1913 - *Monographie géologique et paléontologique du Salève (Haute-Savoie, France).* Mém. Soc. Phys. Hist. nat. Genève, v. 37(4), pp. 296-523, 56 figs., 34 pls., Genève.
- KARAKASCH N., 1897 - *Dépôts crétacés du versant septentrional de la chaîne principale du Caucase et leur faune.* 205 pp., 7 figs., 8 pls., S.-Peterburg.
- KARAKASCH N.I., 1907 - *Le Crétacé inférieur de la Crimée et sa faune.* Trav. Soc. imp. Natur. St. -Petersbourg, v. 32(5), 482 pp., 10 figs., 28 pls., S. -Peterburg.
- KAUFFMAN E.G., 1973 - *Cretaceous Bivalves.* In: HALLAM A. (ed.), *Atlas of Palaeobiogeography*, pp. 353-383, 10 figs., Elsevier, Amsterdam.
- KAUFFMAN E.G., 1977 - *Systematic, Biostratigraphic and Biogeographic Relationships between Middle Cretaceous Euramerican and North Pacific Inoceramidae.* Palaeont. Soc. Japan, Spec. pap. 21 (Mid-Cretaceous Events - Hokkaido symp., 1976), pp. 169-212, Fukuoka.
- KAUFFMAN E.G., 1978 - *South African Middle Cretaceous Inoceramidae.* Ann. Mus. Hist. nat. Nice, v. 4, pp. XVII. 1-XVII. 2, 2 pls., Nice.
- KAUFFMAN E.G., 1979 - *Cretaceous.* In: ROBINSON R.A. and TEICHERT C. (eds.), *Treatise on Invertebrate Paleontology. Part A: Introduction*, pp. A418-487, 10 figs., Geol. Soc. Amer. and Univ. Kansas, Boulder.
- KELLY S.R.A., 1984 - *Bivalvia of the Spilsby Sandstone and Sandringham Sands (Late Jurassic-Early Cretaceous) of eastern England. I.* Palaeontogr. Soc., v. 137, pp. 1-94, 59 figs., 20 pls., London.
- KEMPER E., 1968 - *Geologischer Führer durch die Grafschaft Bentheim und die angrenzenden Gebiete. 3. Aufl.* 172 pp., 36 figs., 13 tabs., 25 pls., Verlag Heimatver. Grafsch. Bentheim, Nordhorn.
- KEMPER E., ERNST G. & THIERMANN A., 1978 - *Fauna, Fazies und Gliederung der Unterkreide im Wiehengebirgsvorland, Osning und im deutsch-niederländischen Grenzgebiet.* Symp. Deutsche Kreide, Münster 1978, Exkursion A, 85 pp., 33 figs., Münster.
- KEMPER E., RAWSON R.F. and THIEULOY J.-P., 1981 - *Ammonites of Tethyan ancestry in the early Lower Cretaceous of north-west Europe.* Palaeontology, v. 24, pp. 251-311, 8 figs., 14 pls., London.
- KNECHTEL M.M., RICHARDS E.F. and RATHBUN M.V., 1947 - *Mesozoic fossils of the Peruvian Andes.* J. Hopkins Univ. Stud. Geol., v. 15, 150 pp., 24 figs., 50 pls., Baltimore.
- KOCIUBYNSKIJ S.P., SAVCZINSKAJA O.V., 1974 - *Bivalvia.* In: BLANK M. J. et al., *Atlas of the Upper Cretaceous fauna of the Donbass.* Kommunariskij Gornometallurg. Inst., pp. 67-118, 2 figs., 30 pls., Nedra, Moskva [In Russian].
- KOKOSZYŃSKA B., 1949 - *Stratigraphy of the Lower Cretaceous in the northern Flysch Carpathians.* Trav. Serv. géol. Pol., v. 6, 99 pp., 1 fig., 5 pls., Warszawa [In Polish].
- KOTETISHVILI E.V., 1965 - *Some Lower Cretaceous bivalves from western Georgia.* Trudy geol. Inst., Akad. Nauk Gruz. SSR, Geol., v. 14, pp. 37-76, 7 pls., Tbilisi [In Russian].
- KOTETISHVILI E.V., 1970 - *Stratigraphy and fauna of the Colchidites and adjoining horizons of western Georgia.* Trudy geol. Inst., Akad. Nauk Gruz. SSR, n. ser., v. 25, 118 pp., 20 pls., Metsniereba, Tbilisi [In Russian].
- KOTETISHVILI E.V., 1977 - *The Albian fauna from Georgia (ammonites and bivalves).* Trudy geol. Inst., Akad., Nauk Gruz. SSR, n. ser., v. 53, 98 pp., 40 pls., Tbilisi [In Russian].

- KOTETISHVILI E.V., 1983 - *Sur la paléozoogéographie des bassins eocrétaçés du Caucase*. Zitteliana, v. 10, pp. 375-386, 8 figs., 6 tabs., München.
- KRENKEL E., 1910 - *Die untere Kreide von Deutsch-Ostafrika*. Beitr. Paläont. Geol. Österr.-Ungarns u. Orients, v. 23, pp. 201-250, 18 figs., 4 pls., Wien.
- KRIMHOLZ G.J. (ed.), 1962 - *Handatlas of the index fossils of the Jurassic and Neocomian deposits of western Turkmenia*. Inst. zemnoj kori L.G.U., 212 pp., 1 fig., 49 pls., Leningrad [In Russian].
- LAMARCK J.B., de, 1801 - *Système des animaux sans vertèbres*. 432 pp., Paris.
- LAMARCK J.B., de, 1819 - *Histoire naturelle des animaux sans vertèbres*, VI, 1^{re} partie. 343 pp., Paris.
- LAMBERT L.R., 1944 - *Algunas Trigonias del Neuquén*. Rev. Mus. La Plata, n. ser., v. 2, Paleont. 14, pp. 357-397, 13 pls., La Plata.
- LANGE E., 1914 - *Die Brachiopoden, Lamellibranchiaten und Anneliden der Trigonia Schwarz-Schicht, nebst vergleichender Übersicht der Trigonien der gesamten Tendaguruschichten*. Arch. Biontol., v. 3(4), pp. 187-289, 8 pls., Berlin.
- LE HÉGARAT G., 1980 - *Berriasien*. In: CAVELIER C., RÔGER J. (éds.), Les étages français et leurs stratotypes. Mém. Bur. Rech. géol. min., v. 109, pp. 96-105, 6 figs., Paris.
- LEYMERIE A., 1841-1842 - *Mémoire sur le terrain Crétacé du Département de l'Aube, contenant des considérations générales sur le terrain Néocomien*. Mém. Soc. géol. France, sér. 1, v. 4, pp. 291-364, 3 pls. (1841); v. 5, pp. 1-34, 18 pls. (1842), Paris.
- LORIOLE DE, P., 1861-1863 - *Description des animaux invertébrés fossiles contenus dans l'étage Néocomien moyen du Mont Salève*. 214 pp., 22 pls., Genève.
- LORIOLE DE, P., 1868 - *Monographie des couches de l'étage Valangien des carrières d'Arzier (Vaud)*. Matér. Paléont. Suisse, sér. 4, 110 pp., 8 pls., Genève.
- LORIOLE DE, P., 1882 - *Études sur la faune des couches du Gault de Cosne (Nièvre)*. Mém. Soc. paléont. Suisse, v. 9, 118 pp., 13 pls., Genève.
- LORIOLE DE, P., et GILLIÉRON V., 1869 - *Monographie paléontologique et stratigraphique de l'étage Urgonien inférieur du Landeron (Cant. de Neuchâtel)*. Nouv. Mém. Soc. helv. Sci. nat., v. 23, pp. 1-123, 8 pls., Zürich.
- LUPPOV N.P. et al., 1983 - *The Valanginian of Mangyshlak*. Akad. Nauk SSSR, Sect. Geol., Geophys., Geochem., 119 pp., 23 figs., 24 pls., Nauka, Moskva [In Russian].
- LYCETT J., 1872-1879 - *A monograph of the British fossil Trigonidae*. Palaeontogr. Soc., 245 pp., 41 pls., London.
- MAAS G., 1895 - *Die untere Kreide des subhercynen Quadersandstein-Gebirges*. Z. dtsh. geol. Ges., v. 47, pp. 227-302, 5 pls., Berlin.
- MAHMOUD I.G., 1956 - *Études paléontologiques sur la faune crétacique du Massif du Moghara (Sinai - Egypte)*. Fac. Sci. Univ. Alexandrie, 189 pp., 81 figs., 19 pls., Alexandrie.
- MANTELL G., 1822 - *The fossils of the South Downs; or illustrations of the Geology of Sussex*. 327 pp., 42 pls., London.
- MAREK S., RACZYŃSKA A., 1976 - *The Warsaw Trough*. In: CIEŚLIŃSKI S. (ed.), Geology of Poland. I. Stratigraphy. 2. Mesozoic, pp. 549-553, Inst. Geol., Warszawa [In Polish].
- MAREK S., RACZYŃSKA A., CIEŚLIŃSKI S., SZYMAKOWSKA F., 1984 - *Lower Cretaceous. Mollusca Bivalvia*. In: MALINOWSKA L. (ed.), Geology of Poland. III. Atlas of index and characteristic fossils. 2c: Mesozoic, Cretaceous. pp. 89-93, 1 pl., Inst. Geol., Warszawa [In Polish].
- MARIE P. et MONGIN D., 1957 - *Le Valanginien du Mont-Rose de la Mandrague (massif de Marseilleveyre, Bouches-du-Rhône)*. Bull. Soc. géol. France, sér. 6, v. 7, pp. 401-424, 4 figs., 1 pl., Paris.
- MARLIÈRE R., 1939 - *La transgression albienne et céno-manienne dans le Hainaut (Études paléontologiques et stratigraphiques)*. Mém. Mus. r. Hist. nat. Belg., n. 89, 441 pp., 42 figs., 8 pls., Bruxelles.
- MASSE J.-P., 1976 - *Les calcaires urgoniens de Provence, Valanginien-Aptien inférieur. Stratigraphie, paléontologie, les paléoenvironnements et leur évolution*. Thèse doct. état, Univ. d'Aix-Marseille II, 3 vols., 445 pp., 125 figs., 60 pls., Marseille.
- MASSE J.-P., 1984 - *Rudistes*. In: COTILLON P., Crétacé inférieur, Synthèse géologique du Sud-Est de la France. Mém. Bur. Rech. géol. min., v. 125, p. 297, 1 tab., Paris.
- MASSE J.-P. et ALLEMANN J., 1982 - *Relations entre les séries carbonatées de plate-forme provençale et sarde au Crétacé inférieur*. Cret. Res., v. 3, pp. 19-33, 4 figs., London.
- MATHÉRON P., 1842-1843 - *Catalogue méthodique et descriptif des corps organisés fossiles du Département des Bouches-du-Rhône et lieux circonvoisins précédé d'un mémoire sur les terrains supérieurs au Grès Bigarré du S.E. de la France*. 269 pp., 41 pls., Marseille.
- MATTHEWS S.C., 1973 - *Notes on open nomenclature and on synonymy lists*. Palaeontology, v. 16, pp. 713-719, London.
- MENEGHINI G., 1857 - *Paléontologie de l'île de Sardaigne ou description des fossiles recueillis dans cette contrée par le général A. De La Marmora*. In: LA MARMORA de, A., Voyage en Sardaigne, v. 3, 584 pp., 8 pls., Turin.
- MICHELIN H., 1838 - *Sur une argile dépendant du Gault*. Mém. Soc. géol. France, v. 3, pp. 97-103, 1 pl., Paris.

- MIDDLEMISS F.A., 1979 - *Boreal and Tethyan Brachiopods in the European Early and Middle Cretaceous*. In: WIEDMANN J. (ed.), *Aspekte der Kreide Europas*. Int. Union geol. Sci., ser. A, v. 6, pp. 351-361, 3 figs., Stuttgart.
- MOESCH C., 1874-1875 - *Monographie der Pholadomyen*. Abh. schweiz. paläont. Ges., v. 1, pp. 1-78, pls. 1-26 (1874); v. 2, pp. 79-135, pls. 27-40 (1875), Basel.
- MONGIN D., 1971 - *Étude systématique de quelques mollusques du Valanginien inférieur de la Martre (Var)*. Trav. Lab. Géol. Fac. Sci. Grenoble, v. 47, pp. 81-89, 1 pl., Grenoble.
- MONGIN D., 1979a - *Observations paléoécologiques et biogéographiques sur les gastéropodes et lamellibranches du stratotype de l'Albien*. In: RAT P. et al., *L'Albien de l'Aube*. Comit. franç. Stratigr., Stratotyp. franç., v. 5, pp. 407-428, 2 pls., C.N.R.S., Paris.
- MONGIN D., 1979b - *Les mollusques du Crétacé inférieur de la Tunisie: Gastéropodes et Lamellibranches (3^e note)*. 7 pp., Paris.
- MONGIN D., 1980 - *Mollusques du Crétacé inférieur de Tunisie (Gastéropodes et Lamellibranches)*. Notes Serv. géol. Tunisie, v. 45, pp. 107-153, 6 figs., 5 pls., Tunis.
- MONGIN D., 1985 - *Les mollusques de l'Albien des Corbières (Sud de la France)*. Modes de vie et paléoécologie. 129 pp., 9 figs., 4 pls., Paris.
- MONGIN D. et TROUVÉ P., 1953 - *Le Valanginien inférieur calcaire du Grand Canõn du Verdon (Basses-Alpes)*. Bull. Soc. géol. France, sér. 6, v. 3, pp. 223-239, 4 figs., 1 pl., Paris.
- MOORE R.C. (ed.), 1969-1971 - *Treatise on Invertebrate Paleontology. Part N. Mollusca 6 (Bivalvia)*. 3 vols., XXXVIII + 1224 pp., Geol. Soc. Amer. and Univ. Kansas, Boulder.
- MORDVILKO T.A., BODYLEVSKI V.I., LUPPOV N.M., 1949 - *Mollusca-Cl. Lamellibranchiata*. In: BERG L.S. et al., *Atlas of index forms of the fossil fauna of the USSR*. X: Lower part of the Cretaceous system. Gosteolizdat, Moskva [In Russian].
- MORONI M.A., RICCO S., 1968 - *Nuovi studi sulla fauna cenomaniana di Brancaleone. Parte I*. Lav. Ist. Geol. Univ. Palermo, v. 6, 65 pp., 33 figs., 28 pls., Palermo.
- MORTER A.A. & WOOD C.J., 1983 - *The biostratigraphy of Upper Albion-Lower Cenomanian Aucellina in Europe*. Zitteliana, v. 10, pp. 515-529, 3 figs., 2 pls., München.
- MÜLLER G., 1900 - *Versteinerungen des Jura und der Kreide*. In: BORNHARDT W. (ed.), *Zur Oberflächen-gestaltung und Geologie Deutsch-Ostafrikas*, v. 7, pp. 514-571, 52 figs., 2 pls., Berlin.
- MUROMTSIEVA T.L., JANIN B.T., 1960 - *Bivalve Molluscs*. In: DRUSHCHITS V.V., KUDRYAVTSEV M. (eds.), *Atlas of the Lower Cretaceous fauna of the northern Caucasus and Crimea*. Glavnoe Uprav. Gazov. Promyshl. Sov. Min. SSSR, VNIIGAS, Trudy, pp. 165-231, 14 figs., 1 tab., 29 pls., Moskva [In Russian].
- NAGAO T., 1934 - *Cretaceous mollusca from the Miyako District, Honshu, Japan*. J. Fac. Sci. Hokkaido imp. Univ., ser. 4, v. 2, pp. 177-277, 17 pls., Sapporo.
- NALDINI E., 1949 - *Faune cretacee della Cirenaica*. Palaeontographia ital. v. 45, pp. 85-110, 1 fig., 1 pl., Pisa.
- NĂSTĂSEANU S., DINCĂ A., 1962 - *Contribuțiuni la cunoașterea Hauterivianului din zona Resita-Moldova Nouă (Banat)*. Dări Seamă Sedint., v. 48, pp. 141-152, 1 fig., 2 pls., București.
- NOETLING F., 1885 - *Die Fauna der baltischen Cenoman-Geschiebe*. Paläont. Abh., v. 2(4), 52 pp., 8 pls., Berlin.
- OEKENTORP K. & SIEGFRIED P., 1974 - *Lamellibranch*. In: KAEVER M., OEKENTORP K. & SIEGFRIED P., *Fossilien Westfalens*. Münster Forsch. Geol. Palaeont., v. 33/34, pp. 123-204, 1 fig., 18 pls., Münster.
- ORBIGNY D' A., 1842 - *Voyage dans l'Amérique méridionale. III. 4^e partie: Paléontologie*. 188 pp., 22 pls., Strasbourg.
- ORBIGNY D' A., 1844-1847 - *Paléontologie Française. Description des Mollusques et Rayonnés Fossiles. Terrains Crétacés. III. Lamellibranches*. 807 pp., 253 pls., Paris.
- ORBIGNY D' A., 1850 - *Prodrome de Paléontologie stratigraphique universelle des animaux mollusques et rayonnés. II*. 427 pp., Paris.
- OWEN H.G., 1984 - *The Albion stage: European province chronology and ammonite zonation*. Cret. Res., v. 5, pp. 329-344, 5 tabs., London.
- PARKINSON J., 1811 - *Organic remains of a former world. III. XVI + 479 pp., 1 fig., 22 pls., London*.
- PARKINSON J., 1819 - *Remarks on the fossils collected by Mr. Phillips near Dover and Folkestone*. Trans. geol. Soc., v. 5, pp. 52-59, 1 pl., London.
- PARONA C.F., BONARELLI G., 1897 - *Fossili albiani d'Escragnolles, del Nizzardo e della Liguria occidentale*. Palaeontographia ital., v. 2, pp. 53-112, 5 pls., Pisa.
- PASSENDORFER E., 1930 - *Étude stratigraphique et paléontologique du Crétacé de la série hautatitique dans les Tatras*. Trav. Serv. géol. Pologne, v. 2, 677 pp., 29 figs., 6 pls., Warszawa.
- PASTERNAK S.I., GAVRILISHIN V.I., GINDA V.A., KOCIUBINSKY S.P., SENKOVSKY J.M., 1968 - *Stratigraphy and fauna of the Cretaceous deposits of western Ukraine*. Akad. Nauk Ukr. SSR, Inst. Geol. Geokhim. Goriotchikh Kopalin, 272 pp., 50 figs., 50 pls., Kiev [In Ukrainian].
- PAUCĂ M. și PATRULIUS D., 1960 - *Contribuții la studiul paleontologic al depozitelor albiene de la Giurgiu (Valea Dunării)*. Stud. Cercet. Geol. Geofiz. Geogr., v. 5, pp. 85-100, 5 figs., 6 pls., București.
- PČELINCEV V. F., 1927 - *The Jurassic and Lower Cretaceous fauna of the Crimea and the Caucasus*. Mém. Com. géol., n. sér., v. 172, 320 pp., 9 pls., Leningrad [In Russian].

- PČELINCEV V.F., 1959 - *Mesozoic rudists from Crimea*. Akad. Nauk SSSR, Geol. Mus. A. P. Karpinskii, 178 pp., 67 figs., 43 pls., Moskva. [In Russian].
- PECORINI G., 1969 - *Le Clavatoracee del "Purbeckiano" di Cala d'Inferno nella Nurra di Alghero (Sardegna nord-occidentale)*. Boll. Soc. sarda Sc. nat., v. 5, 14 pp., 11 figs., Sassari.
- PELLAT E. et COSSMANN M., 1907 - *Le Barrémien supérieur à facies urgonien de Brouzet-lez-Alais (Gard)*. Mém. Soc. géol. France, Paléont., n. 37, 42 pp., 9 figs., 6 pls., Paris.
- PERGAMENT M.A., 1966 - *Zonal stratigraphy and Inocerams of the lowermost Upper Cretaceous on the Pacific coast of the USSR*. Trudy geol. Inst., Akad. Nauk SSSR, v. 146, 83 pp., 18 figs., 36 pls., Nauka, Moskva [In Russian].
- PERKINS B.F., 1960 - *Biostratigraphic studies in the Comanche (Cretaceous) series of northern Mexico and Texas*. Geol. Surv. America, Mem. 83, 138 pp., 26 figs., 34 pls., New York.
- PÉRON A., 1889-1891 - *Description des mollusques fossiles des terrains crétacés de la région sud des hauts-plateaux de la Tunisie recueillis en 1885 et 1886 par M. Philippe Thomas*. I-II. 327 pp., 17 pls., Paris.
- PERVINQUIÈRE L., 1910 - *Gryphaea latissima Lamarck, 1801*. Palaeontologia Universalis, fiche 194, 4 pp., 8 figs., Paris.
- PERVINQUIÈRE L., 1912 - *Études de paléontologie tunisienne. II. Gastropodes et Lamellibranches des terrains crétacés*. Carte géol. Tunisie, XIV + 352 pp., 17 figs., 23 pls., Paris.
- PETTER-RECEVEUR G., 1955 - *Les lamellibranches de Padern (Aude)*. Ann. Paléont., v. 41, pp. 57-74, 1 fig., 3 pls., Paris.
- PICTET F.-J., 1867 - *Études paléontologiques sur la faune à Terebratula diphyoides de Berrias (Ardèche)*. Mélanges paléont., v. 2, pp. 43-131, 1 fig., 21 pls., Genève.
- PICTET F.J. et CAMPICHE G., 1864-1871 - *Description des fossiles du terrain Crétacé des environs de Ste. Croix*. III-IV. Matér. Paléont. Suisse, 558 + 352 pp., 41 + 55 pls., Genève.
- PICTET F.J. et RENEVIER E., 1854-1858 - *Description des fossiles du terrain Aptien de la Perte-du-Rhône et des environs de Ste. Croix*. Matér. Paléont. Suisse, 184 pp., 23 pls., Genève.
- PICTET F.J. et ROUX W., 1847-1853 - *Description des mollusques fossiles qui se trouvent dans les Grès Verts des environs de Genève*. 558 pp., 51 pls., Genève.
- PROZOROVSKII V.A., KOROTKOV V.A., MAMONTOVA E.V., PORETSKAJA E.S., PROZOROVSKAJA E.L., 1961 - *Neocomian of western Turkmenia* Trudy VSEGEI, n. ser., v. 51, 234 pp., 22 figs., 20 pls., Gostoptechisdat, Leningrad [In Russian].
- PUGACZEWSKA H., 1975 - *Neocomian oysters from central Poland*. Acta palaeont. Polon., v. 20, pp. 47-72, 10 pls., Warszawa.
- REGINECK H., 1917 - *Die pelomorphe Deformation bei den jurassischen Pholadomyen und ihr Einfluss auf die bisherige Unterscheidung der Arten*. Mém. Soc. paléont. Suisse, v. 42, 67 pp., 1 fig., 4 pls., Genève.
- RENNGARTEN V., 1926 - *La faune des dépôts crétacés de la région d'Assa-Kambileska, Caucase du Nord*. Mém. Com. géol., n. ser., v. 147, pp. 1-132, 9 pls., Leningrad [In Russian with French summary].
- RENNIE J.V.L., 1936 - *Lower Cretaceous Lamellibranchia from Northern Zululand*. Ann. South Afric. Mus., v. 31, pp. 277-391, 4 figs., 19 pls., Edinburgh.
- RENNIE J.V.L., 1947 - *Os fosséis aptianos de Chalada*. Mem. Comunic. Col. Moçambique, sér. Geol. Min., bol. 9, 81 pp., 5 pls., Lourenço Marques.
- ROBASZYNSKI F. et AMÉDRO F., 1980 - *Synthèse biostratigraphique de l'Aptien au Santonien du Boulonnais à partir de sept groupes paléontologiques: Foraminifères, nannoplankton, Dinoflagellés et macrofaunes*. Rev. Micropaléont., v. 22, pp. 195-321, 28 figs., 20 pls., Paris.
- ROCH E., 1930 - *Études géologiques dans la région méridionale du Maroc occidental*. Notes Mém. Serv. Mines Carte géol. Maroc, v. 9, 542 pp., 75 figs., 27 pls., Macon.
- ROEMER F.A., 1835-1839 - *Die Versteinerungen des norddeutschen Oolithen-Gebirges*. Pp. 1-74 (1835), 75-154 (1836), 155-218 (1837), 16 pls.; Nachtrag, p. 1-47, 4 pls. (1839), Hannover.
- ROLIER L., 1911-1917 - *Fossiles nouveaux ou peu connus des terrains secondaires (mésozoïques) du Jura et des contrées environnantes*. Mém. Soc. paléont. suisse, v. 37 (pp. 1-32, 1911); v. 38 (pp. 33-148, 1912); v. 39 (pp. 149-318, 1913); v. 40 (pp. 319-444, 1914); v. 41 (pp. 445-501, 1916); v. 42 (pp. 503-696+I-XX, 1917), 40 pls., Genève.
- SAUL L.R., 1978 - *The North Pacific Cretaceous Trigoniid genus Yaadia*. Univ. Calif. Publ. geol. Sci., v. 119, 65 pp., 20 figs., 12 pls., Berkeley.
- SAVAZZI E., 1984 - *Functional morphology and autecology of Pseudoptera (Bakevelliid Bivalves, Upper Cretaceous of Portugal)*. Palaeo-geogr., -clim., -ecol., v. 46, pp. 313-324, 5 figs., Amsterdam.
- SAVELIEV A.A., 1958 - *Lower Cretaceous Trigonidae from Mangyshlak and western Turkmenia*. Trud. VNIGRI, n. 125, 517 pp., 14 figs., 58 pls., Gostoptechisdat, Leningrad [In Russian].
- SAVELIEV A.A., 1962 - *Albian Inoceramids from Mangyshlak*. Paleont. Sborn., 3, Trudy VNIGRI, v. 196, pp. 219-254, 11 pls., Leningrad [In Russian].
- SCOTT R.W., 1970 - *Paleoecology and paleontology of the Lower Cretaceous Kiowa Formation, Kansas*. Univ. Kansas paleont. Contr., v. 52, 94 pp., 21 figs., 7 pls., Lawrence.

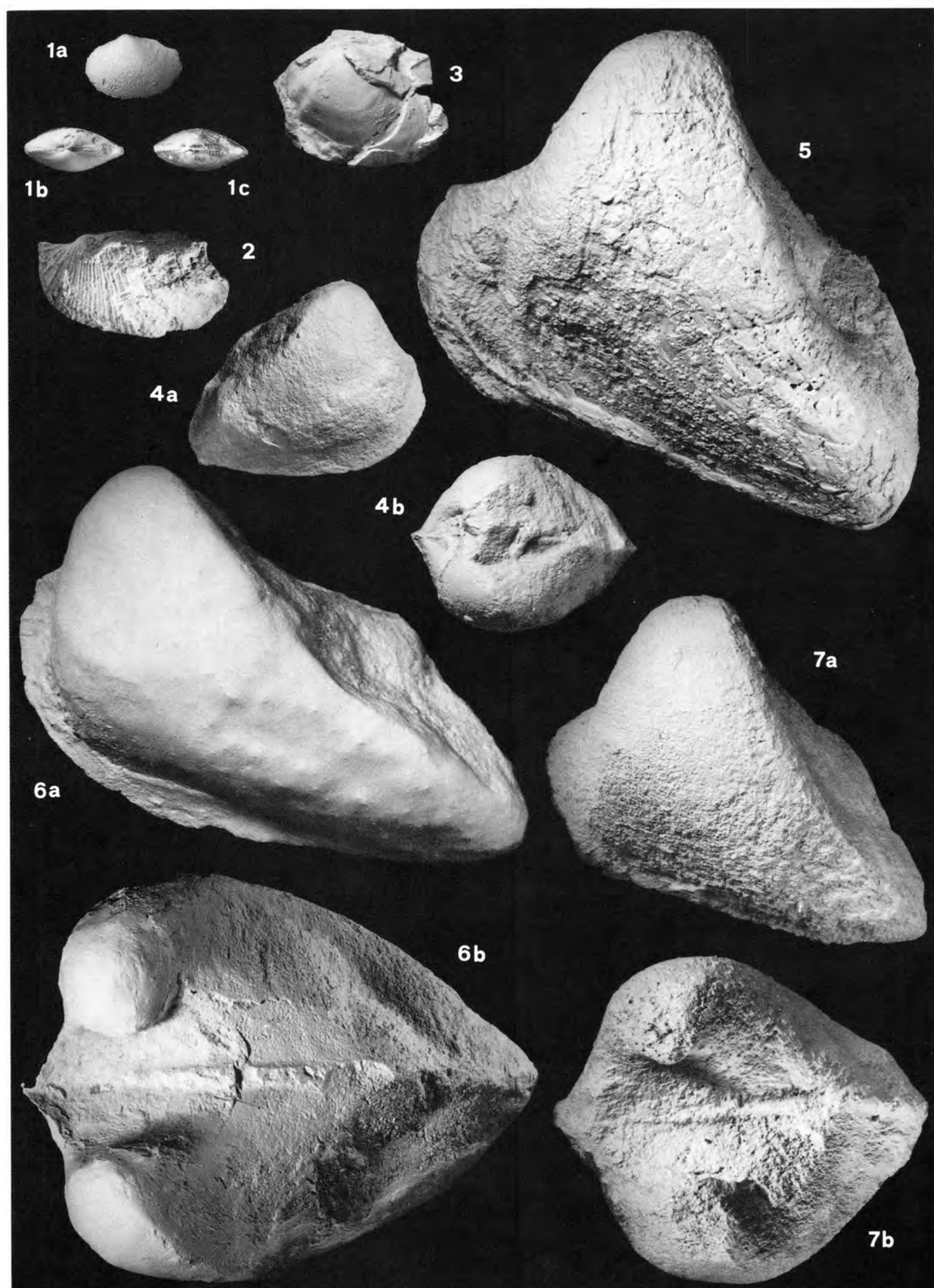
- SCOTT R.W., 1978 - *Paleobiology of Comanchean (Cretaceous) cardiids (Cardiinae), North America*. J. Paleont., v. 52, pp. 881-903, 7 figs., 2 pls., Lawrence.
- SCOTT R.W., 1986 - *Paleobiology of Early Cretaceous protocardiids, Caribbean Province*. J. Paleont., v. 60, pp. 1186-1211, 13 figs., Lawrence.
- SEGUENZA G., 1882 - *Studi geologici e paleontologici sul Cretaceo medio dell'Italia meridionale*. R. Acc. Lincei, Mem. Cl. Sc. fis. mat. nat., v. 12, 152 pp., 21 pls., Roma.
- SEITZ O., 1956 - *Über Ontogenie, Variabilität und Biostratigraphie einiger Inoceramen*. Paläont. Z., v. 30, Sonderh., pp. 3-6, Stuttgart.
- SKEAT E.G. and MADSEN V., 1898 - *On Jurassic, Neocomian and Gault boulders found in Denmark*. Danm. geol. Unders., ser. 2, v. 8, VI+212 pp., 9 pls., Kjøbenhavn.
- SKELTON P.W., 1978 - *The evolution of functional design in rudists (Hippuritacea) and its taxonomic implications*. Phil. Trans. r. Soc. London, B., v. 284, pp. 305-318, 17 figs., London.
- SOBETSKI V.A., 1961 - *Upper Cretaceous Pectinacea of the Middle Pridnestrovia, their systematic composition and ecological features*. Akad. Nauk Moldavian SSR, Inst. Geol. Polezn. Iskopaem., 96 pp., 23 figs., 6 pls., Kishinev [In Russian].
- SOBETSKI V.A., 1977 - *Bivalve molluscs of the Upper Cretaceous platform seas of SW USSR*. Trudy paleont. Inst., Akad. Nauk SSSR, v. 159, 256 pp., 3 figs., 18 pls., Moskva [In Russian].
- SOBETSKI V.A., 1982 - *Bivalvia*. In: SOBETSKI V.A. et al., Atlas of the marine Upper Cretaceous invertebrates of the Pre-caspian depression. Trudy paleont. Inst., Akad. Nauk SSSR, v. 187, 253 pp., 40 figs., 32 pls., Nauka, Moskva [In Russian].
- SORNAY J., 1965 - *Les Inocérames du Crétacé inférieur en France*. Mém. Bur. Rech. géol. min., v. 34, pp. 393-397, Paris.
- SORNAY J., 1981 - *Travail de synthèse du Groupe de Travail sur les "Événements biologiques" (Mid-Cretaceous Events)*. Inocérames. Cret. Res., v. 2, pp. 417-425, 6 tabs., London.
- SOWERBY J. and SOWERBY J. de C., 1812-1846 - *The 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*. 7 vols., pls. 1-383 by J. Sowerby (1812-1822); pls. 384-648 by J. de C. Sowerby (1823-1846), London.
- STOLICZKA F., 1871 - *Cretaceous fauna of Southern India. The Pelecypoda*. Mem. geol. Survey India, Palaeont. Ind., ser. 6, v. 3, 538 pp., 50 pls., Calcutta.
- STÜHMER H.H., SPAETH CHR., SCHMID F., 1982 - *Fossilien Helgolands. 1. Trias und Unter-Kreide*. 184 pp., 28 figs., 70 pls., Niederelbe-Verlag, Otterndorf.
- TASHIRO M. and MATSUDA T., 1986 - *Lower Cretaceous bivalves from the Sakawa area, Shikoku*. Trans. Proc. palaeont. Soc. Japan, n. ser., v. 142, pp. 366-392, 4 figs., 7 pls., Tokyo.
- TAVANI G., 1948 - *La fauna malacologica cretacea della Somalia e dell'Ogaden*. Palaeontographia ital., v. 43, pp. 83-153, 11 pls., Pisa.
- TAVANI G., 1949 - *Rudiste ed altri molluschi cretacei della Magiurtinia (Africa orientale)*. Palaeontographia ital., v. 46, pp. 1-40, 2 figs., 4 pls., Pisa.
- THIEULOY J.-P., 1977 - *Les ammonites boréales des formations néocomiennes du Sud-Est français (province subméditerranéenne)*. Geobios, v. 10, pp. 395-461, 3 figs., 9 pls., Lyon.
- TOULA F., 1889 - *Geologische Untersuchungen im central Balkan*. Denkschr. kais. Akad. Wiss. Wien, math. -naturw. Cl., Abh. Nicht-Mitglied d. Akad., v. 55, 108 pp., 49 figs., 9 pls., Wien.
- TOULA F., 1890 - *Geologische Untersuchungen im östlichen Balkan und in den angrenzenden Gebieten*. Denkschr. kais. Akad. Wiss. Wien, v. 57, pp. 323-400, 41 figs., 7 pls., Wien.
- TREVISAN L., 1937 - *La fauna e i giacimenti del Cenomaniano di facies africana della Sicilia occidentale*. Mem. Ist. Geol. r. Univ. Padova, v. 12, 134 pp., 10 figs., 7 pls., Padova.
- TRÖGER K.-A., 1956 - *Über die Kreideablagerungen des Plauenschen Grundes*. Jb. staatl. Mus. Min. Geol. Dresden, v. 2, pp. 22-124, 12 figs., 10 pls., Dresden.
- TRÖGER K.-A., 1981 - *Zu Problemen der Biostratigraphie der Inoceramen und der Untergliederung des Cenomans und Turons in Mittel- und Osteuropa*. Newsl. Stratigr., v. 9, pp. 139-156, 8 figs., Berlin.
- TURCULET I., 1971 - *Cercetări geologice asupra depozitelor jurasice si eocretacice din cuveta Rarău-Breaza*. Inst. Geol. Bucuresti, Stud. tehn. econ., ser. J, v. 10, 141 pp., 14 figs., 43 pls., Bucuresti.
- TZANKOV V., PAMOUKTCHIEV A., TCHECHMEDJIEVA V., MO-TEKOVA N., 1981 - *Les fossiles de Bulgarie. V. Crétacé supérieur. Grands Foraminifères, Anthozoaires, Gastéropodes, Bivalvia*. Acad. bulg. Sci., 233 pp., 14 figs., 98 pls., Sofia [In Bulgarian with French summary].
- VAN DE POEL L., 1956 - *Faune malacologique du Hervien. Deuxième note*. Bull. Inst. r. Sci. nat. Belg., v. 32, n. 19, 22 pp., 1 pl., Bruxelles.
- VAN DIGGELEN J., 1983 - *De Boulonnais en zijn fossielen*. Gea (Sticht. geol. Aktiv.), v. 16, pp. 20-36, 83 figs., Amsterdam.
- VANKOV L., 1892 - *Šipčanski Balkan i okolica u geoložkom i petrografskom pogledu*. Rad jugoslav. Akad. Znan. i Umjetn., v. 111, Raz. Matem. - Prirod., 15, pp. 51-103, 5 figs., 9 pls., Zagreb.

- VERESTCHAGIN V.N., KINASOV V.P., PARAKETSOV K.V., TEREKHOVA G.P., 1965 - *Handatlas of Cretaceous fauna of NE USSR*. Severo-Vostotchnoe Geol. Up-ravl. Gos. Prouzv. Geol. Komit., 66 pp., 8 figs., 74 pls., Magadan [In Russian].
- VERNEUIL P., DE et COLLOMB E., 1853 - *Coup d'oeil sur la constitution géologique de quelques provinces de l'Espagne*. Bull. Soc. géol. France, sér. 2, v. 2, pp. 61-167, 5 pls., Paris.
- VILANOVA Y PIERA J., 1859 - *Memoria geognóstico-agricólo sobre la Provincia de Castellon*. Mem. r. Acad. Cienc. Madrid, v. 4, pp. 575-803, 6 pls., Madrid.
- VOKES H.E., 1946 - *Contribution to the paleontology of the Lebanon Mts., Republic of Lebanon. 3: The Pelecypod fauna of the "Olive locality" (Aptian) at Abeih*. Bull. amer. Mus. nat. Hist., v. 78, pp. 139-215, 10 pls., New York.
- VOKES H.E., 1980 - *Genera of the Bivalvia: a systematic and bibliographic catalogue (revised and updated)*. Palaeont. Res. Inst., 307 pp., Ithaca, U.S.A.
- WALLER T.R., 1978 - *Morphology, morphoclines and a new classification of the Pteriomorpha (Mollusca: Bivalvia)*. Phil. Trans. r. Soc. London, v. 284, pp. 345-365, 2 figs., London.
- WEAVER C.E., 1931 - *Paleontology of the Jurassic and Cretaceous of West Central Argentina*. Mem. Univ. Washington, v. 1, 596 pp., 62 pls., Seattle.
- WEERTH O., 1884 - *Die Fauna des Neocomsandstein im Teutoburger Walde*. Palaeont. Abh., v. 2, pp. 3-77, 11 pls., Berlin.
- WEIDICH K.F., SCHWERD K. & IMMEL H., 1983 - *Das Helvetikum-Profil im Steinbruch "An der Schanz" bei Burgberg/Allgäu. Lithologie, Stratigraphie und Makrofauna*. Zitteliana, v. 10, pp. 555-573, 3 figs., 1 tab., 2 pls., München.
- WIEDMANN J., 1979 - *Itinéraire géologique à travers le Crétacé moyen des chaînes vascogotiques et celtibériques (Espagne du Nord)*. Cuad. Geol. ibér., v. 5, pp. 127-214, 24 figs., 12 pls., Madrid.
- WIEDMANN J. und DIENI I., 1968 - *Die Kreide Sardiniens und ihre Cephalopoden*. Palaeontographia ital., v. 64, pp. 1-171, 101 figs., 3 tabs., 18 pls., Pisa.
- WIEDMANN J. and KAUFFMAN E.G., 1978 - *Mid-Cretaceous biostratigraphy of northern Spain*. Ann. Mus. Hist. nat. Nice, v. 4, pp. III 1-22, 2 figs., 12 pls., Nice.
- WILTSHIRE T., 1869 - *On the Red Chalk of Hunstanton*. Quart. J. geol. Soc. London, v. 25, pp. 185-191, London.
- WOLLEMAN A., 1896 - *Kurze Uebersicht über die Bivalven und Gastropoden des Hilsconglomerats bei Braunschweig*. Z. dtsh. geol. Ges., v. 48, pp. 830-853, 1 pl., Berlin.
- WOLLEMAN A., 1900 - *Die Bivalven und Gastropoden des deutschen und holländischen Neoms. Abh. preuss. geol. Landesanst., v. 31, 180 pp., 8 pls., Berlin*.
- WOLLEMAN A., 1909 - *Die Bivalven und Gastropoden des norddeutschen Gaults (Aptiens und Albiens)*. Jb. k. preuss. geol. Landesanst., v. 27, pp. 259-300, 5 pls., Berlin.
- WOODS H., 1899-1913 - *A monograph of the Cretaceous Lamellibranchiata of England*. Palaeontogr. Soc., XLIII+705 pp., 104 pls., London.
- WOODS H., 1912 - *The evolution of Inoceramus in the Cretaceous Period*. Quart. J. geol. Soc. London, v. 68, pp. 1-20, 94 figs., London.
- WOODWARD S., 1833 - *An outline of the geology of Norfolk*. 60 pp., 8 pls., Norwich.
- YABE H., NAGAO T. and SHIMIZU S., 1926 - *Cretaceous mollusca from the Sanchû-Graben in the Kwantô mountainland, Japan*. Sci. Rep. Tôhoku imp. Univ., Sendai, ser. 2 (Geol.), v. 9, pp. 33-76, 2 figs., 4 pls., Sendai.
- YOKOYAMA M., 1890 - *Versteinerungen aus der japanischen Kreide*. Palaeontographica, v. 36, pp. 159-200, 8 pls., Stuttgart.
- ZAKHARIEVA-KOVATCHEVA K., 1957 - *Études paléofaunistiques sur la stratigraphie de l'Albien en Bulgarie*. Ann. Univ. Sofia, Fac. Biol., Géol., Géogr., v. 2, Géol., pp. 209-286, 37 pls., Sofia [In Bulgarian with French summary].
- ZAKHAROV V.A., 1970 - *Late Jurassic and Early Cretaceous bivalves of the Siberia North and their ecology. 2. Fam. Astartidae*. Trans. Akad. Nauk SSSR, Siber. Branch, Inst. Geol. Geophys., v. 113, 143 pp., 39 figs., 15 pls., Nauka, Moskva [In Russian].
- ZAKHAROV V.A., 1966 - *Late Jurassic and Early Cretaceous bivalves from northern Siberia and their palaeoecology (Ord. Anisomyaria)*. Akad. Nauk SSSR, Siber. Branch, Inst. Geol. Geophys., 189 pp., 22 figs., 46 pls., Nauka, Moskva [In Russian].
- ZITTEL VON K.A., 1865-1866 - *Die Bivalven der Gosaugebilde in den nordöstlichen Alpen*. Denkschr. k. Akad. Wiss. Wien, v. 24, pp. 105-178 (1865); v. 25, pp. 77-198 (1866), 27 pls., Wien.
- ZONOVA T.D., 1978 - *First finding of Inoceramids of the group Inoceramus sulcatus in the Far East*. In: POJARKOVA Z.N. (ed.), Biostratigraphy of the South of the Far East (Phanerozoic). Akad. Nauk SSSR, Dalnevostochn. Nauch. Centre, Geol. Inst., pp. 78-81, 1 pl., Vladivostok [In Russian].

EXPLANATION OF PLATE I

- FIGS. 1a-1c - *Nuculana (Jupiteria?) phaseolina* (MICHELIN).
1a - Right valve.
1b - Dorsal view of both valves.
1c - Dorsal view of both valves, not whitened; the hinge teeth are visible in transparence.
Upper Albian (probably Vraconian), Orosei; n. 205; x 4.
- FIG. 2 - *Grammatodon (Nanonavis) securis* (LEYMERIE).
Left valve.
Uppermost Valanginian, Orosei; n. 4; x 1.
- FIG. 3 - *Cucullaea (Idonearca) glabra* PARKINSON.
Left valve.
Vraconian, Orosei; n. 67; x 1.
- FIGS. 4a,4b - *Cucullaea (Noramya) "gresslyi"* (DE LORIO) [= *C. (N.) gabrielis* LEYMERIE juv.?].
4a - Right valve, internal mould.
4b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto), n. 255; x 1.
- FIGS. 5-7b - *Cucullaea (Noramya) gabrielis* LEYMERIE.
5 - Left valve, internal mould.
6a - Left valve, internal mould.
6b - Dorsal view of both valves, internal mould.
7a - Left valve, internal mould.
7b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 604, 599, 602; x 1.

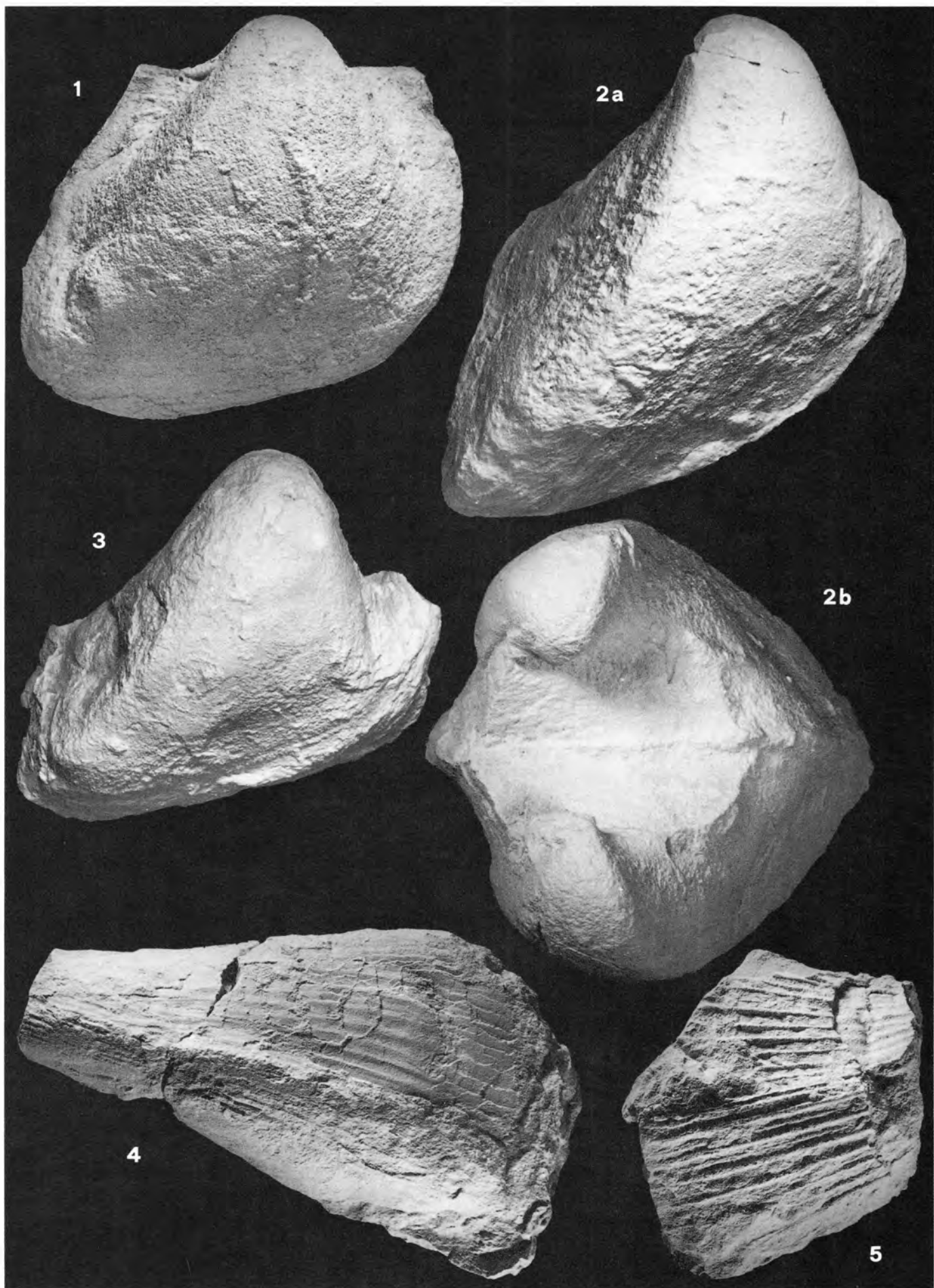
Unless otherwise stated, all the specimens have been whitened.



EXPLANATION OF PLATE II

- FIGS. 1-3 - *Cucullaea (Noramya) gabrielis* (LEYMERIE).
1 - Right valve, composite mould.
2a - Right valve, internal mould.
2b - Dorsal view of both valves, internal mould.
3 - Right valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 593, 227, 590; x 1.
- FIGS. 4,5 - *Pinna (Pinna) robinaldina* D'ORBIGNY.
4 - Left valve, internal mould.
5 - Right valve.
Lower Hauterivian, Sa Oche (Lanaitto); n. 246, 183; x 1.

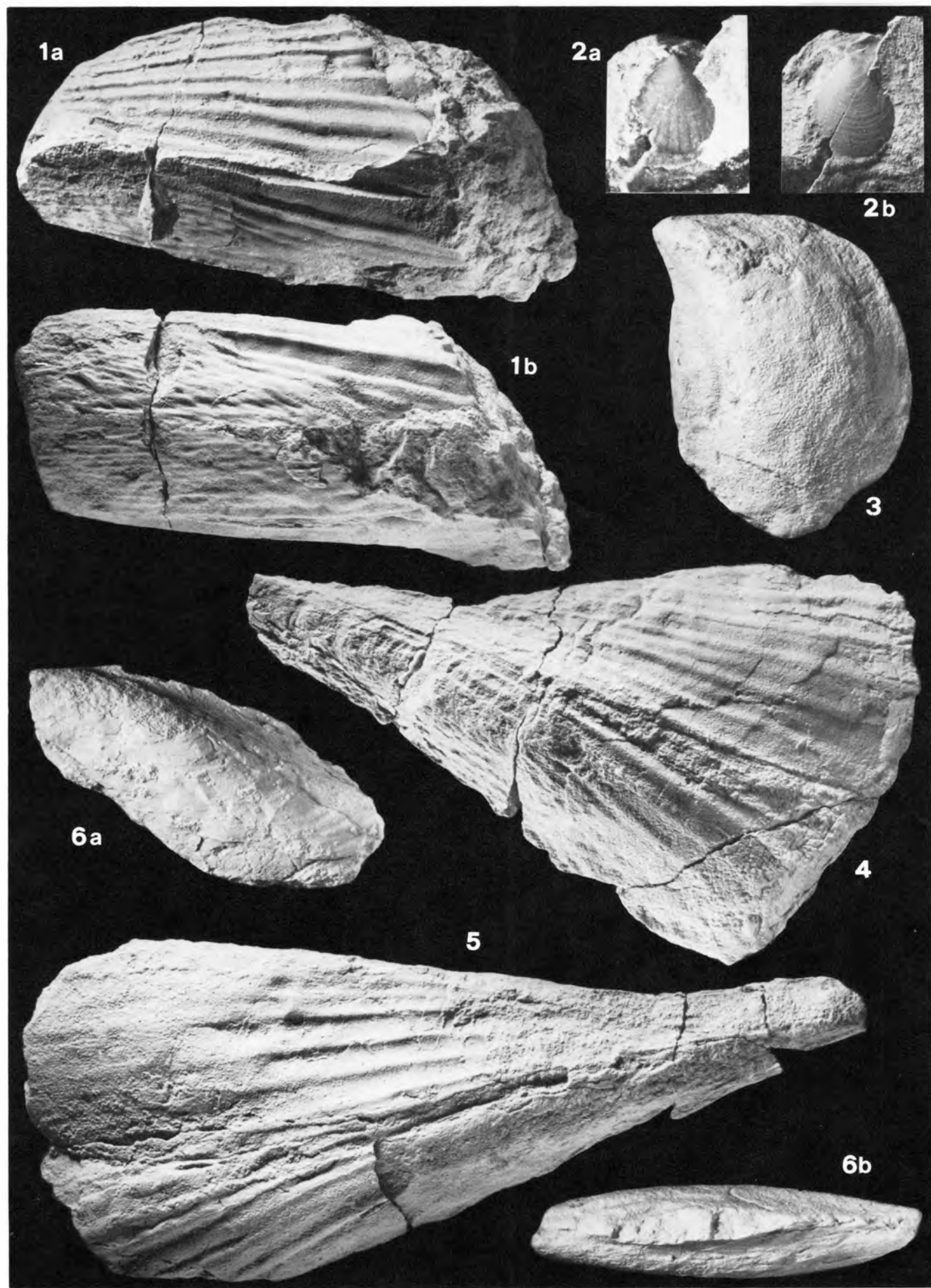
All the specimens have been whitened.



EXPLANATION OF PLATE III

- FIGS. 1a, 1b - *Pinna (Pinna) robinaldina* D'ORBIGNY.
1a - Left valve, internal mould.
1b - Ventral view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 624; x 0.75.
- FIGS. 2a,2b - *Propeamusium ninae* (KARAKASCH).
Right valve; in fig. 2a, not whitened, the internal ribs are visible by transparence.
Upper Albian, Orosei; n. 856; x 4.
- FIG. 3 - *Isognomon (Isognomon) ricordeanus* (D'ORBIGNY).
Left valve, internal mould.
Lower Hauterivian, Su Praicargiu (Lanaitto); n. 195; x 1.
- FIGS. 4,5 - *Pinna (Pinna) sulcifera* DESHAYES in LEYMERIE.
4 - Left valve, internal mould.
5 - Right valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 180, 619; x 0.75.
- FIGS. 6a,6b - *Gervillella anceps* (DESHAYES in LEYMERIE).
6a - Left valve, internal mould with partial shell preservation.
6b - Dorsal view of both valves, internal mould with partial shell preservation.
Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 221; x 1.

Unless otherwise stated, all the specimens have been whitened.



EXPLANATION OF PLATE IV

FIGS. 1a, 1b - *Pinna* (*Stegoconcha*?) *hombresi* PICTET and CAMPICHE.

1a - Right valve, internal mould.

1b - Dorsal view of both valves, internal mould.

Lower Hauterivian, Sa Oche (Lanaitto); n. 252; x 1.

FIGS. 2-4 - *Gervillaria alaeformis* (SOWERBY).

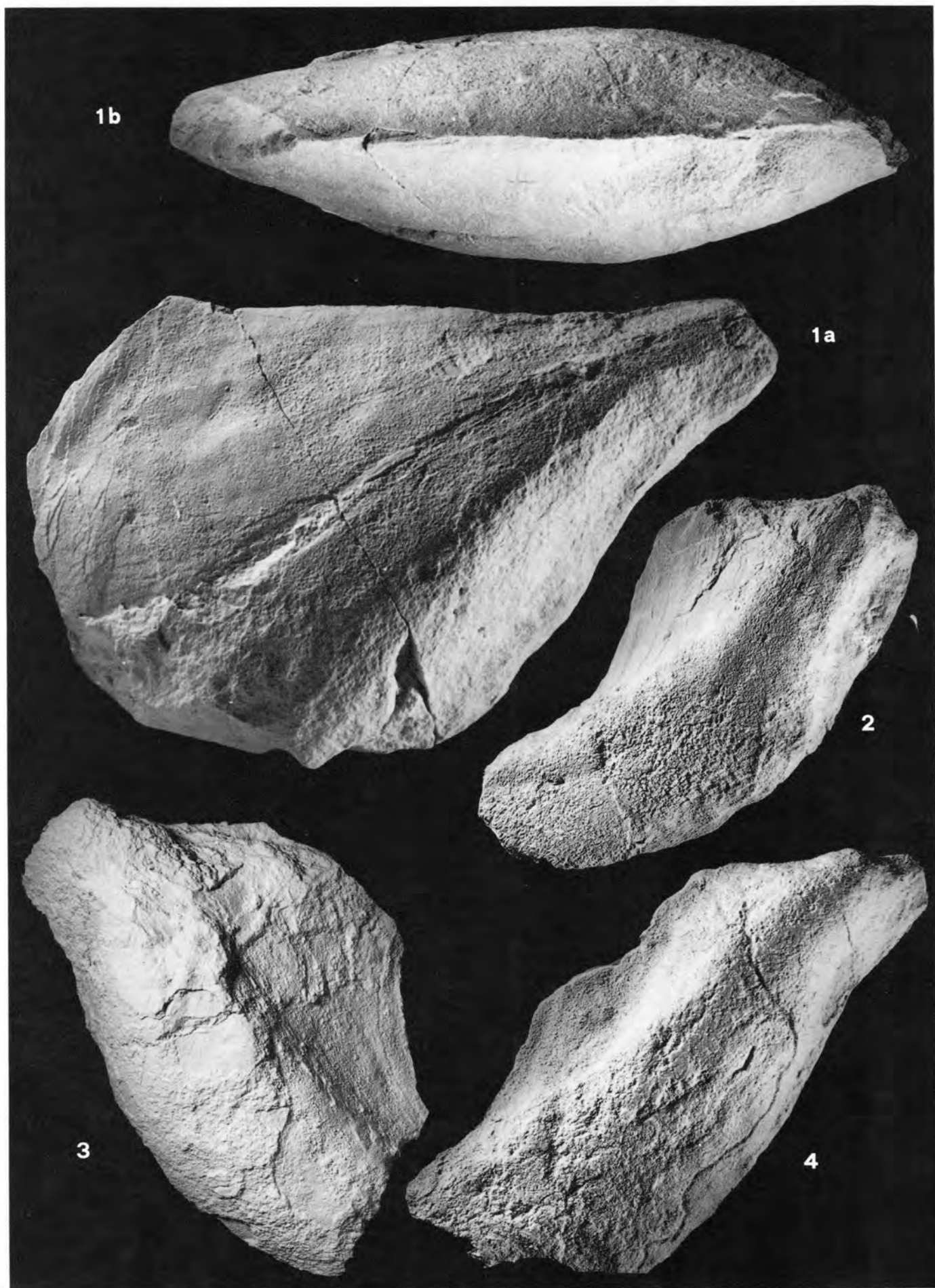
2 - Right valve, internal mould.

3 - Left valve, internal mould with shell fragments.

4 - Right valve, internal mould.

Lower Hauterivian, Sa Oche (Lanaitto); n 444, 456, 241; x 1.

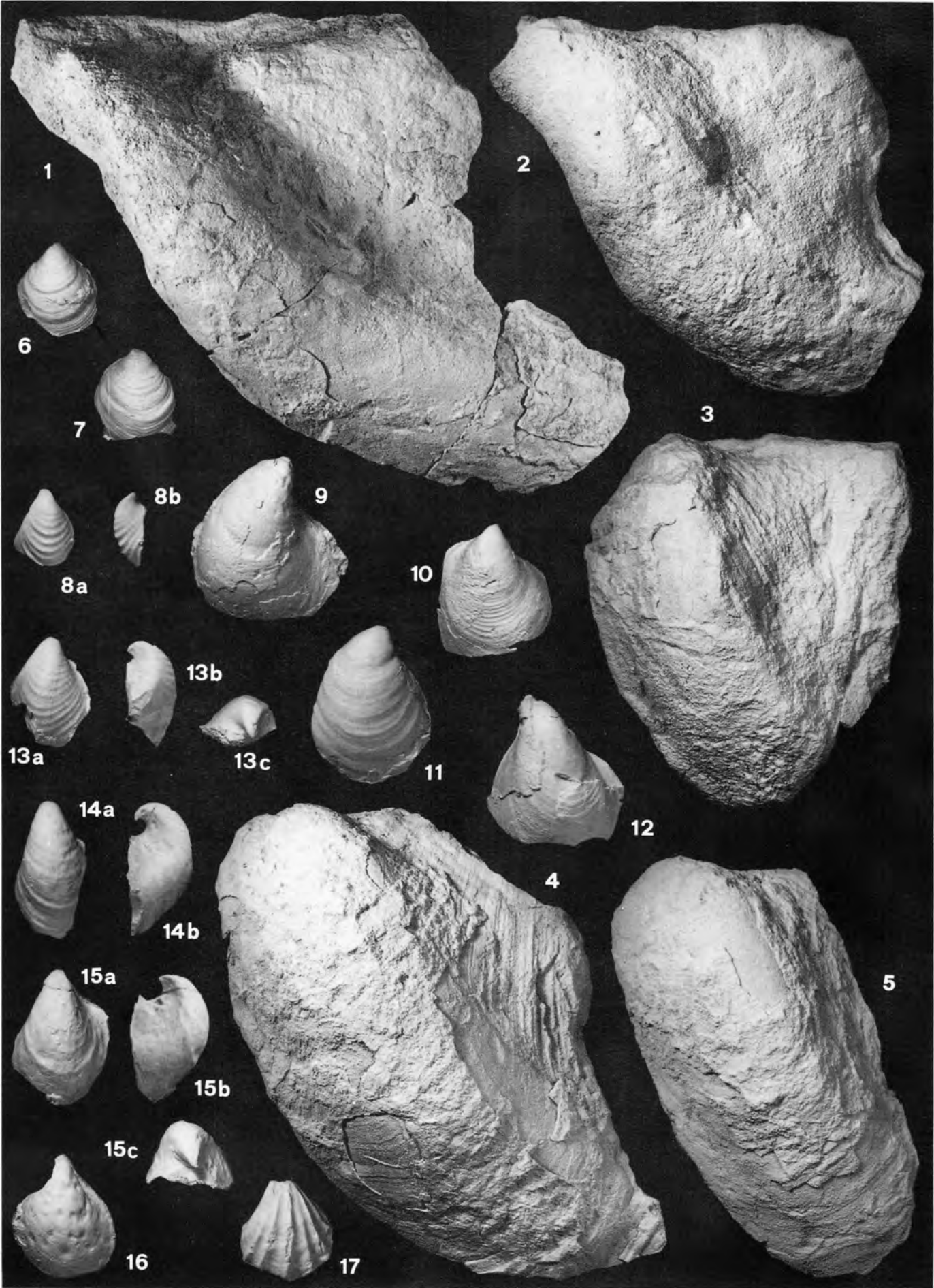
All the specimens have been whitened.



EXPLANATION OF PLATE V

- FIGS. 1,2 - *Gervillaria alaeformis* (SOWERBY).
1 - Left valve, internal mould.
2 - Left valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 445, 455; x 1.
- FIGS. 3-5 - *Gervillaria sowerbyana* (MATHÉRON).
3 - Left valve, internal mould.
4 - Left valve, internal mould with partial shell preservation.
5 - Left valve, internal mould with partial shell preservation.
Lower Hauterivian, Sa Oche (Lanaitto); n. 452, 441, 451; x 1.
- FIGS. 6-13c - *Birostrina concentrica* (PARKINSON).
6,7 - Right valves, internal moulds.
8 - Left valve, internal mould.
9 - Left valve, internal mould with partial shell preservation.
10,11 - Right valves, internal moulds.
12 - Left valve, internal mould with partial shell preservation.
13 - Left valve, internal mould.
Upper Albian, Orosei; n. 122, 43, 29, 54, 84, 42, 51, 37; x 1.
- FIGS. 14a-16 - *Birostrina subsulcata* (WILTSHIRE).
Left valves, internal moulds.
Upper Albian, Orosei; n. 106, 36, 771; x 1.
- FIG. 17 - *Birostrina sulcata* (PARKINSON).
Left valve, internal mould.
Vraconian, Orosei; n. 126; x 1.

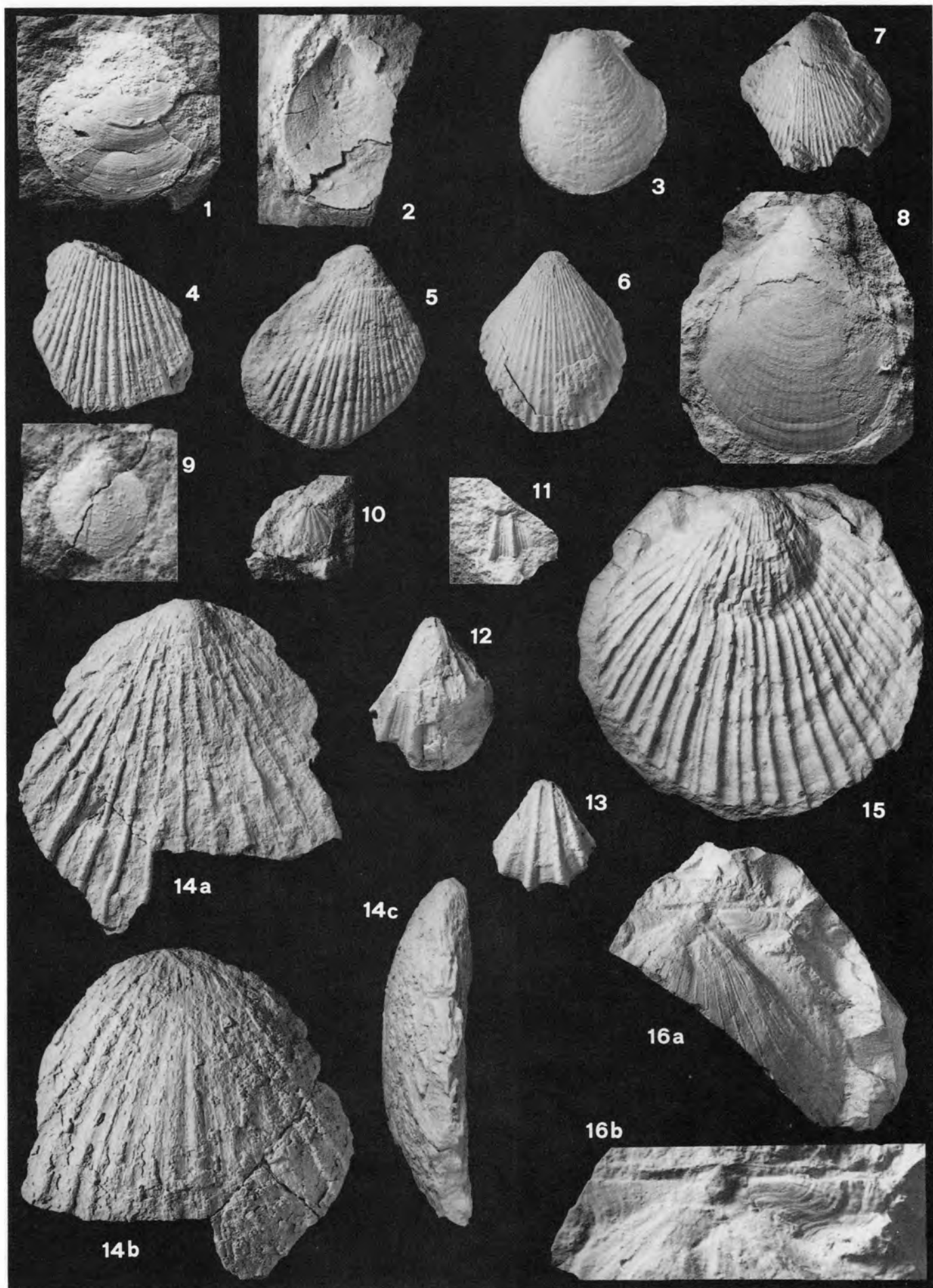
All the specimens have been whitened.



EXPLANATION OF PLATE VI

- FIGS. 1-3 - *Camptonectes cottaldinus* (D'ORBIGNY).
 1 - Left valve, exterior.
 2 - Left valve, interior.
 3 - Right valve, internal mould.
 Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 153, 218; x 1.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 238; x 1.
- FIGS. 4-6 - *Chlamys ? archiaciana* (D'ORBIGNY).
 4 - ? Left valve.
 5 - Right valve.
 6 - ? Left valve, internal mould with partial shell preservation.
 Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 151; x 1.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 775, 789; x 1.
- FIG. 7 - *Chlamys ? cf. elongata* (LAMARCK).
 Left valve, internal mould with partial shell preservation.
 Lower Hauterivian, Mt. Tundu (Dorgali); n. 360; x 1.
- FIG. 8 - *Mimachlamys robinaldina* (D'ORBIGNY).
 Left valve, internal mould.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 786; x 1.
- FIG. 9 - *Entolium orbiculare* (SOWERBY).
 Lower Hauterivian, Orosei; n. 286; x 1.5.
- FIGS. 10-12 - *Neithea (Neithea) atava* (ROEMER).
 10 - Left valve.
 11 - Right valve, composite mould.
 12 - Right valve.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 774; x 1.
 Upper Hauterivian, Orudè (Dorgali); n. 631; x 1.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 763; x 1.
- FIG. 13 - *Neithea (Neithella) valangiensis* (PICTET and CAMPICHE).
 Right valve.
 Lower Hauterivian, Sa Oche (Lanaitto); n. 762; x 1.
- FIGS. 14a-16b - *Euthymipecten astierianus* (D'ORBIGNY).
 14a - Left valve.
 14b - Right valve.
 14c - Lateral view of both valves.
 15 - Left valve, plaster mould.
 16a - Right valve, plaster mould.
 16b - Detail of the auricles, plaster mould.
 Lower Upper Valanginian, Orosei; n. 287; x 1.
 ? Berriasian, Clumans (Alpes-de-Haute-Provence); MAFI K 11129; x 1.
 Berriasian, Berrias (Ardèche); MAFI K 10259; x 1.

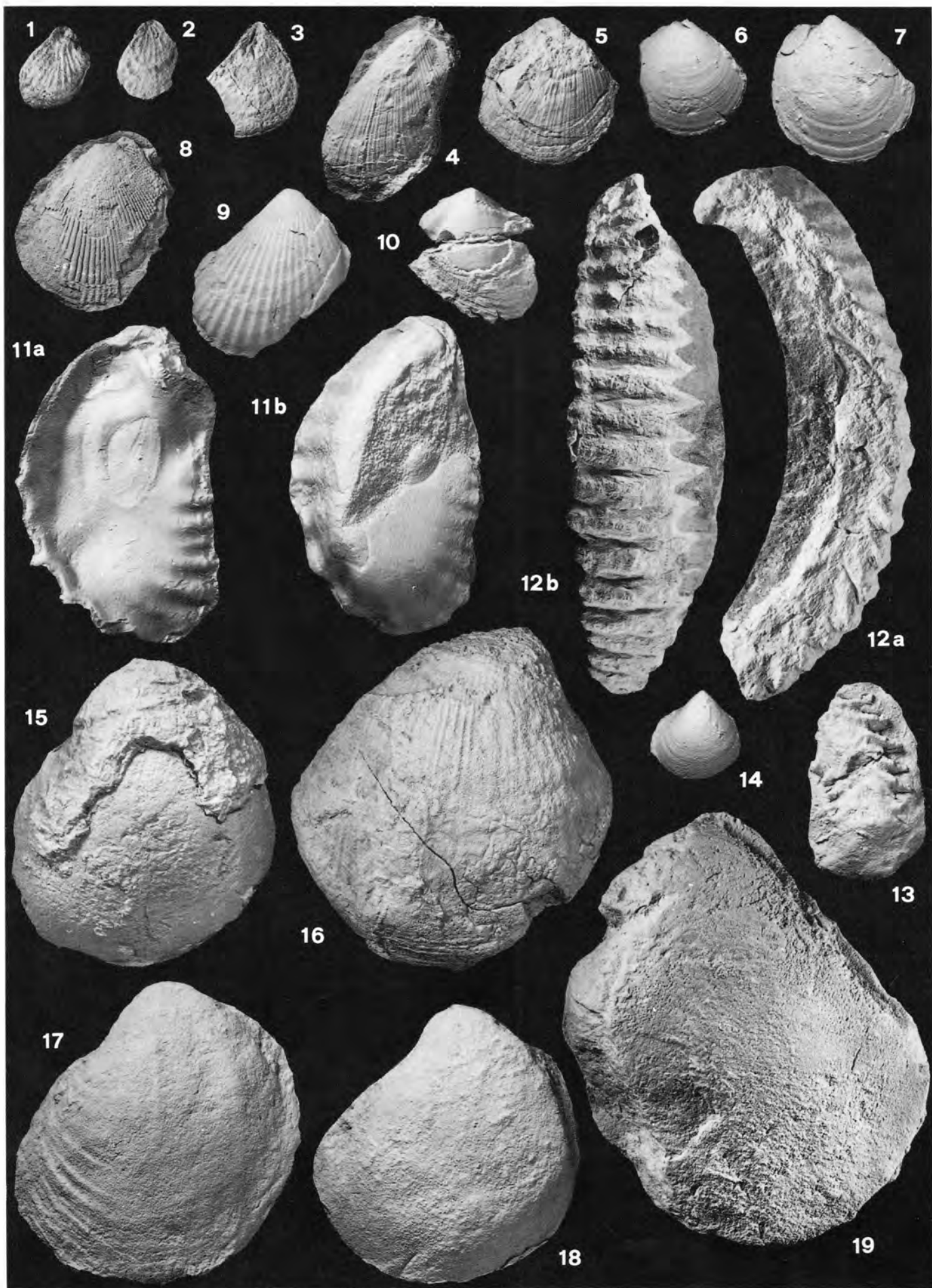
All the specimens have been whitened.



EXPLANATION OF PLATE VII

- FIGS. 1-3 - *Plicatula placunaea* LAMARCK.
Left valves.
Uppermost Valanginian, Orosei; n. 704, 765, 709; x 1.
- FIGS. 4, 5 - *Limaria ? dubisiensis* (PICTET and CAMPICHE).
4 - Left valve, internal mould.
5 - ? Right valve, internal mould with partial shell preservation.
Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 166, 170; x 1.
- FIGS. 6, 7 - *Plagiostoma globosum* (SOWERBY).
Right valves, internal moulds with shell fragments.
Upper Albian, Orosei; n. 130, 129; x 1.5.
- FIG. 8 - *Acesta dorbignyana* (MATHÉRON).
Left valve.
Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 182; x 1.
- FIG. 9 - *Limaria ? elongata* (SOWERBY).
Left valve.
Upper Albian, Orosei; n. 50; x 1.
- FIG. 10 - *Acesta subovalis* (SOWERBY).
Right valve.
Upper Albian, Orosei; n. 62; x 1.
- FIGS. 11a, 11b - *Ceratostreon boussingaulti* (D'ORBIGNY).
11a - Right valve, interior.
11b - Left valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 476; x 1.
- FIGS. 12a-13 - *Rastellum "rectangulare"* (ROEMER).
12a - Right valve.
12b - Right valve, anterior view.
Lower Hauterivian, Pischina Urtaddala (Gorropu); n. 155; x 1.
13 - Right valve.
Uppermost Valanginian, Orosei; n. 276; x 1.
- FIG. 14 - *Thetis minor* SOWERBY.
Left valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 725; x 1.
- FIGS. 15-18 - *Spondylus roemeri* DESHAYES in LEYMERIE.
15 - Left valve, internal mould with partial shell preservation.
16 - Right valve.
Lower Hauterivian, Orosei; n. 275, 697; x 1.
17 - Left valve, composite mould.
18 - Left valve, internal mould.
Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 148, 154; x 1.
- FIG. 19 - *Acesta cf. subrigida* (ROEMER).
Right valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 676; x 1.

All the specimens have been whitened.

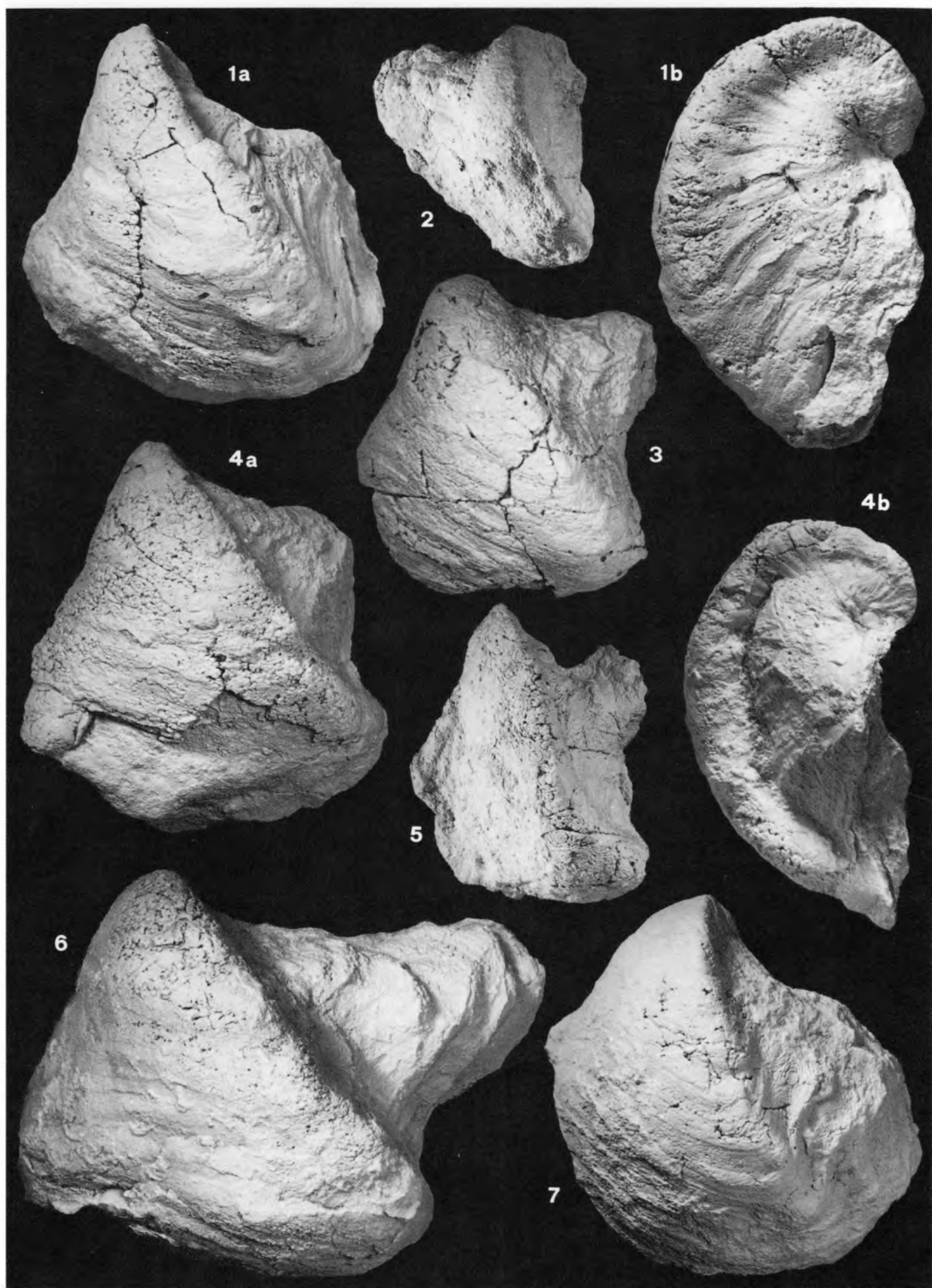


EXPLANATION OF PLATE VIII

- FIGS. 1a-7 - *Aetostreon latissimum* (LAMARCK).
1,3-7 - Left valves.
1b,4b - Posterior views.
Lower Hauterivian, Orosei; n. 509, 295, 305, 519, 508, 510; x 1.
2 - Left valve.
Lower Hauterivian, Sa Oche (Lanaitto); n. 463; x 1.

The concentrically structured silicification centers (beekite) are particularly well visible on the specimens of figs. 4 and 5.

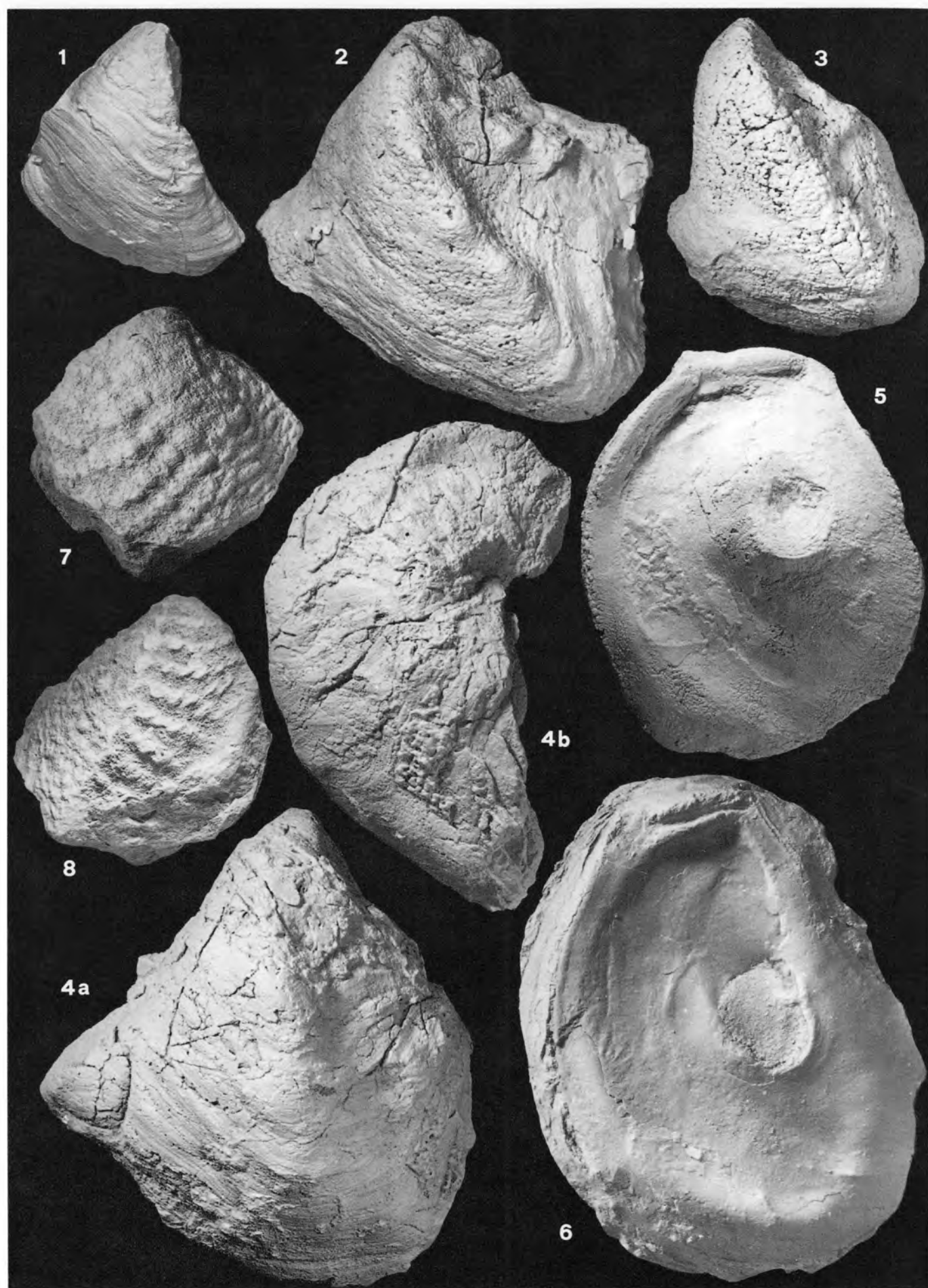
All the specimens have been whitened.



EXPLANATION OF PLATE IX

- FIGS. 1-6 - *Aetostreon latissimum* (LAMARCK).
1 - Left valve.
Middle Hauterivian, Orudè (Dorgali); n. 243; x 1.
2-4 - Left valves.
4b - Posterior view.
Lower Hauterivian, Orosei; n. 493, 292, 492; x 1.
5 - Right valve, interior.
Lower Hauterivian, Orosei; n. 502; x 1.
6 - Right valve, interior.
Lower Hauterivian, Sa Oche (Lanaitto); n. 478; x 1.
The concentrically structured silicification centers (beekite) are particularly well developed in the specimens of figs. 2 and 3.
- FIGS. 7, 8 - *Quadratotrigrionia nodosa* (SOWERBY).
7 - Left valve, composite mould.
8 - Right valve, composite mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 193, 245; x 1.

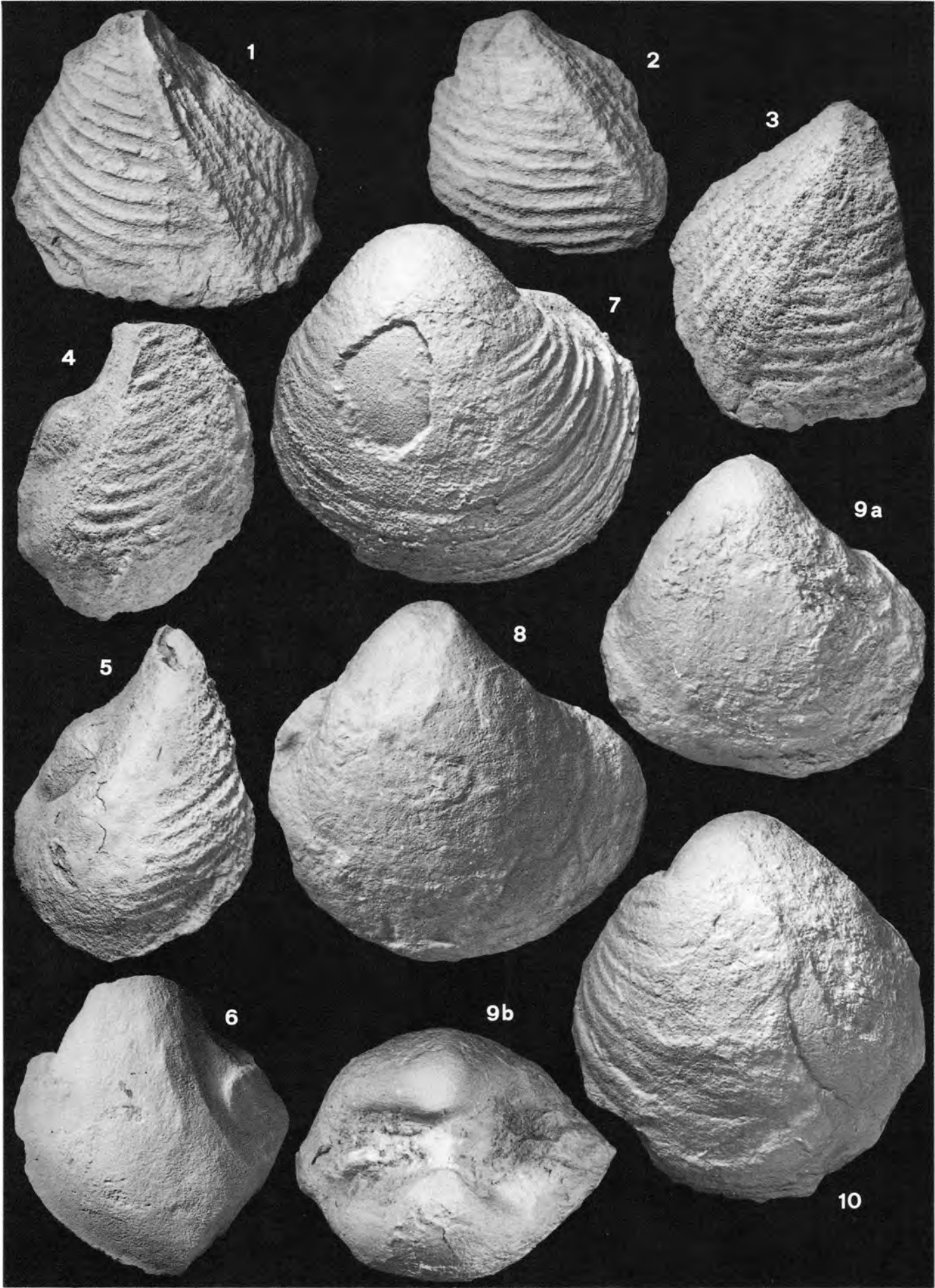
All the specimens have been whitened.



EXPLANATION OF PLATE X

- FIGS. 1-6 - *Trigonia (Trigonia) carinata* AGASSIZ.
1,2 - Left valves, composite moulds.
3-5 - Right valves, composite moulds.
6 - Left valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 185, 575, 544, 562, 549, 810; x 1.
- FIGS. 7-10 - *Sphaera corrugata* SOWERBY. p 46
7 - Right valve.
8 - Right valve, composite mould.
9a - Right valve, internal mould.
9b - Dorsal view of both valves, internal mould.
10 - Left valve, internal mould with partial shell preservation.
Lower Hauterivian, Sa Oche (Lanaitto); n. 644, 184, 671, 652; x 1.

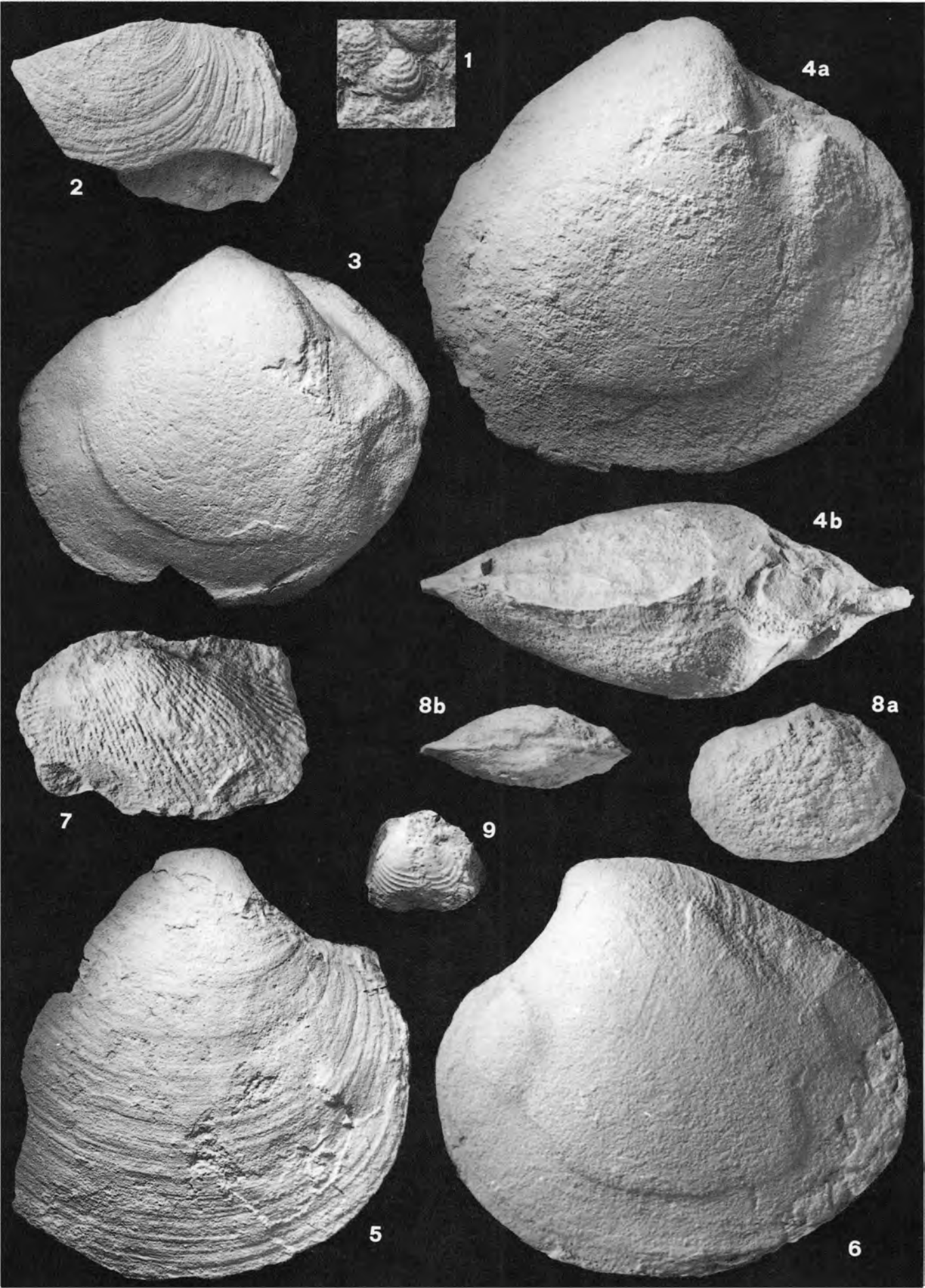
All the specimens have been whitened.



EXPLANATION OF PLATE XI

- FIG. 1 - *Astarte (Astarte) numismalis* D'ORBIGNY.
Left valve, composite mould.
Lower Upper Valanginian, Orosei; n. 801a; x 2.
- FIGS. 2-6 - *Eriphyla gigantea* (DESHAYES in LEYMERIE).
2 - Right valve.
Lower Hauterivian, Sa Oche (Lanaitto); n. 790; x 1.
3 - Left valve, internal mould.
Lower Hauterivian, Orosei; n. 658; x 1.
4a - Right valve, internal mould transitional to composite mould.
4b - Dorsal view of both valves, internal mould transitional to composite mould.
5 - Right valve, composite mould.
6 - Left valve, composite mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 674, 636, 696; x 1.
- FIGS. 7-8b - *Ptychomya (Ptychomya) plana* AGASSIZ.
7 - Left valve, composite mould.
8a - Right valve, internal mould.
8b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 259, 862; x 1.
- FIG. 9 - "*Lucina*" *valdensis* PICTET and CAMPICHE.
Left valve, composite mould.
Gargasian, Orosei; n. 758; x 1.

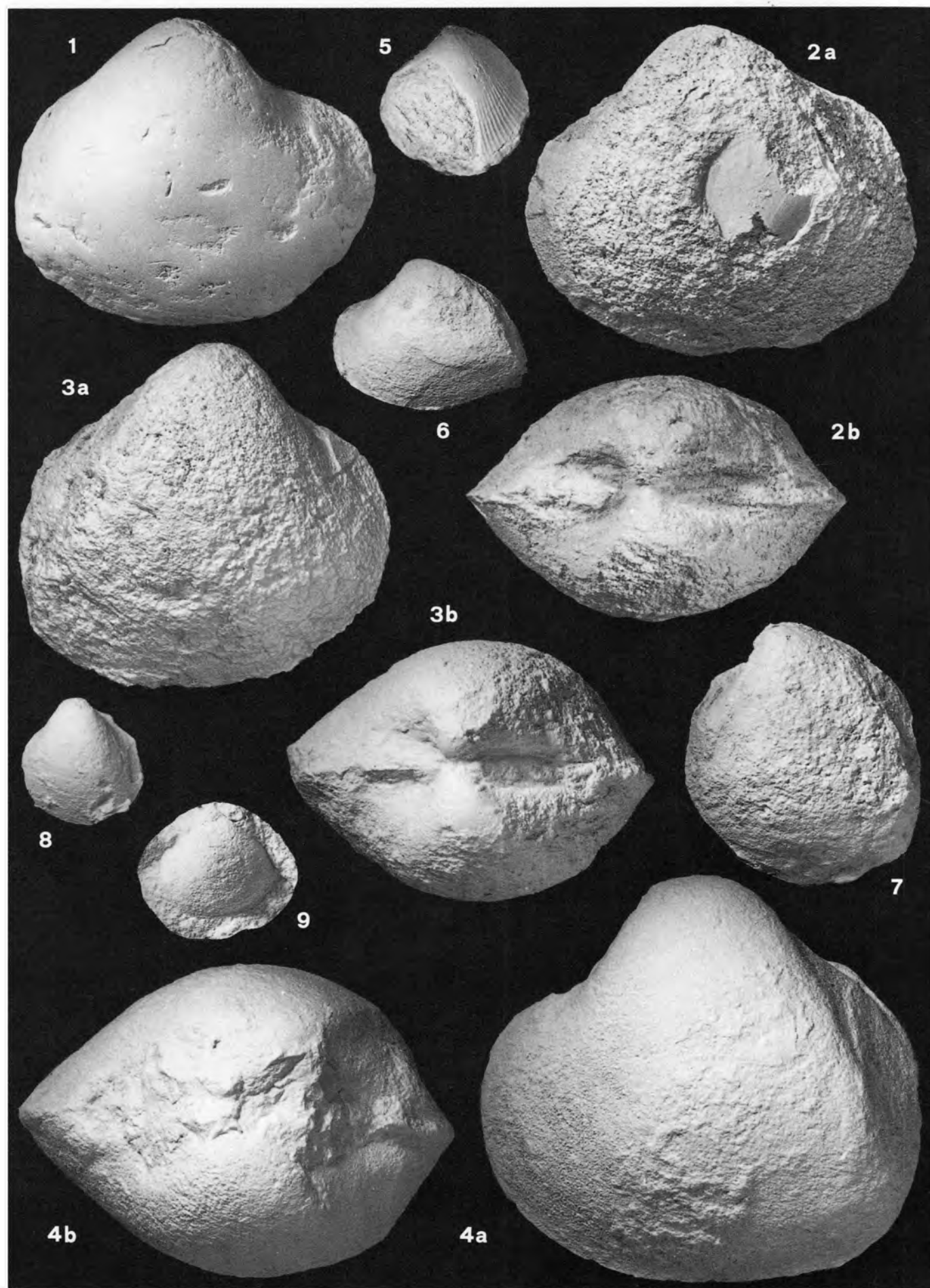
All the specimens have been whitened.



EXPLANATION OF PLATE XII

- FIGS. 1-4b - *Integricardium deshayesianum* (DE LORIO).
1 - Right valve, internal mould.
2a - Left valve, internal mould [with *Mimachlamys robinaldina* (D'ORBIGNY)].
2b - Dorsal view of both valves, internal mould.
3a - Right valve, internal mould.
3b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 250, 662, 669; x 1.
4a - Left valve, internal mould.
4b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Orosei; n. 273; x 1.
- FIG. 5 - *Pleuriocardia ? rauliniana* (D'ORBIGNY).
Left valve.
Vraconian, Orosei; n. 8; x 2.
- FIG. 6 - *Pleuriocardia ? voltzii* (D'ORBIGNY).
Left valve, composite mould.
Lower Hauterivian, Orosei; n. 751; x 1.
- FIG. 5 - "*Cardium*" *gillieron*i PICTET and CAMPICHE.
Left valve, internal mould.
Lower Valanginian, Sa Oche (Lanaitto); n. 860; x 1.
- FIGS. 8, 9 - *Protocardia peregrina* (D'ORBIGNY).
8 - Left valve, internal mould with partial shell preservation.
Uppermost Valanginian, Orosei; n. 2; x 1.5.
9 - Right valve, composite mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 739; x 1.5.

All the specimens have been whitened.



EXPLANATION OF PLATE XIII

- FIG. 1 - *Proveniella crassicornis* (AGASSIZ).
Left valve, internal mould with shell fragments.
Upper Albian, Orosei; n. 46; x 1.
- FIGS. 2, 3 - *Proveniella bernensis* (LEYMERIE).
2 - Left valve, composite mould.
Lower Hauterivian, Orosei; n. 767; x 1.
3 - Right valve, composite mould.
Lower Hauterivian, Carchinarzos (M. Albo); n. 328; x 1.
- FIG. 4 - *Flaventia brongniartina* (LEYMERIE).
Right valve, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 742b; x 1.
- FIGS. 5a, 5b - "*Venus*" *thurmanni* DE LORIOI.
5a - Left valve, internal mould.
5b - Dorsal view of both valves, internal mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 735; x 1.
- FIGS. 6, 7 - "*Venus*" *vendoperana* (LEYMERIE).
Right valves, internal moulds.
Lower Hauterivian, Sa Oche (Lanaitto); n. 744, 727; x 1.
- FIG. 8 - "*Venus*" *cornueliana* D'ORBIGNY.
Left valve, internal mould.
Lower Hauterivian, Carchinarzos (M. Albo); n. 339; x 1.
- FIGS. 9-12 - *Panopea gurgitis* (BRONGNIART in CUVIER).
9 - Left valve, composite mould.
Lower Hauterivian, Orosei; n. 845; x 1.
10, 11 - Right valves, composite moulds.
12 - Left valve, composite mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 425, 396, 395; x 1.
- FIGS. 13, 14 - *Matheronia* (*Matheronia*) *rougonensis* MONGIN.
Left valves.
Uppermost Berriasian-lowermost Valanginian, Carchinarzos (M. Albo); n. 902, 903; x 1.
- FIGS. 15-17b - *Protocardia impressa* (DESHAYES in LEYMERIE).
15 - Right valve, composite mould.
16, 17a - Left valves, composite moulds.
17b - Posterior view of left valve, composite mould; the radial "protocardiid" ribs are visible.
Lower Hauterivian, Sa Oche (Lanaitto); n. 687, 187, 251; x 1.
- FIG. 18 - *Gastrochaena* cf. *sinuosa* PICTET and CAMPICHE.
Uppermost Valanginian, Orosei; n. 3; x 2.
- FIG. 19 - *Gastrochaena* cf. *brevis* PICTET and CAMPICHE.
Upper Albian, Orosei; n. 47; x 2.
- FIG. 20 - *Pholadomya gigantea* (SOWERBY).
Left valve, composite mould.
Uppermost Valanginian, Su Praicargiu (Lanaitto); n. 132; x 1.
- FIG. 21 - *Platymyoidea rostrata* (AGASSIZ).
Left valve, composite mould.
Lower Hauterivian, Sa Oche (Lanaitto); n. 632; x 1.

All the specimens have been whitened.

