

## The Lower Cretaceous Brachiopods of east-central Sardinia

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**SUMMARY** — The Lower Cretaceous brachiopod fauna of east-central Sardinia, here described for the first time, is of particular interest because of the links which it shows with the faunas of Provence and the Jura region. In this respect the brachiopods tend to confirm the analogy between the Lower Cretaceous successions of Sardinia and of south-east France already drawn on stratigraphic and lithologic evidence by Dieni & Massari (1965). This analogy is shown best by the Rhynchonellidae, in which there is a close connection between the Sardinian fauna and that described by Jacob & Fallot (1913) from the Basses Alpes and neighbouring parts of France. The genus *Lamellaerhynchia* is of particular interest in that it has hitherto been thought to be mainly « boreal » and « Jura » in its range. One species of the Sardinian fauna, *L. rostriformis* (Roem.), has previously been recorded from north Germany, England, the Jura region and south-west France.

Among the Terebratulacea links with Provence and the Jura are most clearly seen in the Upper Valanginian and Hauterivian, with the occurrence of *Musculina sanctaerucis* (Catz.) and *Loriolithyris valdensis* (de Lor.), characteristic members of what Middlemiss (1973) has called the Jura Fauna. From its present-day geographical position Sardinia might have been expected to have a Lower Cretaceous fauna of Tethyan affinities but such elements, in fact, do not appear until the Aptian (*Sardope sardoa* gen. nov., sp. nov., « *Terebratula* » *moutoniana* d'Orb.) and Albian (*Nucleata*). The presence of « *Terebratula* » *dutempleana* d'Orb. in the uppermost Aptian may be important as it may be the earliest known appearance of this common Albian species.

The terebratulacean fauna appears, according to present knowledge, to have a high degree of endemism since no less than five species out of thirteen are so far unknown elsewhere: *Sellithyris deningeri* in the Hauterivian; « *Terebratulina* » *insueta* in the Aptian; *Platythyris floresana*, « *Terebratula* » *ichnusae* and « T. » *oroseina* in the Upper Albian. The palaeozoogeographical significance of these species remains to be investigated.

Among the Terebratellidae the presence in the Upper Albian of *Kingena spinulosa* (Davids. & Morris), which was hitherto regarded as having a restricted distribution in England, is particularly significant.

**RIASSUNTO** — [I Brachiopodi del Cretaceo inferiore della Sardegna centro-orientale] — Le faune a brachiopodi del Cretaceo inferiore della Sardegna centro-orientale, qui descritte per la prima volta, rivestono un particolare interesse per le notevoli affinità con quelle della Provenza e del Giura. Sotto questo aspetto i brachiopodi confermano l'analogia tra la successione eocretacea della Sardegna e quella della Francia sud-orientale, messa in risalto da Dieni & Massari (1965) in base a dati stratigrafici e litologici. Questa analogia viene messa in evidenza soprattutto dai Rhynchonellidae, che manifestano uno stretto legame con quelli descritti da Jacob & Fallot (1913) per le Basse Alpi e le zone limitrofe della Francia. Di notevole importanza è la presenza del genere *Lamellaerhynchia*, che finora si riteneva diffuso essenzialmente nelle aree boreali e nel Giura.

Per quanto concerne i Terebratulacea i legami con quelli della Provenza e del Giura sono più evidenti nel Valanginiano superiore e nell'Hauteriviano per la presenza di *Musculina sanctaerucis* (Catz.) e di *Loriolithyris valdensis* (de Lor.), caratteristici membri di quella che Middle-

miss (1973) ha definito la « fauna del Giura ». Le affinità tetidiche che ci si aspetterebbe di trovare in base alla posizione attuale della Sardegna compaiono soltanto nell'Aptiano (*Sardope sardoa* sp. nov., « *Terebratula* » moutoniana d'Orb.) e nell'Albiano (*Nucleata mediterranea* sp. nov.).

La fauna dei Terebratulacea sembra presentare, in base ai dati attualmente a disposizione, un alto grado di endemicità, dato che cinque delle tredici specie determinate sono finora sconosciute altrove: *Sellithyris deningeri* nell'Hauteriviano; « *Terebratulina* » insueta nell'Aptiano; *Platythyris floresana*, « *Terebratula* » *ichnusae* e « T. » *oroseina* nell'Albiano superiore. Il significato paleozoogeografico di queste specie richiede però ulteriori studi.

Tra i Terebratellacea è particolarmente significativa la presenza, nell'Albiano superiore, di *Kingena spinulosa* (Davids. & Morris), finora ritenuta esclusiva dell'Inghilterra.

## INTRODUCTION

This paper is one result of a long-term programme of research at the Institute of Geology of Padua directed toward the illustration of various palaeontological and stratigraphical aspects of the Lower Cretaceous of east-central Sardinia. Monographs of the Upper Valanginian foraminifera (DIENI & MASSARI 1966) and Upper Valanginian-Upper Albian cephalopods (WIEDMANN & DIENI 1968) of Orosei have been published. The Lower Cretaceous brachiopod faunas collected during field researches by one of us in the period 1962-73 are here described. Other works, already in an advanced stage of preparation, will continue the systematic description of the Sardinian cretaceous macrofaunas with the intention of increasing knowledge of the palaeobiogeographical, palaeogeographical and geodynamic evolution of the western Mediterranean.

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## THE LOWER CRETACEOUS OF EAST-CENTRAL SARDINIA (\*)

The Palaeozoic basement of eastern Sardinia, from the Gulf of Olbia in the north to the middle course of the Flumendosa in the south, a distance of about 150 kilometres, is intermittently covered by Mesozoic formations of epicontinental type, locally very thick. These are mainly Jurassic dolomites and limestones; the Lower Cretaceous is represented only locally, particularly in the M. Albo range, at M. Tuttavista near Orosei and in some parts of the Oliena-Urulei massif.

The most complete Cretaceous sequence, which has been studied in detail, is undoubtedly that of the environs of Orosei; for this reason, and because the greatest part of the brachiopods described in this paper were

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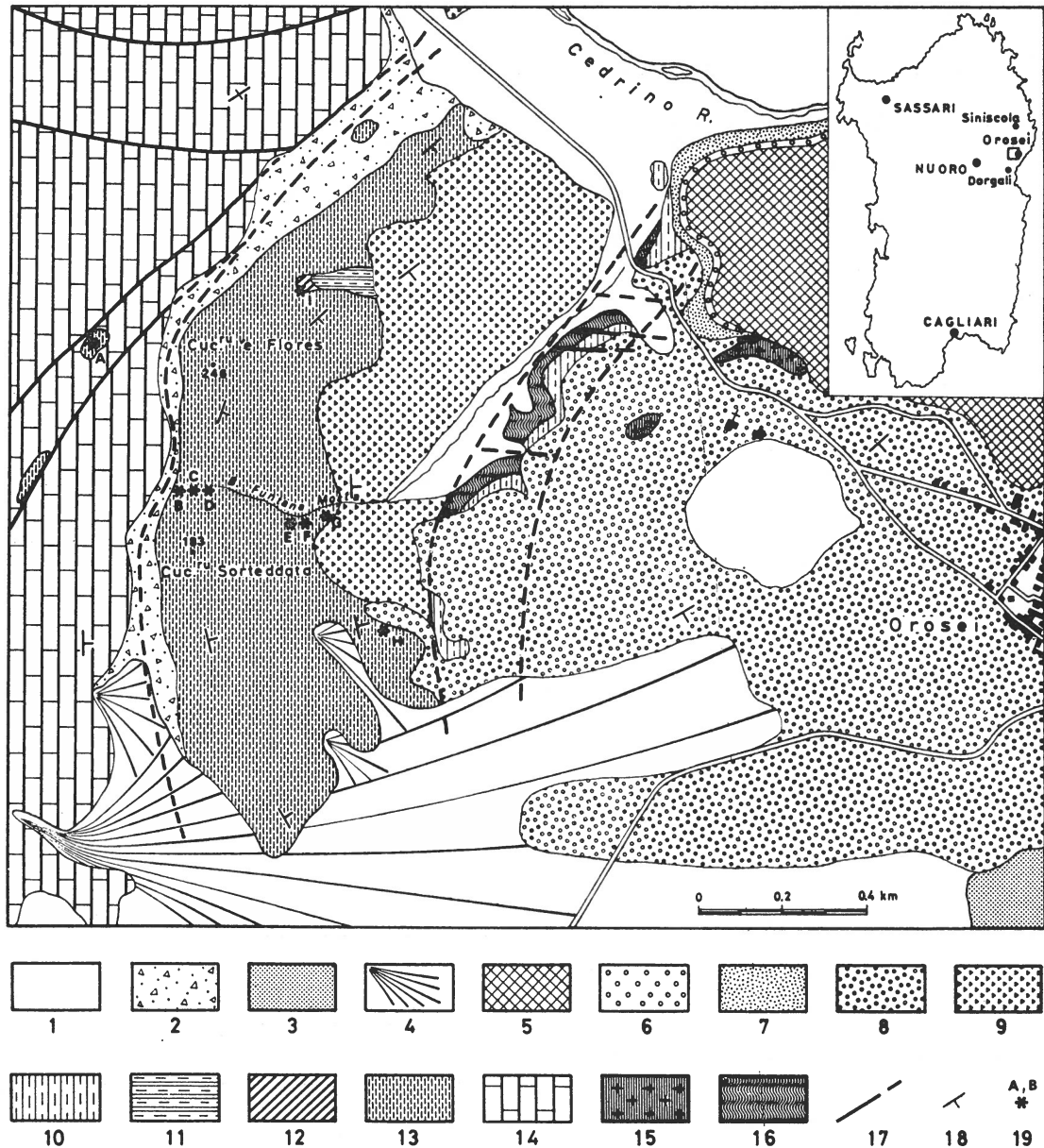


Fig. 1 - Geological sketch map of the environs of Orsei.

**Legend.** QUATERNARY: 1) Recent alluvial deposits; 2) Detrital materials; 3) Tyrrhenian sands and gravels; 4) Alluvial fans; 5) Olivine basalt; 6) Pre-basaltic fluvial-lacustrine sands and gravels (*Nuraghe Casteddu Formation*). LOWER PLIOCENE: 7) Marine sands with foraminifers and macrofossils. ?MIOCENE: 8) Deltaic sandstones and conglomerates (*Orosei Formation*). OLIGOCENE - ?UPPER EOCENE: 9) Polygenetic conglomerates with reworked nummulites (*Cuccuru 'e Flores Formation*). CUISIAN 10) Limestones and arenaceous limestones with nummulites and alveolinas. SANTONIAN: 11) Chalky limestone with globotruncanas. UPPER ALBIAN: 12) Glauconitic calcareous conglomerate rich in macrofossils. LOWER ALBIAN-UPPER VALANGINIAN: 13) Marls, marly limestones, calcarenites, etc., sometimes with chert nodules. ?BERRIASIAN-PORTLANDIAN: 14) Massive and stratified limestones (*M. Bardia Formation*). CRYSTALLINE BASEMENT: 15) Granite; 16) Quartz-phylites, cataclastic to mylonitic. SYMBOLS: 17) Faults; 18) Dip of strata; 19) Important macrofossil localities.

derived from it, this series will be dealt with fully while those of the other localities, not being sufficiently known, will be presented in summary fashion, with emphasis on the differences which they show from that of Orosei.

#### ENVIRONS OF OROSEI

The first information regarding the Mesozoic of Orosei was given by LA MARMORA (1857) who, on the basis of the palaeontological determinations of MENEGHINI (1857), considered the M. Tuttavista-Cuccuru 'e Flores-Cuccuru Sorteddata sequence to be wholly of Cretaceous age. To DENINGER (1907) is due the credit for having distinguished the Jurassic formations (M. Tuttavista) from the Cretaceous ones (C. 'e Flores - C. Sorteddata). The recent researches of DIENI & MASSARI (1963, 1965, 1966) and of WIEDMANN & DIENI (1968) have given precise dating and a very detailed subdivision of the Cretaceous sequence by means of the study of rich microfaunal and microfossil assemblages and of the analysis of the cephalopod faunas, which are particularly abundant at some levels (figs. 1-2).

M. Tuttavista is made up for the most part of a Jurassic series, starting with dolomites resting unconformably on the crystalline basement and on Permian formations; these are followed by a reef complex essentially of Upper Jurassic age. The Jurassic-Cretaceous boundary is difficult to place owing to the lack of a typical fossil association. In the stratigraphically highest part of the reef complex the sedimentary environment tends to become less deep. Among the calcarenites, still clearly marine with rare *Pseudocyclammia*, *Nautiloculina*, *Trocholina elongata* (LEUP.), *Cayeuxia piae* FROLLO, *Salpingoporella annulata* CAR., *Clypeina jurassica* FAVRE, *Thaumatoporella parvovesiculifera* (RAIN.), referable to the Portlandian, there are intercalated lithographic limestones which become dominant upwards. The lagoonal environment of origin of these lithographic limestones, which contain sporadic

ostracods, is suggested partly by the presence of some horizons of intraformational breccias with black, dark grey or brown lithoclasts similar to those often noted in the French-Swiss Jura at about the Jurassic-Cretaceous boundary. The stratigraphical horizons which succeed this indicate a return to marine conditions, demonstrated by the presence of pseudo-oolitic and oolitic calcarenites with coral debris, *Lithocodium*, *Trocholina alpina* (LEUP.), *T. elongata* (LEUP.). It is possible that the lagoonal facies (« purbeckian facies ») marks the Jurassic-Cretaceous boundary and that the succeeding calcarenites represent the *Berriasian*.

A gap in the succession, corresponding to the Lower Valanginian (*Kilianella roubaudiana* Zone) separates the calcarenites from the marls of the *Upper Valanginian*, which fill pockets developed in the surface of the calcarenites, indicating an interruption of sedimentation accompanied by solution of the limestones. The attribution of these marls to the Upper Valanginian has been made possible by the finding of ammonites (at locality A on figures 1 and 2) [*Lytoceras sauculum* (DRUSHTCH.), *Olcostephanus* (O.) *astierianus* (d'ORB.), *Neocomites* (N.) *teschenensis* (UHLIG), etc.] and by the study of the rich foraminiferal faunas [*Buccicrenata italica* DIENI & MASS., *Triplasia aequalis* (ROEM.), *Dorothia kummi* (ZEDLER), *Lenticulina* (L.) *guttata* (DAM), *L. (L.) nodosa* (REUSS), *L. (L.) protodecimae* DIENI & MASS., *Citharina seitzii* BART. & BR., *Tristix excavata* (REUSS), *Spirillina italica* DIENI & MASS., etc.].

The transition to the Cretaceous of C. 'e Flores and C. Sorteddata, hills situated at the foot of the eastern slope of M. Tuttavista (fig. 1), is marked by grey marls with chert nodules (20 m), also shown to be of *Upper Valanginian* age by the presence (locality B) of *Haploceras* (*Neolisoceras*) *grasianum* (d'ORB.), *Neocomites* (N.) *neocomiensis* (d'ORB.), *N. (N.) teschenensis* (UHLIG); with these ammonites are associated *Aetostreon couloni* (DEFR.), very abundant, *Grammatodon* (*Nanonavis*) *securis*

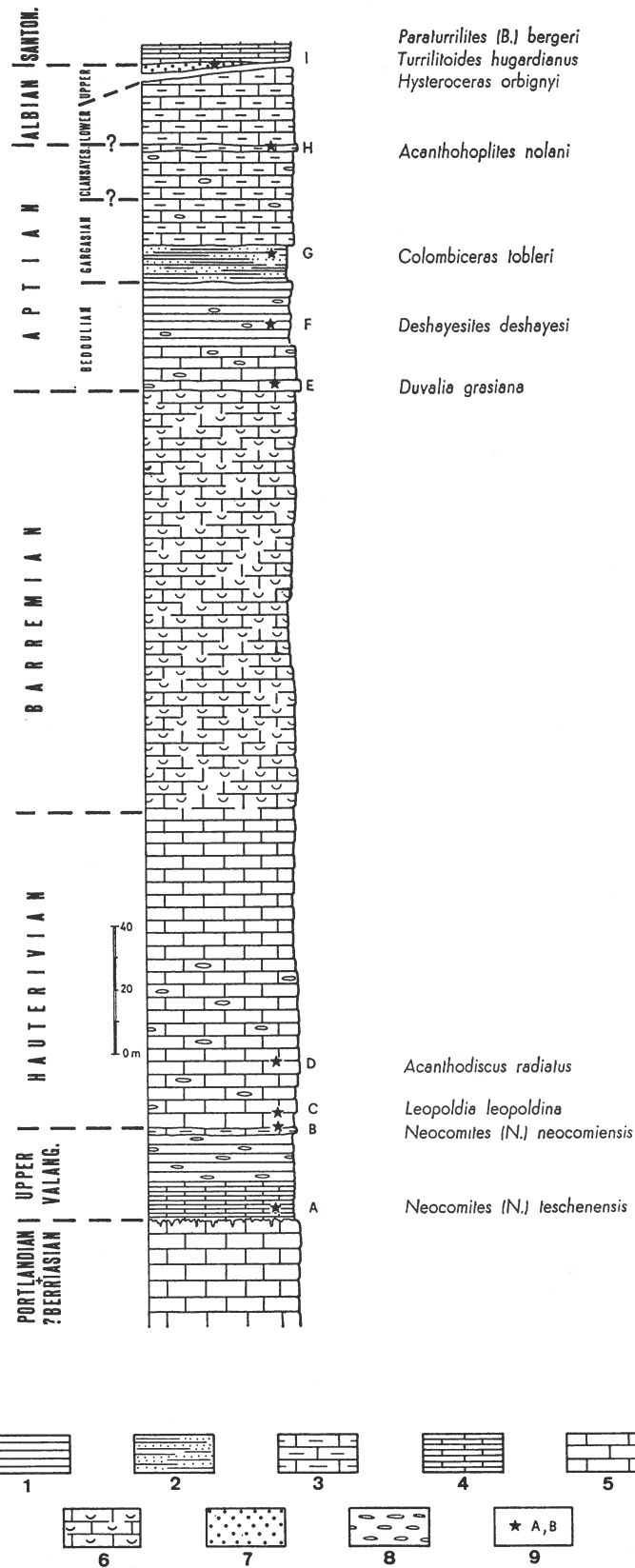


Fig. 2 - Columnar section of the Upper Jurassic-Cretaceous stratigraphical sequence of M. Tuttavista-Cuccuru 'e Flores (Orosei). (From Wiedmann & Diéni 1968).

**Legend.** 1) Marl; 2) Glauconitic marl; 3) Marly limestone; 4) Calcarenite; 5) Limestone; 6) Oolitic and pseudoolitic limestone; 7) Calcareous conglomerate; 8) Chert nodules; 9) Macrofossil-bearing strata and their most significant cephalopod species.

(LEYM.), *Protocardia* (*P.*) *peregrina* (d'ORB.), etc. Among the brachiopods are present:

*Loriolithyris valdensis* (de LORIOL)  
«*Lamellaerhynchia*» *renauxiana* (d'ORBIGNY)

The *Hauterivian* begins with a horizon of slightly bituminous argillaceous limestone (c. 1 m) passing up into intraformational breccia (locality C) with *Phylloceras* (*Ph.*) *spathi* COLL., *Crioceratites* (*Cr.*) *sablieri* (ASTIER), *Leopoldia leopoldina* (d'ORB.), *Spitidiscus rotula* (J. SOW.), *Cyatoceras pseudoelegans* (d'ORB.), *Aetostreon couloni* (DEFR.), *Rastellum rectangulare* (ROEM.), *Sphaera corrugata* J. SOW., etc. The brachiopods are represented by the following species:

*Sellithyris deningeri* sp. nov.  
*Loriolithyris valdensis* (de LORIOL)  
«*Oblongarcula*» sp.  
*Lamellaerhynchia rostriformis* (ROEMER)  
«*Lamellaerhynchia*» *renauxiana* (d'ORBIGNY)  
*Belbekella rotundicosta* (JACOB & FALLOT)

The presence among the microfossils of rare calpionellids [*Calpionellites darderi* (COL.), *Tintinnopsella carpathica* (MURG. & FIL.)] is to be noted. Thereafter follows a monotonous series of whitish, grey and yellowish limestones, locally with chert nodules and generally unstratified, which in its lowest part contains large ammonites still indicative of the Lower Hauterivian (locality D) [*Acanthodiscus radiatus* (BRUG.), *A. pseudoradiatus* BAUMB., *Leopoldia cryptoceras* (d'ORB.), *Oosterella cultrata* (d'ORB.)]. The dominant lithotype consists of calcarenites locally oolitic, with rare detrital grains of quartz, phosphate and glauconite in the lower part. The total thickness of the Hauterivian is about 100 m.

The Hauterivian calcarenites gradually pass up, by enlargement of grain-size, into oolitic or pseudo-oolitic sediments which, in their upper middle part, are clearly seen to be derived from the disaggregation of a bioconstructed reefal lithology, with repeated transport and prolonged re-working of the fragments («*urgonian facies*»). These

constitute an uniform series of whitish bioclastic limestones, usually unstratified, 130 m thick and referable to the *Barremian*. The lower limit of this stage is poorly defined because of the gradualness of the passage from the underlying limestones with regard to the litho- as well as the biofacies. From the micropalaeontological point of view the abundance of orbitolinids is remarkable, especially in the upper part [*Paleodictyoconus barremianus* (MOULL.), *Urgonina alpillensis* (FOURY), *Paracoskolinina sunnilandensis* (MAYNC), *Valserina broennimanni* SCHROED. & CONR., *Orbitolinopsis elongata* DIENI, MASS. & MOULL., *O. subkiliani* DIENI, MASS. & MOULL., etc.] Also present are *Netrocholina friburgensis* GUILL. & REICH., *Debarina habounerensis* FOURC., RAOULT & VILA, *Choffatella decipiens* SCHLUMB., «*Arenobulimina*» *flandrini* MOULL., *Pseudolituonella gavenensis* FOURY, *Praereticulinella cuvillieri* DELOFFRE & HAM., *Sabaudia minuta* (HOFK.), *Cuneolina hensoni* DALB., *Pfenderina globosa* FOURY, *Melathrokerion praesigali* (BANN.), etc.]. The microflora is also well represented in the upper part, with abundant remains of Codiaceae (*Arabicodium aegagrapiloides* ELL., *Boueina hockstetteri* TOULA, etc.), Dasycladaceae [*Clypeina? solkani* CONR. & RAD., *Salpingoporella dinarica* RAD., *S. muehlbergii* (LOR.), *Pseudoactinoporella fragilis* CONR., *Likanella? danilovae* RAD., etc.] and *Bacinella irregularis* RAD.

The *Aptian* begins with a thick (3 m) layer of fine-grained, light-brown limestone, locally siliceous, and sometimes having the character of an intraformational breccia with glauconitized and phosphatized lithoclasts (locality E). It contains guards of *Duvalia grasiana* (DUV.) and fish teeth. Among the brachiopods the commonest is

*Sardope sardoa* gen. nov., sp. nov.

while the following occur rarely:

*Tropeothyris salevensis* (de LORIOL)  
«*Terebratula*» cf. *moutoniana* d'ORBIGNY  
«*Terebratulina*» *insueta* sp. nov.

There follow very fine grained marly limestones (c. 10 m) and grey marls (c. 20 m) with chert nodules; the stratification is very close and regular, and the lithological change is accompanied by a notable impoverishment of the organic content and by an abrupt modification of the microfauna. Among the macrofossils (locality F) are rare *Deshayesites deshayesi* (LEYM.) and among the foraminifers are sporadic *Praeglobotruncana* (HEDB.) sp., small globigerinas and extremely rare *Conorotalites aptiensis* BETT.; the presence of *D. deshayesi* indicates the Lower Aptian (*Bedoulian*).

The ratio of planktonic to benthic foraminifers increases in the succeeding group, about 10 m thick, of strongly glauconitic marls; they include a well-defined horizon of intraformational breccia, with lithoclasts intensely impregnated by glauconite and phosphate, denoting a stratigraphic discontinuity the magnitude of which is not determinable on palaeontological evidence. Among the planktonic foraminifers are frequent *Globigerinella ferreolensis* (MOULL.), *G. sigali* CHEV., *Globigerinelloides algeriana* CUSHM. & DAM; *Neobibolites semicanaliculatus* BLAINV. is common, particularly in the upper part (locality G), accompanied by other belemnites and by *Colombiceras tobleri* (JACOB), *C. caucasicum tyrrhenicum* WIEDM. & DIENI, which are indicative of Middle Aptian (*Gargasian*).

There follows a monotonous series (c. 28 m) of calcarenites, more or less argillaceous, regularly stratified, and locally with chert nodules. Among the foraminifers there is a progressive impoverishment in the planktonic with respect to the benthic ones (orbitolinids, rare *Cuneolina*, etc.).

After this appear marly, detrital-biostatic limestones, visible for 22 metres, which represent the last outcrop in stratigraphical continuity with the sequence described up till now. At the base (locality H) there is an intraformational conglomerate with the same characteristics as the preceding ones and rich in cephalopods indicative of the Up-

per Aptian (*Clansayesian*) [*Valdedorsella getulina* (COQ.), *Melchiorites melchioris* (TIETZE), *M. emerici* (RASP.), *Beudanticeras zuercheri* (JACOB), *Acanthobolites abichi* (ANTH.), *A. nolani* (SEUN.), *Neobibolites strombecki* STOLL., *N. aptiensis* KIL.]. In this horizon the following species of brachiopods are present:

«*Terebratula*» *dutempleana* d'ORBIGNY  
«*Terebratulina*» *martiniana* d'ORBIGNY  
*Tamarella tamarindus* (J. de C. SOWERBY)

The succeeding beds, because of the presence of *Praeglobotruncana* (HEDB.) *washitensis* (CARSEY), belong most likely to the *Lower Albian*.

North-east of Cuccuru 'e Flores, resting unconformably on the sequence just described, there is a horizon (0,5 m) of calcareous conglomerate, with lithoclasts often glauconitized or silicified, exceptionally rich in macrofossils. The ammonites [*Phylloceras* (*Hypophylloceras*) *thetys* (d'ORB.), *P. (H.) sardoum* WIEDM. & DIENI, *P. (H.) velledae velledae* (MICH.), *P. (H.) seresitense* PERV., *Zelandites dozei schroederi* WIEDM., *Tetragonites rectangularis* WIEDM., *Hamites (H.) virgulatus* (BRONGN.), *Lechites gaudini* (PICT. & CAMP.), *L. moreti* BREISTR., *L. italicus* WIEDM. & DIENI, *Anisoceras (A.) perarmatum* PICT. & CAMP., *Pseudohelicoceras robertianum* (d'ORB.), *Turrilitoides (T.) hugardianus* (d'ORB.), *Ostlingoceras puzosianum* (d'ORB.), *Paraturrilites (Bergericeras) bergeri* (BRONGN.), *Scaphites meriani* PICT. & CAMP., *Puzosia provincialis* (PAR. & BON.), *Hysteroceas binum* (J. SOW.), *H. orbigny* (SPATH), *Stoliczkaia notha* (SEEL.), etc.] demonstrate that this level comprises many palaeontological zones, all belonging to the Upper Albian (*Upper Albian* s.s. and *Vraconian*); it evidently constitutes a condensed sequence. Also well represented are hydrozoans (*Parkeria sphaerica* CARP.), pelecypods [*Inoceramus (I.) concentricus* PARK., *I. (Birostrina) sulcatus* PARK., etc.], gastropods [*Petropona gresslyana* (PICT. & ROUX), *Antico-*

*nulus conoideus* (J. SOW.), *Conotomaria lima* (d'ORB.), *Pterodonta gaultina* (PICT. & ROUX), etc.], nautiloids [*Eutrephoceras clementinum* (d'ORB.), *Cymatoceras radiatum* (J. SOW.)], belemnites [*Neobibolites minimus* (LISTER), *N. pinguis* STOLL., *N. ultimus* (d'ORB.)] and echinoids [*Conulus castaneus* (AGASS.), etc.]. The abundant brachiopods are represented by the following species:

- « *Terebratula* » *ichnusae* sp. nov.
- « *Terebratula* » *oroseina* sp. nov.
- Nucleata mediterranea* sp. nov.
- Platythyris floresana* sp. nov.
- Kingena spinulosa* (DAVIDSON & MORRIS)
- Orbirhynchia parkinsoni* OWEN
- Orbirhynchia parkinsoni* f. *paludensis*  
(JACOB & FALLOT)
- Orbirhynchia parkinsoni* f. *rencurelensis*  
(JACOB & FALLOT)
- « A » gen. nov., sp. nov.

In the matrix of the conglomerate are very numerous microfossils, among which are *Pithonella ovalis* (KAUFM.), *Planomalina buxtorfi* (GAND.), *Praeglobotruncana* (*Hedb.*) *planispira* (TAPP.), *P. (H.) washitensis* (CARS.), *Rotalipora ticinensis* (GAND.), *R. appenninica* (RENZ), etc.

The youngest part of the Cretaceous series of Orosei is constituted by an outcrop of chalky limestone of *Santonian* age unconformable on the Upper Albian conglomerate. There are abundant *Globotruncana concavata* (BROTZ.), *Gbt. coronata* BOLLI, *Gbt. fornicata* PLUMM., *Gbt. lapparenti* BOLLI, *Gbt. linneiana* (d'ORB.), *Gbt. mariei* BANN. & BLOW, *Gbt. renzi* GAND., *Gbt. sigali* REICH., *Stensioïna exsculpta gracilis* BROTZ., *Heterohelix* spp. and radiolarians.

Summarizing, from a sedimentological point of view the Cretaceous series of Orosei is characterized by the frequency of abrupt vertical changes of facies, sometimes accompanied by intraformational breccias with rich macrofaunas, occasionally condensed, or by hardgrounds. This is consistent with a regime of neritic-epicontinental sedimentation characterized by acute sensitivity to any

alteration in the equilibrium of the depositional environment. Such alterations were caused, at least in the case of the largest stratigraphical gaps (Lower Valanginian, Middle Albian, Cenomanian-Turonian, Coniacian), by tectonic pulsations, some weak, others strong (Middle Albian), which were preludes to the Laramide tectonic phase.

#### M. ALBO

At M. Albo the Lower Cretaceous appears only near the north-eastern extremity of the chain (where is a limited outcrop of limestones with chert nodules, of Upper Hauterivian age, in the neighbourhood of Tanca Altara) and in the region of Sas Mesas, on the south-eastern slope of the massif. In the latter area the series is more complete even though involved in gravitational sliding (DIENI & MASSARI, 1970); the sequence is very similar to that of Orosei but seems not to extend above the Barremian. The only brachiopods found, which have been collected in levels referable to the Hauterivian (with *Aetostreon couloni*, *Rastellum rectangulare*, etc.) represent the following species:

- Musculina sanctaecrucis* (CATZIGRAS)
- Lamellaerhynchia rostriformis* (ROEMER)

The fact is worth noting that *M. sanctaecrucis* has not until now been found in any other locality of Sardinia.

#### OLIENA-URZULEI MASSIF

In this region the Lower Cretaceous outcrops extensively, especially in the cores of the various synclines. The stratigraphical sequence up to Hauterivian inclusive is very similar to that of Orosei; locally there appear sub-reefal limestones with orbitolinas (« urgonian facies ») which are certainly of post-Barremian age. Brachiopods are very abundant in the Lower Hauterivian part (upper part of the « Orizzonte di Orudé »; AMADESI & AL. 1960), so much so as to constitute local lumachelles. These levels are



certainly those in which DENINGER (1907) found, near Costas d'Ossu (territory of Dorgali), the only species known until now from the Sardinian Lower Cretaceous (*Waldheimia pseudojurensis* LEYM. and *Terebratula Moutoniana* d'ORB.). The forms found in this region, all of Lower Hauterivian age, are:

*Sellithyris deningeri* sp. nov.

« *Terebratulina* » sp.

« *Rugitela* » sp.

*Belothyris pseudojurensis* (LEYMERIE)

*Lamellaerhynchia rostriformis* (ROEMER)

*Belbekella rotundicosta* (JACOB & FALLOT)

*Sulcirhynchia ardescica* (JACOB & FALLOT)

It is interesting to note how the rhynchonellides and *Belothyris pseudojurensis* are exclusively linked to the decidedly calcareous lithology and how *Sellithyris deningeri* is instead characteristic of the marly horizons. As regards the stratigraphical position of the various lumachellic layers, it should be mentioned that the bed almost totally composed of *S. deningeri* (with *Aetostreon couloni*, *Rastellum rectangulare*) occupies the lowermost position within the Lower Hauterivian sequence; it is followed, at a vertical distance of a few metres, by a bed formed only by rhynchonellides and, higher, by one which exclusively contains *B. pseudojurensis*.

#### CHARACTERISTICS OF THE BRACHIOPOD FAUNA

The Lower Cretaceous brachiopod fauna of east-central Sardinia, here described for the first time, is of particular interest because of the links which it shows with the faunas of Provence and the Jura region. In this respect the brachiopods tend to confirm the analogy between the Lower Cretaceous successions of Sardinia and of south-east France already drawn on stratigraphic and lithologic evidence by Dieni and Massari

(1965). This analogy is shown best by the Rhynchonellidae, in which there is a close connection between the Sardinian fauna and that described by Jacob and FalLOT (1913) from Basses Alpes and neighbouring parts of France. The genus *Lamellaerhynchia* is of particular interest in that it has hitherto been thought to be mainly 'boreal' and 'Jura' in its range. One species of the Sardinian fauna, *L. rostriformis* (ROEMER), has previously been recorded from north Germany, England, the Jura region and south-west France.

Among the Terebratulacea links with Provence and the Jura are most clearly seen in the Upper Valanginian and Hauterivian, with the occurrence of *Musculina sanctaecrucis* (CATZ.) and *Loriolithyris valdensis* (de LOR.), characteristic members of what Middlemiss (1973) has called the Jura Fauna. From its present-day geographical position Sardinia might have been expected to have a Lower Cretaceous fauna of Tethyan affinities but such elements, in fact, do not appear until the Aptian [*Sardope sardoa* sp. nov., « *Terebratula* » *moutoniana* (d'ORB.)] and Albian (*Nucleata mediterranea* sp. nov.). The presence of « *Terebratula* » *dutempleana* d'ORB. in the uppermost Aptian may be important as it may be the earliest known appearance of this common Albian species.

The terebratulacean fauna appears, according to present knowledge, to have a high degree of endemism since no less than five species out of thirteen are so far unknown elsewhere: *Sellithyris deningeri* in the Hauterivian; « *Terebratulina* » *insueta* in the Aptian; *Platythyris floresana*, « *Terebratula* » *icbnusae* and « *T.* » *oroiseina* in the Albian. The palaeozoogeographical significance of these species remains to be investigated.

Among the terebratellidae the presence in the Upper Albian of Orosei of *Kingena spinulosa* (DAVIDS. & MORRIS), which was hitherto regarded as having a restricted distribution in England, is particularly significant.

## SYSTEMATIC DESCRIPTIONS

Phylum BRACHIOPODA Duméril, 1806  
 Class ARTICULATA Huxley, 1869  
 Order TEREBRATULIDA Waagen, 1883  
 Sub-order TEREBRATULIDINA  
 Waagen, 1883 (\*) <sup>(1)</sup>  
 Superfamily TEREBRATULACEA Gray, 1840  
 Family TEREBRATULIDAE Gray, 1840  
 Sub-Family SELLITHYRIDINAE  
 Muir-Wood, 1965  
 Genus SELLITHYRIS Middlemiss, 1959  
 Type-species: *Terebratula selli*  
 J. de C. Sowerby, 1823 <sup>(2)</sup>

(\*) I. DIENI & F. A. MIDDLEMISS.

<sup>(1)</sup> TERMINOLOGY — The terms used are mainly those of Middlemiss (1959) and the Treatise (Part H), but the following appear to need a brief comment:

*Clubbed.* In 1959 this term was confined to hinge plates; a clubbed hinge plate « becomes thicker inwards, its inner margin in particular thickened and blunt or rounded ». Since in such hinge plates the thickening usually encloses the crural bases, the term is here applied to crural bases.

*Cuneate hinge plate:* a term borrowed from Pinder (ms.). The hinge plate joins the crural base by means of an abrupt wedged-shaped thickening. If the dorsal edge of the cuneate thickening extends dorsalwards as a distinct ridge, the hinge plate is *keeled* as depicted in fig. 1 J of Middlemiss 1959.

*Piped hinge plate.* This term is used as in Middlemiss (1959). It should be noted that the essential character of such hinge plate is the very small size of the crural bases which, when embedded in secondary thickening, gives a narrow rounded thickened rim to the hinge plate.

*Crural base:* used here as in the Treatise, in place of *inner lamina* of Middlemiss (1959).

*Crural flange.* This term is used in the original sense of Middlemiss (1959) and as defined in the Treatise, as « lateral projection from crus formed by anterior extension of part of outer hinge plate adjacent to crural base », not in the sense of Makridin (1964) (also discussed by Barczyk 1969) of anterior extensions of the loop.

*Episulcation, paraplication, sulcification.* These terms are used in reference to plication of the anterior commissure (as in Middlemiss 1959), not to the folding of the shell (as in the Treatise), since the commissure may in some cases be plicated without the shell being correspondingly folded.

<sup>(2)</sup> Dates of publication of works by J. Sowerby and J. de C. Sowerby are based upon the advice of Mr. R. J. Cleavelly (pers. comm.).

SELLITHYRIS DENINGERI sp. nov.  
 Pl. 32, figs. 1-11; text-figs. 3-4

? 1907 *Terebratula Moutoniana*  
 d'Orb. - DENINGER, p. 469  
 (non d'Orbigny, 1847).

*Holotype* — IGPSB (Istituto di Geologia, Padova, collez. Sardegna) 224, from the Hauterivian, south of M. Uddè, Lanaitto, Sardinia. Dep. Institute of Geology, University of Padua.

Dimen. <sup>(3)</sup> of Holotype	L.	B.	T.
		22.6	19.2
<i>Paratypes</i>	L.	B.	T.
	IGPSB 213	14.5	11.7
» 212	16.4	13.0	9.0
» 208	18.0	15.0	9.9
» 210	18.1	14.8	10.0
» 214	19.0	14.8	9.9
» 207	19.6	16.5	11.0
» 322	23.7	19.3	13.2
» 216	24.0	19.4	15.4
» 201	25.2	20.5	14.2
» 235	27.9	22.6	16.6

IGPSB 322 is from the Hauterivian of Orudè Valley, the remainder from the Hauterivian south of M. Uddè, Lanaitto, Sardinia. All deposited in the Institute of Geology, University of Padua.

*Name* — The species is named in honour of Karl Deninger, who was the first to describe Cretaceous brachiopods from central eastern Sardinia.

*Diagnosis* — *Sellithyris* distinctly longer than broad, maximum breadth anterior of mid-line. Valves equally convex. Umbo sub-erect to erect. Foramen mesothyrid to per-mesothyrid, non-labiate. Lateral commissure oblique. Anterior commissure sulcinate to episulcate; median sinus small; plicae and sinuses rounded. Folding affecting anterior half of shell in adult. Hinge plates usually concave, rarely resupinate, well differentiated from inner socket ridges. Crural processes gently incurved, thickened at their dorsal

<sup>(3)</sup> All dimensions are in millimetres.

ends, not flanged. Descending lamellae of loop thin. Transverse band high, broad, trapezoid. Euseptoidum well developed posterior of the crura; flanked by two euseptoidum-like ridges.

*Description* — This species develops biplication at an early growth stage, some specimens 13.5 mm in length being already

sulciphate, while others of that length and smaller are uniplicate. Episulcation is seen only in large specimens over 25 mm in length. Fig. 4 shows that the growth is isometric. The specimens from the Lower Hauterivian of M. Uddè and those of the same age from the Orudè Valley were, in each case, all collected from one bed and

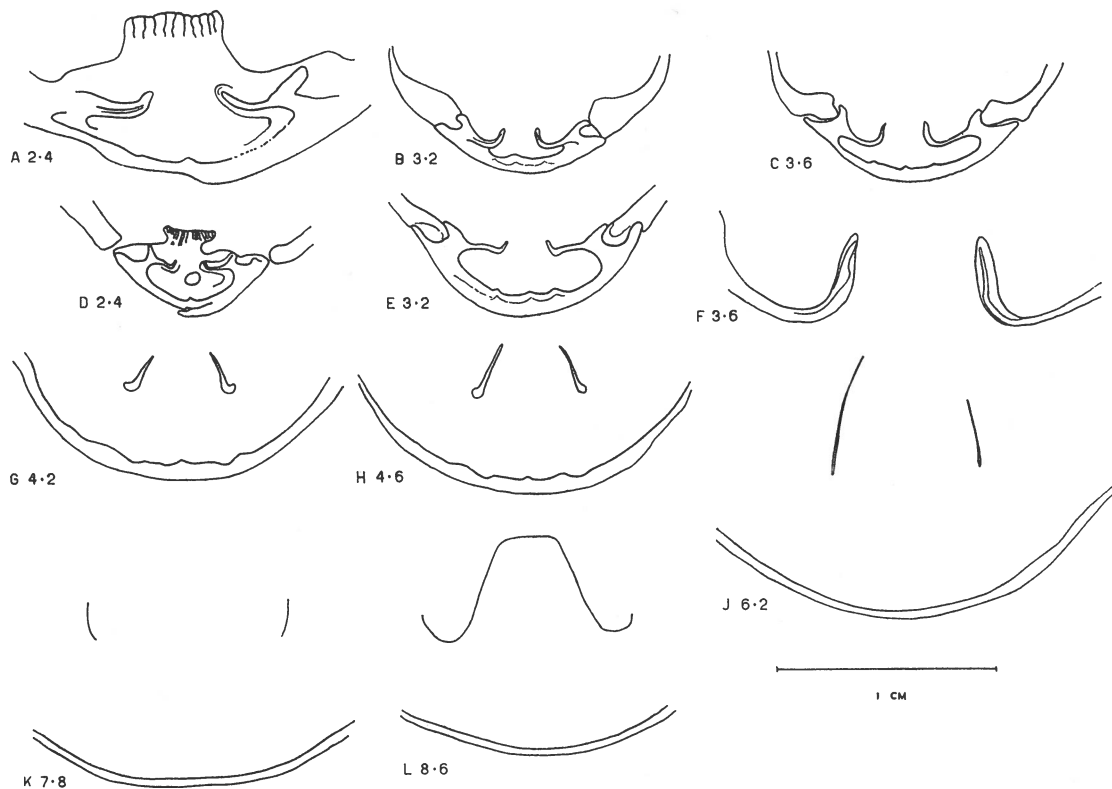


Fig. 3 - Transverse sections through *Sellithyris deningeri* sp. nov. (\*).

A-C IGPSB 219 to show the development of the hinge plates. A is at 3x the scale of B and C to show the juvenile hinge plates enclosed in the cardinal process.

D-E IGPSB 201 to show the unusual resupinate hinge plates of this individual.

F The hinge plates of IGPSB 219 to show the development of the crural bases, enclosed by secondary thickening (3x the scale of the other sections).

G-L IGPSB 201. Maximum height of the crural processes is shown in J. The high-arched and slightly trapezoid transverse band is seen in L.

The centimetre scale does not apply to A or F.

Both specimens are from the Hauterivian of M. Uddè, Dergali.

(\*). The numbers appended to the serial sections indicate the distance in millimetres from the ventral beak.

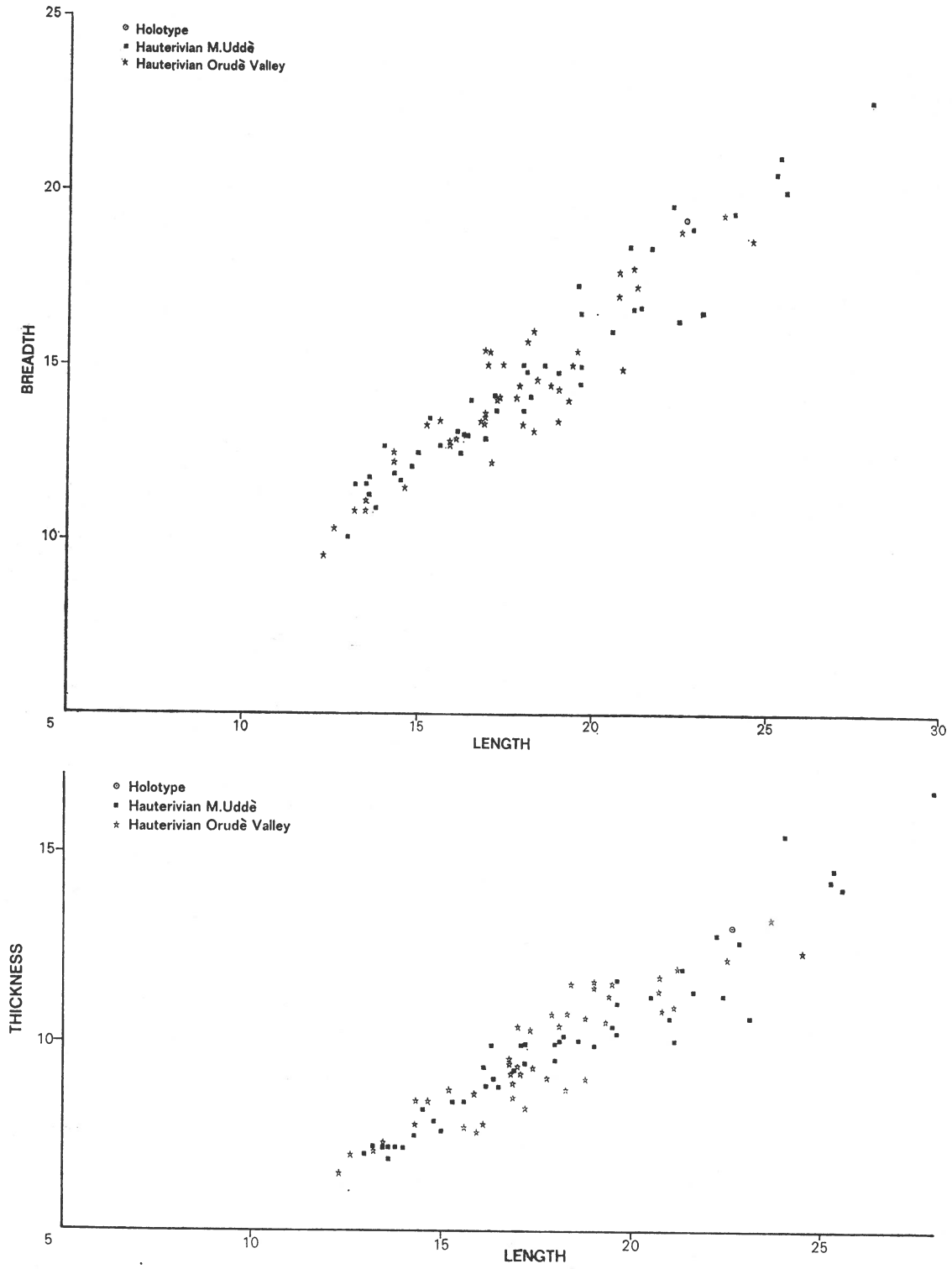


Fig. 4 - Relationships of length to width and length to thickness in *Sellithyris deningeri* sp. nov.

represent homogeneous populations, probably life-assemblages.

*Material* — 65 specimens from the Lower Hauterivian, 1 km. south of M. Uddè, Lannaitto, Dorgali; 66 specimens from the Lower Hauterivian, Orudè Valley, east of M. Omene, Dorgali; 2 specimens from the Lower Hauterivian, Badde Funtana Morta, Orosei.

*Remarks* — This is the most abundant terebratulacean species found in the Lower Cretaceous of central eastern Sardinia, where it is characteristic of the marly facies of the Lower Hauterivian. Deninger (1907) recorded, without figuring, *Terebratula moutoniana* d'Orb. from the « Neocomian » south of Costas d'Ossu, Dorgali. This very probably refers to *S. deningeri*, since this species is very common at this locality, whereas *T. moutoniana* has not been found during the recent re-study of this area; one doubtful specimen only has been collected from the basal Aptian of Orosei (p. 191).

This species has a strong superficial resemblance to *Loriolithyris valdensis* (de Lor.), an abundant species in the Upper Valanginian and Hauterivian of the Jura region, especially in the moderately elongate shape with maximum breadth anterior of the mid-line, the sub-erect to erect umbo and the very rounded plication of the anterior commissure. *L. valdensis* differs externally from *S. deningeri* in the position of the line of maximum breadth, which is further forward in *L. valdensis*, and in the umbo, which in *L. valdensis* tends to be more produced, causing the symphytium to lie at a high angle to the commissural plane; the symphytium is also more clearly visible in *L. valdensis*. Internally the main differences are in the shape of the hinge plates and the presence in *S. deningeri* of the lateral euseptoidum-like ridges on either side of the euseptoidum.

*S. deningeri* differs markedly from the Hauterivian forms of *S. sella* (J. de C. Sowerby). The latter are much more depressed, broader in relation to their length, their maximum breadth corresponds approximately to the mid line, folding affects a greater pro-

portion of the shell, and the umbo is less erect than in *S. deningeri*.

Genus MUSCULINA Schuchert  
& Le Vene, 1929, emend.

Type-species: *Terebratula biplicata acuta* von Buch, 1834 [= *Musculina sanctaerucis* (Catzigras, 1948)] (non *Terebratula acuta* Sowerby, 1816).

*Emended diagnosis* — Small (not more than 35 mm long); elongated (much longer than wide), drawn out posteriorly. P/A ratio high (nearly 2). Brachial valve strongly convex posteriorly, flattening anteriorly. Umbo straight to sub-erect; symphytium well-exposed and clearly bordered by ridges. Foramen rather small, mesothyrid to permesothyrid; beak ridges rounded. Anterior commissure sulcinate. Shell folded in accordance with the plication. Plication and folding developed at an early growth stage. Cardinal process small, secondarily enlarged by callus. Hinge plates strongly concave. Crural bases high but not sharply differentiated from hinge plates, clubbed. Crural processes thickened at their bases and incurved at their tips; crura not flanged. Loop lamellae narrow. Transverse band narrow, high-arched.

*Remarks* — The name *Musculus* was used by Scheuchzer (1716) in clear reference to the species here called *Musculina sanctaerucis*. The name was passed over as pre-Linnaean by von Buch, Quenstedt and later authors, although mentioned by Quenstedt (1871). Buckman (1907) resuscitated the name, apparently thinking it would be applicable to most Cretaceous biplicate terebratulids. By that time *Musculus* was preoccupied by a lamellibranch and Schuchert & Le Vene (1929) proposed *Musculina* as *nomen novum*. All these authors appear to have had the same type species in mind thus, although as described below there has been some difficulty with the name of the species, there seems no doubt about the valid name of the genus.

MUSCULINA SANCTAECRUCIS (Catzigras)  
Pl. 32, figs. 12-15; text-figs. 5-6

- 1834 *Terebratula biplicata acuta* - VON BUCH, p. 108 (non *Terebratula acuta* J. Sowerby, 1816).
- 1835 *Terebratula biplicata acuta* - VON BUCH, p. 128 (non *Terebratula acuta* J. Sowerby, 1816).
- 1849 *Terebratula praelonga* Sow. - D'ORBIGNY <sup>(5)</sup>, p. 75; pl. 505, fig. 1-7 (non *Terebratula praelonga* J. de C. Sowerby, 1836).

- 1851 *Terebratula biplicata acuta* von Buch - QUENSTEDT, p. 473; pl. 38, fig. 2 (as *T. acuta*).
- v 1861 *Terebratula acuta* Quenst. - DE LORIOI, p. 115; pl. 15, fig. 1-10.
- 1867 *Terebratula biplicata acuta* von Buch - QUENSTEDT, p. 565; pl. 48, fig. 2.
- 1871 *Terebratula biplicata acuta* von Buch - QUENSTEDT, p. 384; pl. 48, fig. 70-74 (as *T. acuta*).
- v 1872 *Terebratula acuta* Quenst. - PICTET, p. 14; pl. 202, fig. 14-18.
- 1885 *Terebratula biplicata acuta* von Buch - QUENSTEDT, p. 720; pl. 55, fig. 41.

(5) Dates of publication of works by d'Orbigny are cited according to Sherborn (1899).

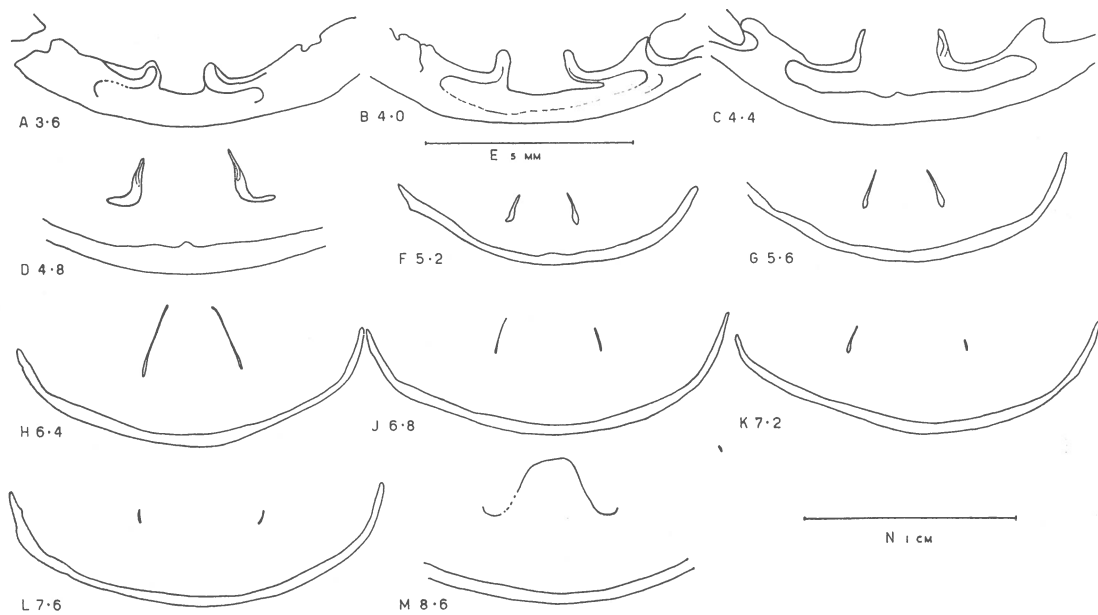


Fig. 5 - Transverse sections through *Musculina sanctaecrucis* (Catzigras).

A-D are at 2x the scale of F-M. The development of the crural bases is seen in C and D. Maximum height of the crural processes is seen in H.

E scale for sections A-D.

N scale for sections F-M.

IGPSB 135, Lower Hauterivian, Sas Mesas, Monte Albo.

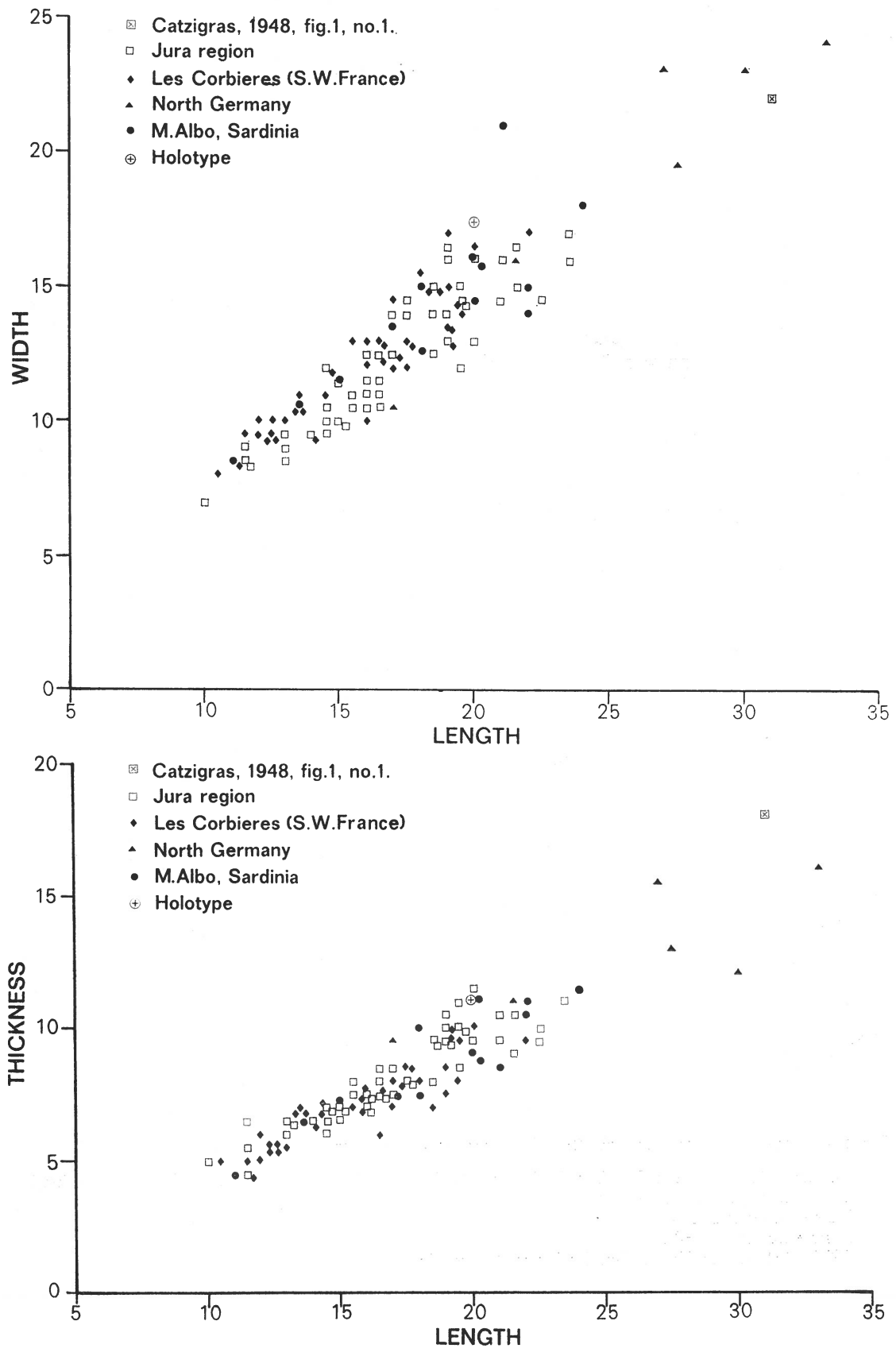


Fig. 6 - Relationships of length to width and length to thickness in *Musculina sanctaecrucis* (Catzigras).

- 1907 *Musculus acutus* Quenst. -  
BUCKMAN, p. 530.
- 1929 *Musculina acuta* Quenst. -  
SCHUCHERT & LE VENE, p.  
120.
- + 1948 *Terebratula sanctae crucis* -  
CATZIGRAS, p. 391, fig. 1  
(1-4, 8, 10, 12, 15-17, 19).
- 1960 «*Terebratula*» *acuta acuta*  
Quenst. - SMIRNOVA, p. 374;  
pl. 1, fig. 2.
- 1962 *Terebratula sanctae crucis*  
Catz. - LEFAVRAIS-RAYMOND,  
pl. 6, fig. 2.
- v 1965 *Musculina biennensis* - MUIR-  
WOOD in MOORE, p. H793,  
fig. 658(1), 659(2).
- 1966 *Sellithyris acuta* (Quenst.) -  
VOGDANOVA & LOBACHEVA,  
p. 56, fig. 20; pl. 5, fig. 1-2.
- v 1968 *Musculina sanctaecrucis* (Cat-  
zigras) - MIDDLEMISS, p. 19,  
fig. 9; pl. B, fig. 3-4.
- 1972 *Sellithyris acuta* (Quenst.) -  
SMIRNOVA, p. 80, fig. 39,  
pl. 7, fig. 4.

*Holotype* — The specimen figured by Quenstedt (1851, pl. 38, fig. 2; 1867, pl. 48, fig. 2; 1871, pl. 48, fig. 70; 1885, pl. 55, fig. 41), from the Neocomian of Neuchâtel, Switzerland. The specimen is preserved in the Geologisches-Paläontologisches Institut und Museum, Tübingen (labelled 48.70).

*Diagnosis* — As for genus.

*Description* — Typical examples of this species, from the Hauterivian marls of the Hauterive area, Switzerland, are unmistakable. Quenstedt (1871) remarked «Man erkennt die Neufchateller Form auf den ersten Blick». The main elements of this distinctive appearance are (a) the high ratio of length to breadth, (b) the high P/A ratio, (c) the posterior tapering of the pedicle valve, (d) the well developed folding and plication for the size of the shell, (e) the bulbous convexity of the posterior part of the brachial valve, (f) the relatively straight beak, (g) the well-exposed and clearly bor-

dered symphytium. When the species is traced away from the Jura region into southern France and Spain more variation is found. The specimens from Sardinia are rather poorly preserved and partly silicified but are generally typical in shape and proportions.

*Material* — 15 specimens from the Lower Hauterivian of Sas Mesas, Monte Albo, Sardinia.

*Remarks* — Von Buch (1834) was the first to apply a post-Linnaean name to this species, but he regarded it as a variety of *Terebratula biplicata* Sowerby, calling it *T. biplicata acuta*. He was clearly referring to the present species since he said it occurred in the «Kreidemergel des Jura, bei Neuchâtel, Haute Rive» and described it as «klein und spitz . . . Die Falten stehen scharf hervor und eng aneinander». He remarked that its small size would have justified making it a separate species had not larger specimens also occurred in the same beds.

Quenstedt (1851, 1867, 1871) followed von Buch's lead in regarding it as a variety *acuta* of *T. biplicata*. In 1851, while the name *T. biplicata acuta* appears in the text, the name *T. acuta* is used in the explanation of plate 38, fig. 2. This was clearly a misprint as in the second and third editions of the same work (1867, 1885) he reprinted the same figure but corrected the caption to *T. biplicata acuta*. Since von Buch's name was a *nomen nudum*, authorship of the name *T. biplicata acuta* must be ascribed to Quenstedt 1851. De Loriol (1861) and Pictet (1872) raised the taxon to species rank as *T. acuta* Quenstedt 1851. Buckman (1907) took Quenstedt's (1871) passing mention, that Scheuchzer in 1716 had used the name *Musculus anomius* for this form, as justification for ascribing the binomial form *Musculus acutus* to Quenstedt. When Schuchert & Le Vene (1929) had proposed their *nomen novum* (see above) there was an apparent species *Musculina acuta* (Quenstedt). As a specific name, however, *T. acuta* Quenstedt 1851 is a junior homonym of *Terebratula acuta* Sowerby 1816, a species of the Lower Juras-



sic. Von Buch and Quenstedt were well aware of the existence of *T. acuta* Sowerby, as both referred to it in their works and Quenstedt (1851) figured it; this makes it still more clear that his use of the name for the Cretaceous form was an inadvertent error.

A new name was needed and this was supplied by Catzigras (1948) with her *Terebratula sanctae crucis*. Muir-Wood (in Moore 1965) overlooked Catzigras' work and named the species *Musculina biennensis* - generically correct but the trivial name is clearly a junior synonym. Russian authors (e.g. Smirnova 1972) have continued to use the name *acuta*.

*Distribution* — *M. sanctaerucis* can be regarded as the Hauterivian brachiopod par excellence in western Europe. It is abundant in that stage in the Jura region (Jura, Doubs, Haute-Saône, Neuchâtel, Mont Salève) and the south-east Paris Basin (Yonne, Haute-Marne, Aube) and also occurs fairly commonly in the south of France (Drôme, Var, Aude, Pyrénées-Orientales, central Pyrénées). In the Hauterivian it also reached Sardinia and, probably at that time, Ibiza. In the boreal Hauterivian it is known from most German localities in the shallow-water marginal facies: Berklingen, the Salzgitter area and the Teoutoburgerwald, but never in large numbers, and it is unknown in England. Smirnova (1972) records it from the Lower

Hauterivian of the northern Caucasus, Voganova & Lobacheva (1966) from that of the Kopet Daga (Turkmenistan).

The species is found rarely in the Barremian (Vaud, south-east Paris Basin) and the Aptian (Aude; also eastern Spain according to Mallada 1887), but is not certainly known to occur in the Valanginian. Corroy (1925) states that it does not extend higher than basal Barremian in the Paris Basin.

Genus LORIOLITHYRIS Middlemiss, 1968

Type-species: *Terebratula russillensis*  
de Loriol, 1866

LORIOLITHYRIS VALDENSIS (de Loriol)  
Pl. 36, figs. 9-10; text-fig. 7

v + 1868 *Terebratula valdensis* - DE  
LORIO, p. 52; pl. 4, fig.  
9-12.

v 1872 *Terebratula valdensis* de Lor.  
- PICTET, p. 66; pl. 201, fig.  
11-15.

non 1939 *Terebratula valdensis* var.  
*kentugajensis* - MOISSEEV, p.  
200; pl. 2, fig. 6.

1960 *Terebratula valdensis* de Lor.  
- SMIRNOVA, p. 374; pl. 1,  
fig. 1.

#### EXPLANATION OF PLATE 32

Figs. 1-11 - *Sellitthyris deningeri* sp. nov.

1 a-d IGPSB 224. HOLOTYPE.

2 a-d IGPSB 201, 3 a-d IGPSB 207, 4 a-d IGPSB 208, 5 a-d IGPSB 210, 6 a-d IGPSB 212,  
7 a-d IGPSB 213, 8 a-d IGPSB 214, 9 a-d IGPSB 216, 10 a-d IGPSB 235, 11 a-d IGPSB 322.

All from Hauterivian, south of M. Uddè, Lanaitto, except IGPSB 322 (fig. 11) which is from Hauterivian of Orudè Valley.

Figs. 12-15 - *Musculina sanctaerucis* (Catzigras)

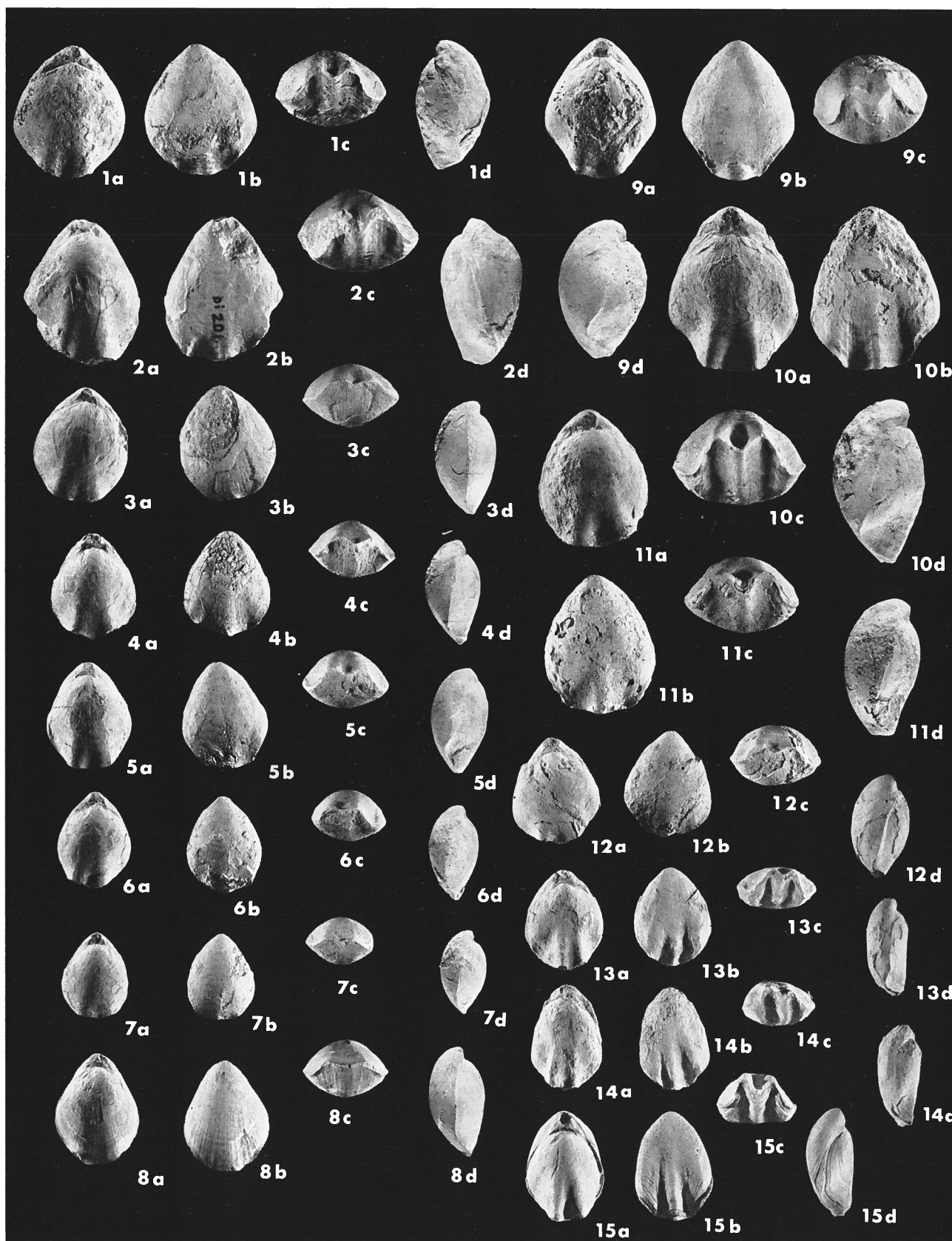
12 a-d IGPSB 138, 13 a-d IGPSB 143, 14 a-d IGPSB 149.

Lower Hauterivian, Sas Mesas, M. Albo.

15 a-d BM B 35735. A typical example from the Hauterivian Marls of Hauterive, Neuchâtel, Switzerland.

All figures at natural size.

I. DIENI - F.A., MIDDLEMISS - E.F. OWEN  
THE LOWER CRETACEOUS BRACHIOPODS OF EAST-CENTRAL SARDINIA





- pars 1966 *Sellithyris valdensis* (de Lor.) - VOGDANOVA & LOBACHEVA, p. 55, fig. 19; pl. 5, fig. 7 (non pl. 7, fig. 11).  
 v 1968 *Loriolithyris valdensis* (de Lor.) - MIDDLEMISS, p. 12, fig. 5; pl. A, fig. 5.  
 1972 *Sellithyris valdensis* (Lor.) - SMIRNOVA, p. 81; pl. 7, fig. 5.

*Lectotype* — Dep. Museum d'Histoire Naturelle, Geneva (Arzier Collection), no. CB 1505. Designated by Middlemiss 1968. Figured by de Loriol 1868, pl. 4, fig. 9 a-d, from Bed B of the Valanginian, Arzier quarries, Vaud, Switzerland.

*Diagnosis* — *Loriolithyris* distinctly longer than broad, maximum breadth well anterior of mid-line. Valves equally convex. Umbo erect, often produced. Foramen mesothyrid, slightly marginate, to labiate. Lateral commissure arched. Anterior commissure sulciphate to episulcate, median sinus small. Plicae and sinuses of the commissure rounded. Folding affects the anterior third

of the shell in adults. Hinge-plates concave to sigmoid, piped, becoming thin anteriorly. Crural processes thin and sharp-pointed.

*Material* — 2 specimens from the Upper Valanginian (IGPSB 1, 4), 2 from the Lower Hauterivian (IGPSB 127, 128), Badde Funtana Morta, Orosei, Sardinia.

<i>Dimensions</i>	L.	B.	T.
IGPSB 128	12.8	10.5	5.8
» 1	13.7	11.7	6.7
» 127	15.9	13.4	7.6
» 4	20.5	16.3	10.3

*Distribution* — The species is most abundant in the Berriasian and Valanginian of the Jura region (Sainte-Croix, Arzier, Salève); Corroy (1925) lists it from the Valanginian of the south-east Paris Basin. It occurs in the Hauterivian of Auxerre (Yonne) and Vassy (Haute-Marne). Smirnova (1972) records it from the Valanginian of Georgia (U.S.S.R.) and the Lower Hauterivian of the northern Caucasus, Vogdanova & Lobacheva (1966) from the Neocomian of the Kopet Daga (Turkmenistan). Museum specimens

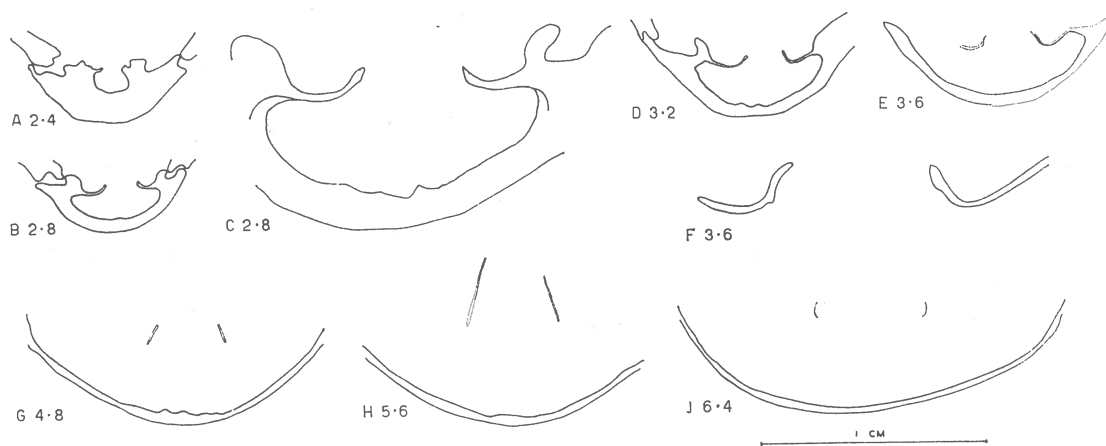


Fig. 7 - Transverse sections through *Loriolithyris valdensis* (de Lor.).

C and F are at 3x the scale of the other sections. The piped hinge plates are seen in B-D. C shows the development of the very small crural bases, a further stage in which is seen in E and F (slightly oblique to the axis of the shell).

Maximum height of the crural processes is shown in H. The transverse band was not preserved.

The centimetre scale does not apply to C or F.

IGPSB 4, Upper Valanginian, Badde Funtana Morta, Orosei.

(British Museum and Mus. Nat. Hist., Paris) come from the Barremian of Basses Alpes and Alpes Maritimes and the Aptian of La Presta (Neuchâtel). It occurs also in the Valanginian and Hauterivian of eastern Spain. The British Museum collection contains specimens, which appear closely comparable, from the Neocomian of Morocco and Algeria.

Sub-family RECTITHYRIDINAE  
Muir-Wood, 1965

Genus TROPEOTHYRIS Smirnova, 1972

Type-species: *Tropeothyris kugusemi*  
Smirnova, 1972

TROPEOTHYRIS SALEVENSIS (de Loriol)  
Pl. 33, figs. 1, 7; text-fig. 8

v + 1863 *Terebratula salevensis* - DE  
LORIOI, p. 118; pl. 15, fig.  
11-16.

v 1866 *Terebratula salevensis* de  
Lor. - DE LORIOI, p. 86.

v 1872 *Terebratula salevensis* de  
Lor. - PICTET, p. 72; pl.  
202, fig. 9.

1960 *Terebratula salevensis* de  
Lor. - SMIRNOVA, p. 374; pl.  
1, fig. 4.

non 1966 *Selliathyris salevensis* (de Lor.)  
- VOGDANOVA & LOBACHEVA,  
p. 51, fig. 17; pl. 5, fig. 3-4.

v 1968 «*Terebratula*» cf. *salevensis*  
de Lor. - MIDDLEMISS, p.  
21, fig. 10; pl. B, fig. 5-6.

1972 *Tropeothyris salevensis* Pict.  
- SMIRNOVA, p. 73, fig. 35;  
pl. 6, fig. 4.

*Lectotype* — Here designated. De Loriol  
1863, pl. 15, fig. 11a-d. Specimen preserved  
in the Museum d'Histoire Naturelle, Geneva  
(unnumbered).

*Emended diagnosis* — *Tropeothyris* of  
elongate oval form; maximum breadth some-  
what anterior of mid-line. Both valves  
very convex; pedicle valve with maximum  
convexity close to umbo. Umbo erect. Sym-

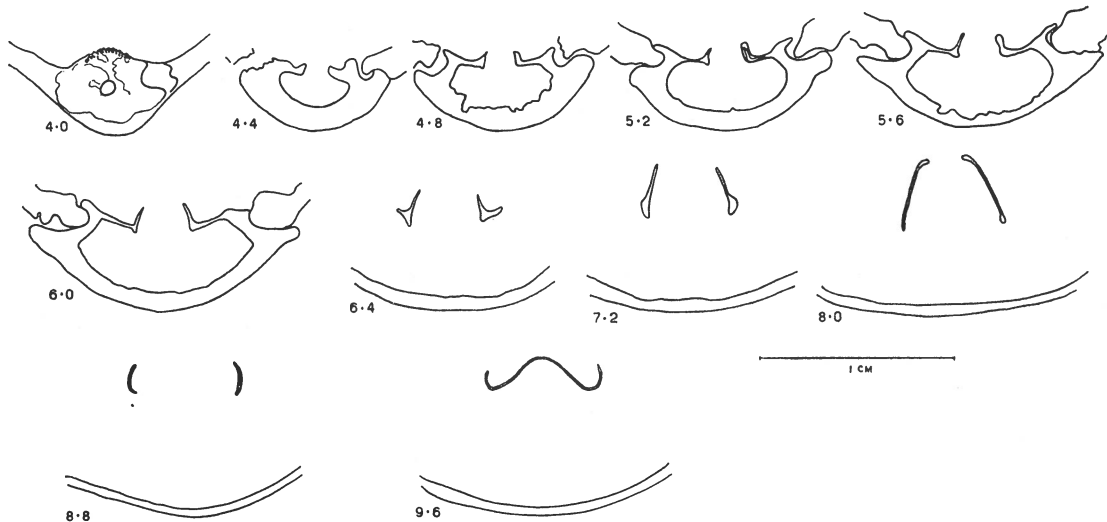


Fig. 8 - Transverse sections through *Tropeothyris salevensis* (de Lor.).

Selective silicification of primary skeletal structures within the cardinal process had occurred in this specimen, as indicated at 4.0. The fundamentally horizontal hinge plates, with well-developed crural bases, are seen at 4.4 - 6.0. Maximum height of the crural processes is shown at 8.0. The transverse band in this individual, seen at 9.6., is unusually low for the species.  
IGPSR 23, basal Aptian, Badde Funtana Morta, Orosei.

phytium very short and broad. Foramen mesothyrid, may be slightly labiate. Beak ridges very rounded. Lateral commissure oblique. Anterior commissure episulcate, plicae and sinuses rounded. Shell folded only at anterior end in adults; plication and folding developed at a late stage of growth. Hinge plates horizontal, keeled, well differentiated from inner socket ridges. Crural bases slightly clubbed, set at almost a right angle to the hinge plates. Transverse band medium to high-arched.

*Description* — Pictet (1872) gives a good description of this species. He rightly points, as essential features, to the very small amount of folding and to the rounded appearance of the whole shell, lacking angles. The plication of the anterior commissure is usually gentle - de Loriol (in Pictet, 1872) states that the commissure may be almost straight. De Loriol also emphasizes the relatively narrow and thick shape of the shell, adding that wide specimens are rare.

*Material* — 3 specimens from the basal Aptian, Badde Funtana Morta, Orosei, Sardinia.

<i>Dimensions</i>		L.	B.	T.
IGPSB	22	—	17.0	13.0
»	23	25.0	18.3	15.0
»	24	25.0	17.1	17.0

*Remarks* — The few specimens from Sardinia closely resemble Pictet's (1872) figure.

The specimens ascribed to *Sellithyris salevensis* by Vogdanova & Lobacheva (1966) are here excluded from *T. salevensis* because the serial sections they give (fig. 17) do not agree with those given here, by Middlemiss (1968) and by Smirnova (1972).

*Distribution* — This species was apparently always rather rare. The type area is the Hauterivian and Barremian of Mont Salève (Haute-Savoie); mainly the Hauterivian - Pictet (1872) states that it is rare in the Barremian. It is also known from the Hauterivian of Les Corbières (Aude). Smirnova (1960) records it from the Lower Barremian of the Crimea (Smirnova, 1972, gives it as occurring in the Berriasian of the Crimea, without mentioning the Barremian). It continued into the Aptian, being known from that stage in Les Corbières and the

Santander area of northern Spain. It also occurs in the Barremian or Aptian of Ibiza (Balearic Islands).

Genus « TEREBRATULA » *sensu lato*

« TEREBRATULA » DUTEMPLEANA d'Orbigny  
Pl. 33, fig. 2; text-fig. 9

- v pars 1815 *Terebratula biplicata* - J. SOWERBY, p. 201; pl. 90, fig. 1 (non 2-5).  
1823 *Terebratula biplicata* Sow. - J. de C. SOWERBY, p. 53; pl. 437.  
? 1829 *Terebratula subundata* - PHILLIPS, pl. 2, fig. 25.  
pars + 1849 *Terebratula Dutempleana* - d'ORBIGNY, p. 93; pl. 511, fig. 1, 2, 3, 6, 7. (v) non fig. 4 & 5.  
non 1853 *Terebratula Dutempleana* d'Orb. - PICTET & ROUX, p. 536; pl. 51, fig. 1-4.  
pars 1855 *Terebratula biplicata* Brocc. - DAVIDSON, p. 55; pl. 6, fig. 1-9 (as var. *Dutempleana*), ? 10-11, 12 (as var. *obtusa*), ? 13-28, 29-30, ? 30-32; pl. 9, fig. 40 (as *Terebratula biplicata*?) (non Brocchi, 1814); non pl. 6, fig. 33-49.  
non 1858 *Terebratula biplicata* (Brocc.) Sow. - PICTET & RENEVIER, p. 143; pl. 20, fig. 2.  
? 1867 *Terebratula biplicata* Sow. - SCHLOENBACH, p. 33; pl. 21, fig. 1-6.  
1871 *Terebratula biplicata* Sow. - QUENSTEDT, p. 381; pl. 48, fig. 13, 61-67.  
v non 1872 *Terebratula Dutempleana* d'Orb. - PICTET, p. 82; pl. 205, fig. 1-5.  
non 1872 *Terebratula biplicata* var. *Dutempleana* d'Orb. - STOLICZKA, p. 20; pl. 4, fig. 14-17; pl. 5, fig. 1-3 (= *Concin-*

- nithyris andurensis* Sahni, 1960).
- non 1872 *Terebratula biplicata* Sow. - GEINITZ, p. 151; pl. 34, fig. 1-11.
- 1874 *Terebratula biplicata* Sow. - DAVIDSON, p. 33; pl. 5, fig. 1-2.
- 1897 *Terebratula Dutempleana* d'Orb. - PARONA & BONARELLI, p. 66.
- 1903 *Terebratula biplicata* var. *dutempleana* - LAMPLUGH & WALKER, p. 251; pl. 17, fig. 1a-b.
- 1930 *Terebratula Dutempleana* d'Orb. - PASSENDORFER, p. 230.
- ? 1930 *Terebratula dutempleana* d'Orb. - MUIR-WOOD, p. 31; pl. 6, fig. 1-2, ? 3-4.
- ? 1949 *Terebratula Dutempleana* d'Orb. - COLLIGNON, p. 12; pl. 1, fig. 12.
- non. 1958 *Terebratula* (? *Concinnithyris*) *biplicata* (Sow.), var. - SAHNI, p. 6; pl. 1, fig. 8-14.
- ? 1969 *Terebratula dutemplei* d'Orb. PANOW, p. 583; pl. 111, fig. 1, fig. 2-3 (as var. *longimontana* Tiessen).
- 1960 *Terebratula dutempleana* d'Orb. - PAUCA & PATRULIUS, p. 88; pl. 2, fig. 10.
- non 1960 «*Terebratula*» *dutempleana* Orb. - SMIRNOVA, p. 375; pl. 1, fig. 6-7.
- non 1972 *Praelongithyris dutempleana* (Orb.) - SMIRNOVA, p. 66; fig. 31; pl. 5, fig. 3.

*Lectotype* — British Museum (Nat. Hist.) no. B 61531, Cambridge Greensand, Castle Hill, Cambridge, England. Fig. J. Sowerby 1815, pl. 90, fig. 1.

*Emended diagnosis* — Shell pear-shaped or oval to elongate pentagonal. Maximum breadth well anterior of mid-line (P/A ratio usually more than 2). Both valves strongly convex, pedicle valve more convex than bra-

chial, especially near the umbo; both valves flattening anteriorly. Umbo sub-erect to erect. Foramen large, strongly labiate. Symphytium very short, but visible. Lateral commissure broadly arched ventralwards. Anterior commissure gently sulcinate to gently episulcate, with broad, low-arched median sinus and rather angular lateral plicae. Folding affecting not more than anterior third of the shell. Hinge plates horizontal, cuneate. keeled. Transverse band low-arched.

*Description* — Although the high P/A ratio, posteriorly drawn out shape and broad anterior region, strongly labiate foramen and distinctive shape of the anterior commissure give most members of this species an unmistakable appearance, there is a good deal of variation in proportions. Unusually broad or thick specimens are frequently found. The two specimens from Sardinia are, however, typical of the species.

*Material* — 2 specimens from the Clansayesian of Badde Funtana Morta, Orosei, Sardinia.

<i>Dimensions</i>	L.	B.	T.
IPGSB 40	30.8	24.2	18.8
(the other specimen not adequately measurable).			

*Remarks* — J. Sowerby (1815) described this species under the name *Terebratula biplicata* but d'Orbigny and later authors have considered this species to be homonymous with *Anomia biplicata* Brocchi 1814. D'Orbigny (1849) erected the new specific name *Terebratula Dutempleana* expressly as a replacement for *T. biplicata* Sowerby, therefore by Article 72(d) of the International Code the type specimen of the latter is also the type specimen of *T. dutempleana* d'Orbigny. Sowerby (1815, pl. 90) figured four specimens but only fig. 1 is the species for which d'Orbigny intended the name *Dutempleana* and is the only one cited in his synonymy. The original of this figure is therefore chosen as the lectotype of the species. The other specimens figured by Sowerby under the name *T. biplicata* are of a form from the Warminster Greensand (Cenoma-

nian) which remains to be investigated in detail but is certainly specifically, perhaps generically, distinct from *T. dutempleana*.

D'Orbigny himself (1849, pl. 511) figured a variety of forms under his new name. His figures 4 and 5 (which appear to represent one specimen in spite of an indication in the explanation of plates that they represent separate specimens) are of a form which is certainly not the same species as Sowerby's fig. 1. Unfortunately this is the only one of d'Orbigny's figured specimens which can now be traced in the d'Orbigny Collection in Paris. Madame D. Gaspard (pers. comm.) has identified it as specimen no. 6017A (Mus. Nat. d'Hist. Nat.) [now *Praelongithyris rogeri* Gaspard (Gaspard 1974)].

De Loriol (in Pictet, 1872) figured as *T. Dutempleana* a series of forms from the

Jura region. These, which are in the Lausanne Museum, have now been reinvestigated and are certainly generically, as well as specifically, distinct from *T. dutempleana*. They represent an undescribed species of which numerous examples have come from the Aptian of La Presta, in the Val de Travers. This accounts for de Loriol's strongly emphasized statement that *T. dutempleana* occurs in the Lower Aptian in the Jura region, a horizon at which it is not known elsewhere. Similar specimens were figured by Pictet & Roux (1853) and Pictet & Renevier (1858) from the Upper Aptian of the Perte du Rhône.

The question whether or not Sowerby's name *T. biplicata* is valid for this species has been much discussed. Brocchi (1814) applied the name *Anomia biplicata* to a spe-



Fig. 9 - Transverse sections through «*Terebratula*» *dutempleana* d'Orb.

The well-developed pedicle collar is seen at 1.2 - 1.6. Detail within the cardinal process at 6.4 has been lost by silicification. Maximum height of the crural processes is seen at 14.0. The shortness of the loop is noteworthy.

IGPSB 40, Clansayesian, Badde Funtana Morta, Orosei.



cimen which was at the time thought to be of Cretaceous age. This specimen was examined by Saemann & Triger (1861) and also by Deslongchamps (see Davidson 1874, p. 33-34), who all concluded that it was of Lower Jurassic age and probably identical with *Terebratula indentata* Sowerby, although the state of preservation was not adequate to allow certain determination. Apparently the specimen has since been lost (Rossi Ronchetti 1952). Because of this uncertainty, Davidson (1874) concluded that Brocchi's name could be ignored and that Sowerby's name was valid; in this he was followed by Sahni (1958). If this were the case, d'Orbigny's name *T. Dutempleana* would be an absolute synonym and unusable. However, (a) Brocchi's name was applied to a specimen which was still in existence in 1861; (b) the fact that he so applied the name has been known ever since, and the name has not become a *nomen oblitum*; (c) Brocchi's name has priority over Sowerby's. It therefore seems that the name is tied to Brocchi's specimen and cannot be used for any other species. The only way in which Sowerby's name could be made available would be by a decision of the International Commission to use its plenary powers to suppress Brocchi's name, but in view of the existence of d'Orbigny's perfectly good *nomen substitutum* (*T. Dutempleana*) this seems unnecessary.

D'Orbigny in his original description spelled the specific name *Dutempliana*, although on plate 511 he used the spelling *Dutempleana*. As the species was named in honour of Dutemple, the spelling with an *i* can be regarded as an inadvertent error [Article 32 (a) (ii) of the International Code] and is invalid.

The *Praelongithyris dutempleana* of Smirnova (1972) appears from the serial sections given to be a species of *Praelongithyris*; the internal structures certainly resemble that genus and are quite unlike those of «*T.*» *dutempleana* d'Orbigny. There is considerable external resemblance between «*T.*» *dutempleana* and *Praelongithyris praelongiforma* Middlemiss, especially in the drawn out posterior part of the shell and the labiate foramen. The main differences, apart from internal structures, lie in the relative anterior flattening of «*T.*» *dutempleana*, compared with the blunt anterior of *P. praelongiforma*, the less erect umbo and better-exposed symphytium of the latter, and the distinctive anterior commissure of «*T.*» *dutempleana*.

*Cyrtothyris middlemissi* Calzada, 1972, from the Aptian and Albian of Spain and the south of France, has a very strong external resemblance to «*T.*» *dutempleana*, but its umbo is less erect and the foramen less labiate, as well as the generic differences in the internal structures. It is possible that

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#### EXPLANATION OF PLATE 33

Figs. 1 and 7 - *Tropeothyris salevensis* (de Loriol)

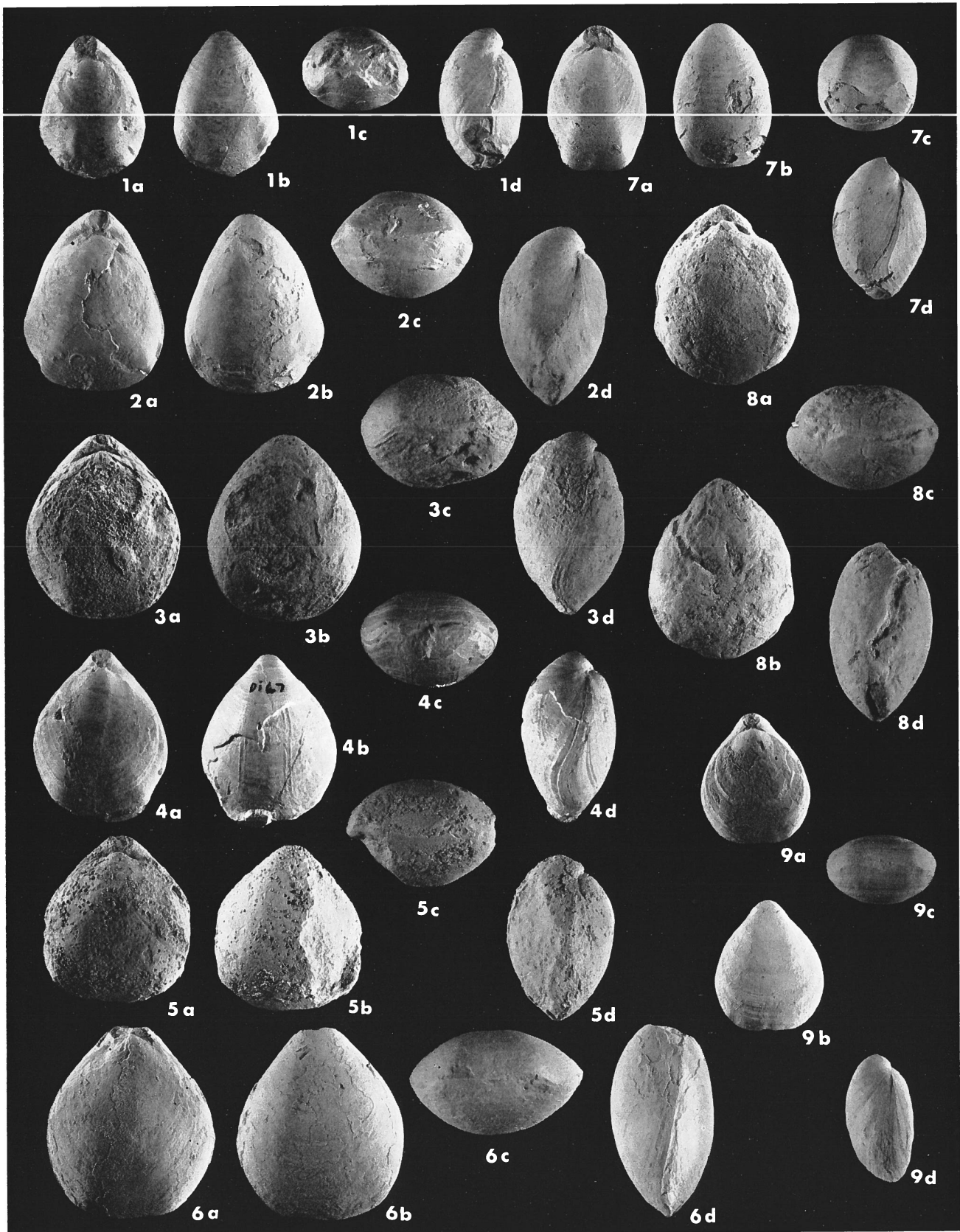
1 a-d IGPSB 23, 7 a-d IGPSB 24.  
Basal Aptian, Badde Funtana Morta, Orosei.

Fig. 2 a-d - «*Terebratula*» *dutempleana* d'Orbigny. IGPSB 40.  
Clansayesian, Badde Funtana Morta, Orosei.

Figs. 3-6, 8-9 - «*Terebratula*» *ichnusae* sp. nov.

3 a-d IGPSB 70. HOLOTYPE.  
4 a-d IGPSB 47, 5 a-d IGPSB 65, 6 a-d IGPSB 66, 8 a-d IGPSB 68, 9 a-d IGPSB 81.  
All from Vraconian, Cuccuru 'e Flores, Orosei.  
All figures at natural size.

I. DIENI - F.A., MIDDLEMISS - E.F. OWEN  
THE LOWER CRETACEOUS BRACHIOPODS OF EAST-CENTRAL SARDINIA





some of the specimens of «*T.*» *dutempleana* recorded from the lower part of the Aptian (e.g. by Pictet 1872) could be *C. middlemissi*.

The specimens figured by Collignon (1949) from the Albian of Madagascar are externally different from *T. dutempleana* and perhaps should be referred to another species.

«*T.*» *dutempleana* has never yet been satisfactorily assigned to a genus. It is hoped to discuss this problem in a later publication and for this reason we have thought it advisable for the present to keep it under the generalised heading of «*Terebratula*».

*Distribution* — «*T.*» *dutempleana* is stated by d'Orbigny to be found in the Albian «Wherever that stage occurs». He records it from the Albian of many localities in northern, eastern and southern France.

It is common in the Red Chalk (Upper Albian) of eastern England as well as occurring in the Gault (Albian) of southern England. It occurs also in the Albian of central Switzerland and of the Polish Carpathians, northern Spain, Ibiza, and possibly of Madagascar and north India.

It appears to continue into the Lower Cenomanian in England (Cambridge Greensand) and Germany (Westphalian Greensand), although the Cenomanian age of the Cambridge Greensand examples is in some doubt, as they may be derived (Casey 1965, Hart 1973). The specific identity of the German specimens remains to be investigated; Schloenbach's (1867) figures appear to represent more than one species, as do those of Geinitz (1872). The relationship of «*T.*» *dutempleana* to the undoubtedly Cenomanian species represented by Sowerby's (1815) figures 2-5 also remains to be investigated. Sahni (1958) figured as *T. biplicata* Sowerby some specimens from the Cenomanian Chalk Marl of Kent and Sussex, but these appear to be typical *Concinthyris*.

In the Aptian the species is very rare. It is certainly known from the Clansayesian of Sardinia (herein) and also from the Upper Aptian of south-east Spain.

«*TEREBRATULA*» ICHNUSAE sp. nov.

Pl. 33, figs. 3-6, 8-9; text-fig. 10

*Holotype* — IGPSB 70, from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

<i>Dimensions of Holotype</i>			
	L.	B.	T.
	31.4	26.4	19.8
<i>Paratypes</i>			
	L.	B.	T.
IGPSB 50	—	17.5	9.9
» 81	22.3	19.0	12.2
» 45	23.4	21.8	14.0
» 65	28.5	25.7	18.8
» 47	29.6	23.3	16.8
» 66	—	29.0	18.1
» 68	31.0	25.3	18.2

*Name* — Derived from Ἰχνοῦσα, the ancient Greek name of Sardinia.

*Diagnosis* — Sub-circular to oval in dorsal profile; maximum breadth about the mid-line. Valves approximately equally convex. Apical angle 80-90°. Umbo sub-erect. Foramen slightly labiate. Symphytium small, but visible. Lateral commissure gently oblique. Anterior commissure sulcificate, with shallow plicae and sinuses; median sinus broad and shallow, lateral plicae slightly angular. Shell exhibiting folding only at extreme anterior edge. Pedicle collar well developed. Hinge plates narrow, horizontal, cuneate. Crural bases high, making a right angle with the hinge plates. Crural processes incurved. Loop short and narrow, transverse band low-arched.

*Description* — Biplication of the anterior commissure is late in developing in this species, not appearing until the shell is over 23 mm in length. Even in the largest of the specimens, the plication is gentle.

*Material* — 8 specimens from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia.

*Remarks* — This species resembles «*T.*» *dutempleana* in the labiate foramen, and the distinctive shape of the anterior commissure, and also in its internal structures. It differs above all in the dorsal profile, which is more

sub-circular, lacking the drawn-out posterior part of «*T.*» *dutempleana*, the lower P/A ratio, and the higher apical angle. It differs also in the more gentle plication of its anterior commissure and the smaller extent to which the shell is affected by folding.

The species shows some resemblance to Davidson's (1855) plate 6, fig. 10, figured as *Terebratula biplicata* var. *obtusa* Sow., from the Cambridge Greensand of England, but the latter is relatively broader and more circular and has a still higher apical angle.

«*T.*» *ichnusae* also shows some resemblance to *Terebratula samanensis* Muir-Wood, 1930, from the Albian of the northern Punjab, India, but the specimens she figured are poor and comparison is difficult. They appear to be somewhat more obese and to be more triangular in the posterior part of the shell than our species.

«*T. ichnusae*» differs from «*T.*» *moutoniana* d'Orb. in having a labiate foramen, more circular dorsal profile, approximately

equally convex valves and narrower and thicker hinge plates.

This species is certainly congeneric with «*T.*» *dutempleana* (see the remarks on generic affinity given under the heading of that species).

«*TEREBRATULA*» *OROSEINA* sp. nov.

Pl. 34, figs. 1-2; text-fig. 11

*Holotype* — IGPSB 48, from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

<i>Dimensions of Holotype</i>			
L.	B.	T.	
25.5	—	18.0	

<i>Dimensions of paratypes</i>			
IGPSB	L.	B.	T.
84	20.8	17.0	14.2
» 69	—	23.3	17.6

All from same locality as holotype. Dep. Institute of Geology, University of Padua.

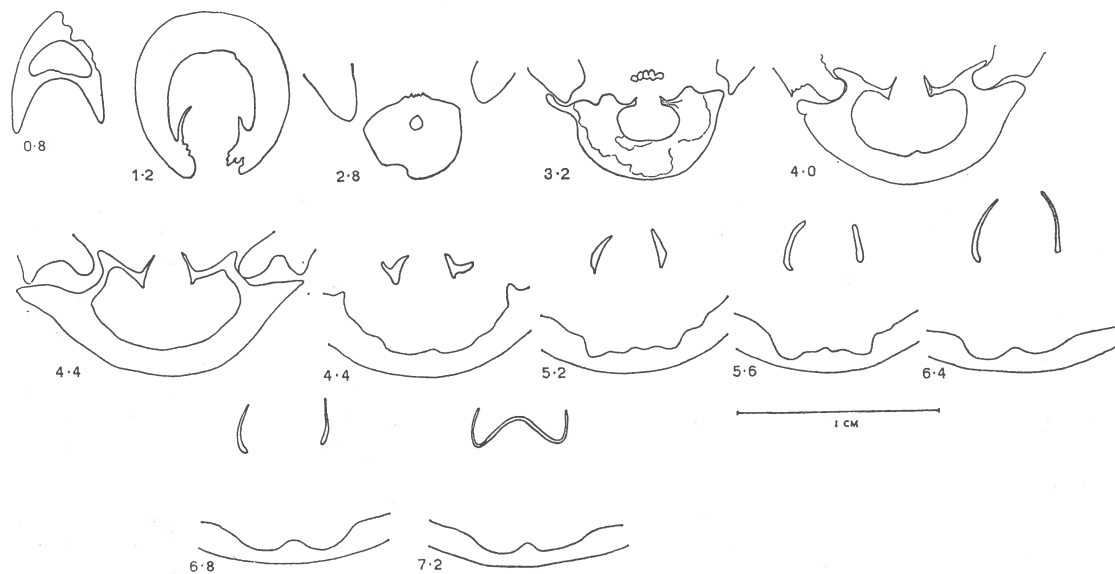


Fig. 10 - Transverse sections through «*Terebratula*» *ichnusae* sp. nov.

The well-developed pedicle collar is seen at 0.8-1.2. Detail in all the sections 0.8-4.0 has been obscured by silicification. Maximum height of the crural processes is shown at 6.4. IGPSB 47, Vraconian, Cuccuru 'e Flores, Orosei.

*Name* — The name is derived from the type locality.

*Diagnosis* — Sub-circular in dorsal profile; maximum breadth slightly anterior of mid-line. Both valves strongly convex. Apical angle 80°-90°. Umbo erect. Foramen slightly labiate. Symphytium very short and narrow. Beak ridges very rounded. Lateral commissure oblique. Anterior commissure episulcate, with broad and low-arched median sinus. Slight folding affecting anterior quarter of shell in adults. Prominent longitudinal striation visible in shell. Pedicle collar well developed. Hinge plates horizontal, cuneate. Crural processes thick. Loop short and narrow; tranverse band low-arched.

*Material* — 3 specimens as above.

*Remarks* — «*T.*» *oroseina* is closely related to «*T.*» *dutempleana* and has similar internal structures and anterior commissure but differs in being relatively much shorter, thicker and more obese. It differs from «*T.*» *ichnusae*, which occurs with in the same beds, in being more obese, particularly the brachial valve and in showing greater development of plication and folding.

A form externally resembling «*T.*» *oroseina* occurs in the Red Chalk (Upper Albian) of Hunstanton, England, where it has usually been taken as a variant of «*T.*» *dutempleana*.

«*TEREBRATULA*» cf. *MOUTONIANA*  
d'Orbigny  
Pl. 36, fig. 11

+ 1849 *Terebratula Moutoniana* -  
D'ORBIGNY, p. 89; pl. 510,  
fig. 1-5.

non 1907 *Terebratula Moutoniana*  
d'Orb - DENINGER, p. 469.

<i>Dimensions</i>	L.	B.	T.
IGPSB 26	21.6	17.3	11.0

*Description* — One specimen from the basal Aptian of Badde Funtana Morta, Orseoi, can probably be assigned to this species. The form is oval, with sub-erect umbo; the lateral commissure is oblique and the anterior commissure very gently sulcificate. The foramen is circular and not labiate. The length/thickness ratio is high, but that may be because the shell is that of a relatively young individual.

This specimen agrees with «*T.*» *moutoniana* mainly in the shape of the umbo and in the fact that the pedicle valve is more convex than the brachial.

*Remarks* — *Terebratula moutoniana* is a species that has given rise to much confusion ever since various forms from the English Aptian were mistakenly ascribed to it by Lankester (1863), Meyer (1864) and others.

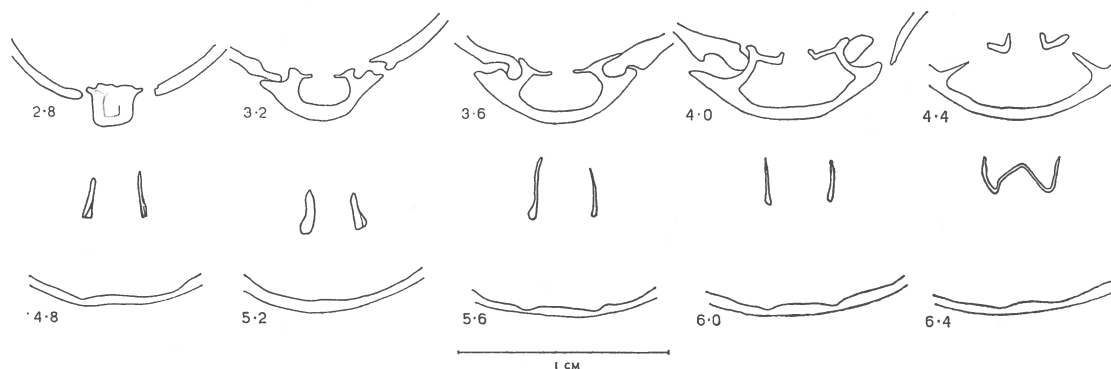


Fig. 11 - Transverse sections through «*Terebratula*» *oroseina* sp. nov.

The crural bases are small in the early stages but are well developed by 4.0. Maximum height of the crural processes is seen at 5.6.

IGPSB 84, Vraconian, Cuccuru 'e Flores, Orseoi.

These forms have now been referred to species belonging to the genera *Platythyris* and *Vectella* by Middlemiss (1959) and Owen (1965) respectively. That the confusion still persists is shown by Smirnova (1972), who figures serial sections of a species which she calls *Platythyris moutoniana* (d'Orb.). The sections are typical of a member of the genus *Platythyris* but differ considerably from those of «*T.*» *moutoniana*.

«*T.*» *moutoniana* was recorded from the «Neocomian» of Costas d'Ossu, Dorgali, Sardinia, by Deninger (1907). As noted on p. 178 these specimens were probably *Selli-  
thyris deningeri*.

The genus to which «*T.*» *moutoniana* d'Orb. should belong is not at present known. We have only one specimen from Sardinia and therefore think it advisable to retain a generalised name for it. The generic affinities of the species will be settled only by investigation of d'Orbigny's type material; this is at present being done.

Family PYGOPIDAE Muir-Wood, 1965, emend.

*Emended Diagnosis* — *Terebratulacea* lacking true crural bases. The hinge plates

are horizontal, tapering or with rounded inner edges, and pass forward as horizontal structures to join the crura. The loop is short and the transverse band low-arched.

Sub-Family PYGOPINAE nov.

Type-genus: *Pygope* Link, 1830.

*Diagnosis* — *Pygopidae* with deep dorsal median sulcus; shell may develop two lateral lobes which come into contact and fuse in adult stage, enclosing median perforation.

Genus NUCLEATA Quenstedt, 1868

Type-species: *Terebratulites nucleatus*  
Schlotheim, 1820

NUCLEATA MEDITERRANEA sp. nov.  
Pl. 34, figs. 3-10; text-fig. 12

*Holotype* — IGPSB 59, from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

#### EXPLANATION OF PLATE 34

Figs. 1-2 - «*Terebratula*» *oroseina* sp. nov.

1 a-d IGPSB 48. HOLOTYPE.  
2 a-d IGPSB 84.  
Vraconian, Cuccuru 'e Flores, Orosei.

Figs. 3-10 - *Nucleata mediterranea* sp. nov.

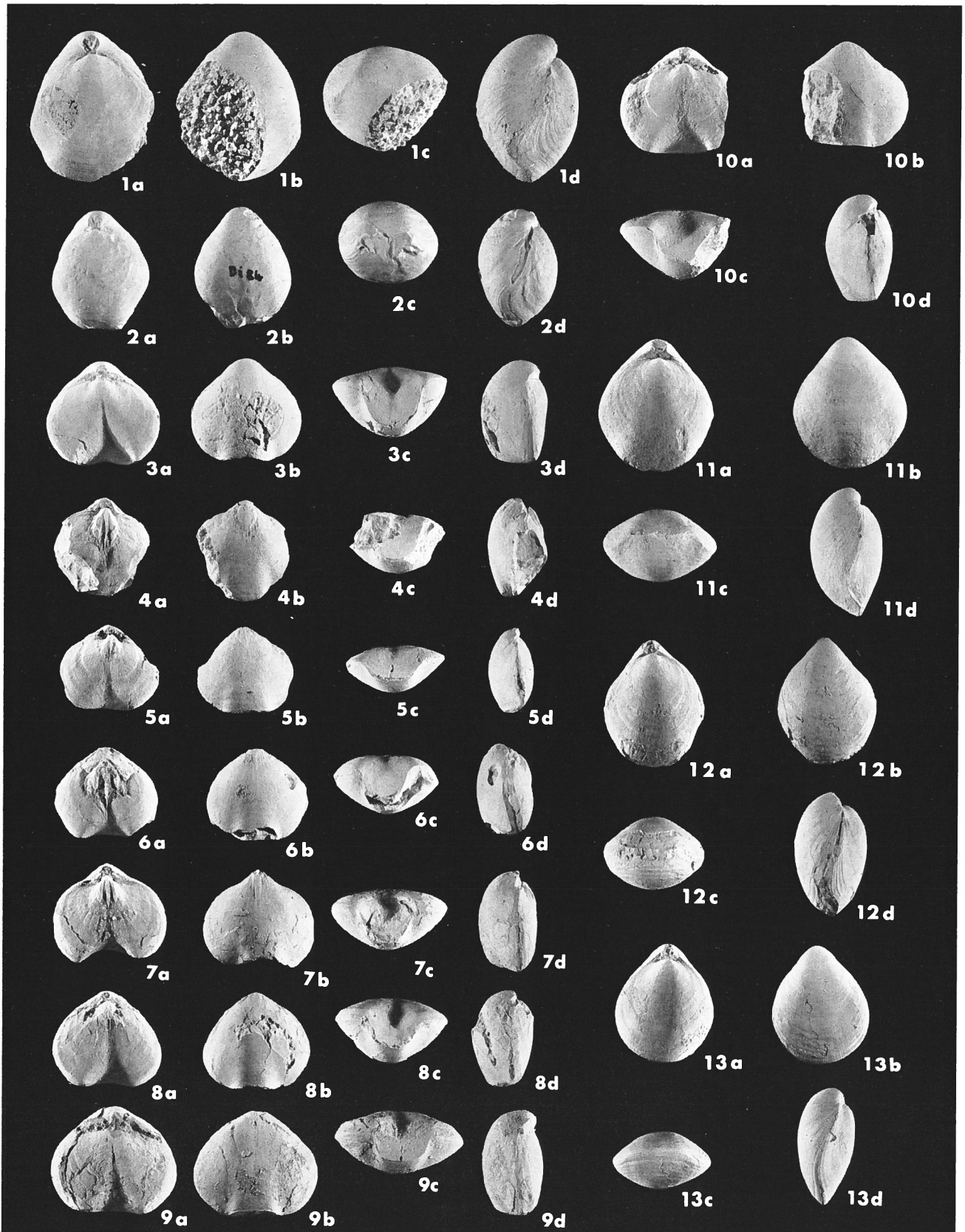
3 a-d IGPSB 59. HOLOTYPE.  
Vraconian, Cuccuru 'e Flores, Orosei.  
4 a-d IGPSB 433, 5 a-d IGPSB 434, 6 a-d IGPSB 435, 7 a-d IGPSB 436, 8 a-d IGPSB 437,  
9 a-d IGPSB 438, 10 a-d IGPSB 439.  
Vraconian, Oued Seybouse, Algeria.

Figs. 11-13 - *Platythyris floresana* sp. nov.

11 a-d IGPSB 97. HOLOTYPE.  
12 a-d IGPSB 64, 13 a-d IGPSB 73.  
All from Upper Albian, Cuccuru 'e Flores, Orosei.

All figures at natural size.

I. DIENI - F.A., MIDDLEMISS - E.F. OWEN  
THE LOWER CRETACEOUS BRACHIOPODS OF EAST-CENTRAL SARDINIA







Dimensions of Holotype L.		B.	T.	
		17.8	19.4	12.2
Paratypes		L.	B.	T.
IGPSB	434	15.0	17.1	8.0
»	435	15.7	17.8	10.1
»	436	16.7	19.6	10.5
»	437	16.7	18.9	11.3
»	433	17.3	—	10.2
»	438	18.3	21.7	10.8
»	439	18.6	—	12.0

From the Oued Cheniout Anticline, Oued Seybouse, south of Bône, Algeria. Dep. Institute of Geology, University of Padua.

*Name* — The name refers to the discovery of the species in both Sardinia and Algeria in the Mediterranean area.

*Diagnosis* — *Nucleata* slightly broader than long. Pedicle valve inflated posteriorly, abruptly truncated anteriorly. Brachial valve flat to gently convex. Umbo erect to incurved. Foramen small, mesothyrid. Beak ridges and cardinal area well defined. Lateral commissure straight. Anterior commissure with deep, evenly arched, median sinus. Pedicle valve with low rounded fold anteriorly; brachial valve with sulcus which develops rapidly in anterior half of shell.

*Description* — Juvenile forms are sub-circular but at a length of about 10 mm already show the dorsal sulcus developing.

*Material* — One specimen from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia. 28 specimens from the Vraconian of Oued Seybouse, south of Bône, Algeria.

*Remarks* — This is the youngest species of the genus *Nucleata* so far described, the youngest previously being from the Albian of La Balme de Rencurel (Isère, France). It is very similar to the form figured by d'Orbigny (1849, pl. 508, fig. 15-18) as *Terebratula hippopus* Roemer (from the Barremian of the south of France), but has a less inflated brachial valve and slightly less deep sinus than d'Orbigny's specimen.

*Terebratula hippopus* d'Orbigny 1849 is quite different from *Terebratula hippopus* Roemer 1840, as has often been pointed out,

for example by de Loriol (in Pictet 1872, p. 105) and Davidson (1874, p. 53). Schloenbach (1867, p. 94) gave the name *Terebratula strombecki* to the specimen represented by d'Orbigny's fig. 15-18. D'Orbigny's figures 12-14, although named *Terebratula hippopus* by him, must represent a completely different species. *Terebratula hippopus* Roemer has been shown by Owen (1965) to be a member of the *Zeilleriidae* and was referred by him to the genus *Rugitela* Muir-Wood 1936. The confusion engendered by d'Orbigny's figure causes difficulties to authors right up to the present day. Karasch (1907) figured a *Nucleata* under the name of *Zeilleria hippopus* and Smirnova (1960 and 1972) figured specimens as *Nucleata hippopus* which, from her descriptions, clearly belong to the genus *Nucleata* and are not *T. hippopus* Roemer. Fülöp (1964) figured as *Nucleata hippopus* good specimens of the genus *Nucleata* from the Bakony Forest.

*Nucleata* appears to be a very uniform genus from the Jurassic to the uppermost Albian and because of this authors have tended to erect species based upon relatively small differences. Barczyk (1972) has recognized four different species among the Middle Tithonian and Berriasian forms of Poland; three of these species are recorded also from the Oxfordian outside Poland, but none is recorded from higher than the Berriasian. Of these four species, *N. bouei* (Zejsz.) has a much more angular sinus and more prominent anterior edge to the pedicle valve than *N. mediterranea*; *N. nucleata* (Schloth.) also has a more prominent anterior edge to the pedicle valve; *N. planulata* (Zejsz.) has a larger and deeper sinus; *N. rupicola* (Zittel) has a narrower sinus.

We consider that the morphological differences between the present specimens and those previously described, together with the considerable gap in age, make it advisable to erect a new species, especially as the specimens from the Vraconian of Algeria are uniform in their characters and accord very closely with the holotype.

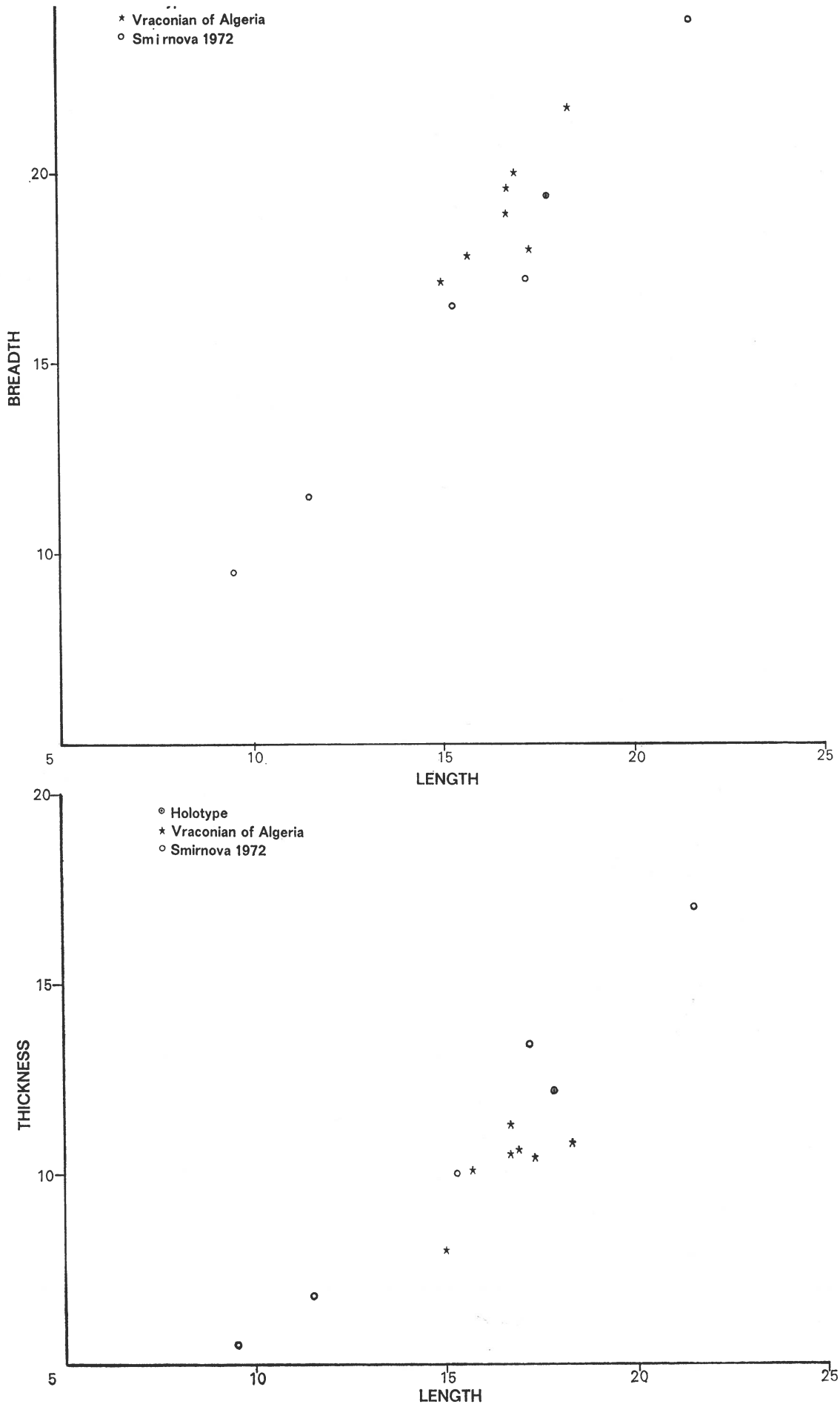


Fig. 12 - Relationships of length to width and length to thickness in *Nucleata mediterranea* sp. nov. and the species of *Nucleata* figured by Smirnova 1972.

Fig. 12 compares *N. mediterranea* with the specimens described by Smirnova (1972) as *N. hippopus*. It can be seen that the Russian specimens tend to be equal in length and breadth (whereas *N. mediterranea* is always broader than long) and to be thicker than the latter species. In these respects the Russian specimens show more resemblance to d'Orbigny's specimen (1849, fig. 15-18), which is also nearer to them in age.

Sub-family PLATYTHYRIDINAE nov.

Type-genus: *Platythyris* Middlemiss, 1959

*Diagnosis* — *Pygopidae* with biconvex shells, without dorsal median sulcus or perforation.

Genus PLATYTHYRIS Middlemiss, 1959, emend.

Type-species: *Platythyris comptonensis* Middlemiss, 1959

*Emended diagnosis* — Shell elongate, oval, or pear-shaped. Lateral commissure arched, anterior commissure rectimarginate, uniplicate or gently sulcinate, or gently sulcate. Shell capillate, or smooth with more or less obvious longitudinal striae. Umbo sub-erect to erect. Foramen mesothyrid to permesothyrid. Symphytium short or very short. Beak ridges rounded. Cardinal process small. Hinge plates horizontal to very slightly concave, tapering, or with rounded inner margins. Crural processes incurved. Loop short; transverse band low-arched.

*Remarks* — Popiel-Barczyk (1972) has referred to this genus the species *T. capillata* d'Archiac 1846, which occurs in the Cenomanian of many parts of northern and central Europe, and *T. rugulosa* Morris 1847 from the Cenomanian of England, France, Poland and Russia.

Species included:

- P. comptonensis* Middlemiss, 1959
- P. minor* Middlemiss, 1959
- T. capillata* d'Archiac, 1846
- T. rugulosa* Morris, 1847
- P. floresana* nov.

PLATYTHYRIS FLORESANA sp. nov.

Pl. 34, figs. 11-13 and Pl. 35, figs. 1-8; text-figs. 13-14

*Holotype* — IGPSB 97, from the Upper Albian of Cuccuru 'e Flores, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

<i>Dimensions of Holotype</i>			
	L.	B.	T.
	22.6	19.8	12.9
<i>Paratypes</i>			
	L.	B.	T.
IGPSB 99	18.6	17.0	10.9
» 73	20.2	17.0	10.1
» 110	20.7	18.5	10.9
» 64	21.6	17.3	12.9
» 71	21.7	19.7	11.5
» 89	22.0	18.2	13.1
» 100	—	20.0	11.6
» 76	23.9	20.6	13.6
» 115	24.3	20.8	13.0
» 116	32.2	27.0	19.5

From the Upper Albian of Cuccuru 'e Flores, Orosei. All dep. Institute of Geology, University of Padua.

*Name* — The name *floresana* derives from the locality Cuccuru 'e Flores (the « hill of flowers »).

*Diagnosis* — *Platythyris* of moderately elongate to pear shape in dorsal profile. Pedicle valve more convex than brachial. Maximum breadth anterior of mid-line. Umbo sub-erect to erect. Foramen mesothyrid. Symphytium short and wide. Beak ridges rounded. Lateral commissure arched. Anterior commissure rectimarginate to uniplicate, to squarely uniplicate or very gently sulcinate. Shell finely capillate, about eleven capilli in 4 mm near the anterior margin. Pedicle collar present. Hinge plates horizontal to very

slightly concave, with rounded inner margins. Crural processes incurved. Transverse band very low-arched. Euseptoidium absent.

*Description* — The capillation is usually rather faint and is difficult to see on some specimens, but is present at all growth stages observed. The almost erect or erect umbo is developed at an early growth stage since the earliest growth stage observed (15.4 mm in length) has an umbo almost as erect as the adults.

*Material* — 35 specimens from the Upper Albian, including Vraconian, of Cuccuru 'e Flores, Orosei, Sardinia.

*Remarks* — This is the most abundant brachiopod species in the Sardinian Upper Albian, although it becomes less frequent in the Vraconian. It differs from *Platythyris capillata* (d'Archiac) (the type of which comes from the Cenomanian of Belgium) in being relatively longer, in having a more erect umbo, and especially, in having fainter and more widely-spaced capilli. Internally it differs in having wider and thinner hinge plates and a narrower loop. In the latter respects it more closely resembles related

undescribed species which occur in the English Lower Albian, but differs from them externally in having less distinct beak ridges, a non-labiate foramen and fainter and more widely-spaced capilli. It differs from *Platythyris comptonensis* Middl. and *P. minor* Middl., from the English Aptian, in that those two species lack true capillation, although the longitudinal striation of the shell may be so strong as almost to resemble capillation, but possess a strong euseptoidium, which is absent in *P. floresana*.

#### Genus SARDOPE nov.

Type-species: *Sardope sardoa* nov.

*Name* — The name is derived from Sardinia, the suffix OPE being taken from the type genus of the family.

*Diagnosis* — Moderately elongated oval shell, flattened anteriorly. Both valves with maximum convexity close to umbo; extreme posterior part of brachial valve inflated. Ventral umbo very short, straight; dorsal

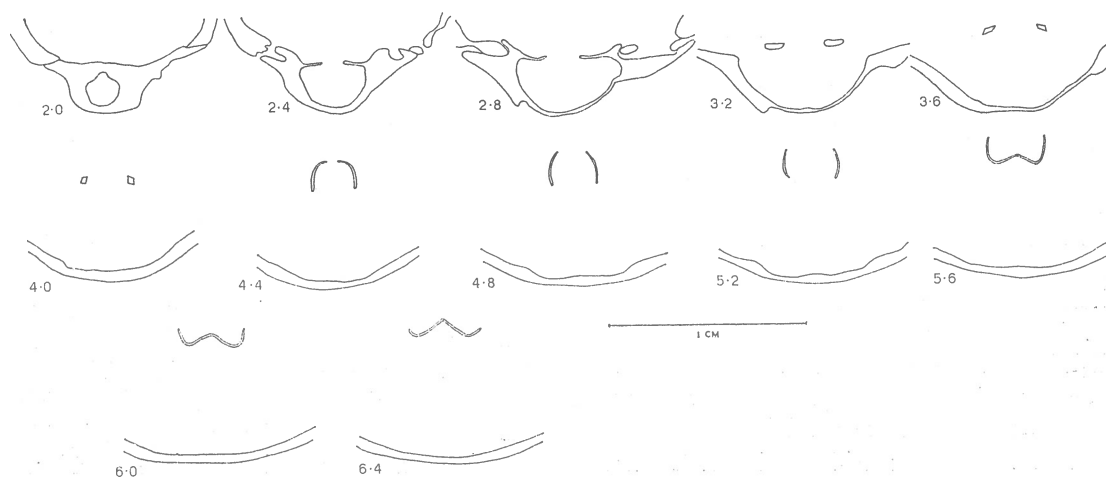


Fig. 13 - Transverse sections through *Platythyris floresana* sp. nov.

Detail of the cardinal process at 2.0 has been lost by silicification. The horizontal hinge plates are shown at 2.4 - 2.8, and can be seen at 3.2 - 3.6 to pass forward to the crura without the development of crural bases. The compact, incurved crural processes are well seen at 4.4.  
IGPSB 71, Upper Albian, Cuccuru 'e Flores, Orosei.

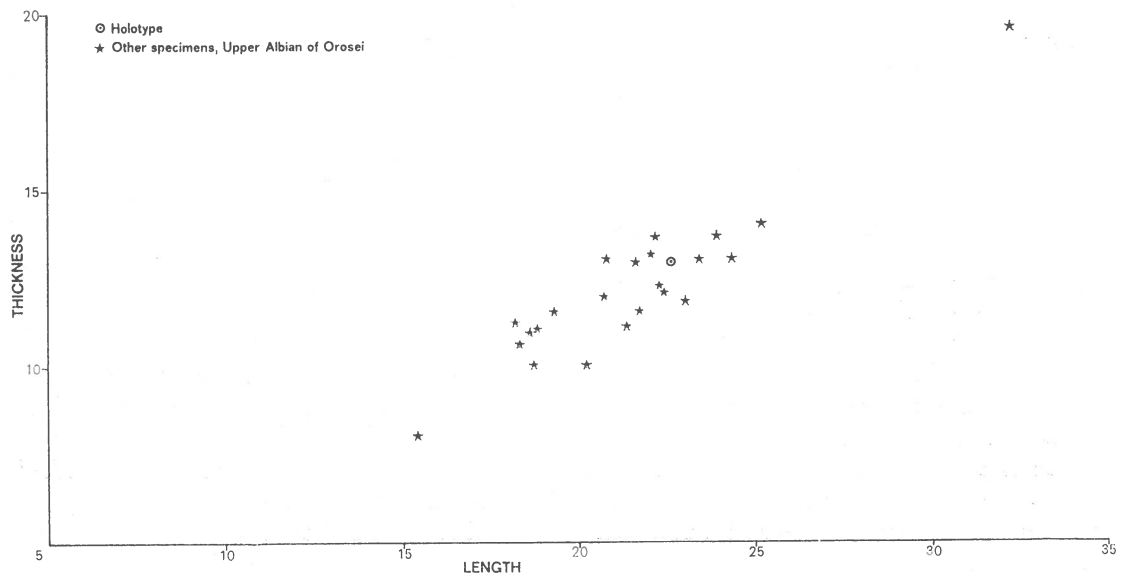
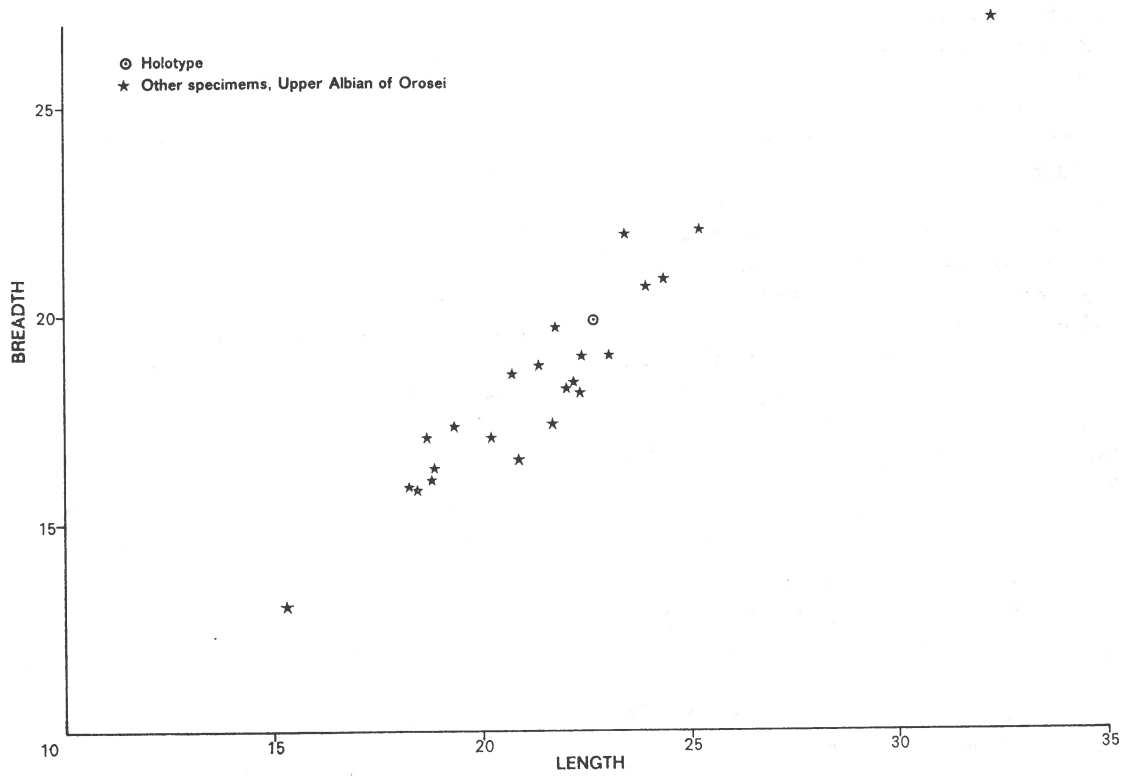


Fig. 14 - Relationships of length to width and length to thickness in *Platythyris floresana* sp. nov.

umbo incurved. Foramen small, circular, mesothyrid. Beak ridges very rounded; cardinal area poorly defined. Deltidium very short. Lateral commissure straight or gently curved. Anterior commissure rectimarginate to very gently sulcinate or parasulcate. Cardinal process initially very small, secondarily extended along hinge plates to leave posterior umbonal cavity. Hinge teeth massive. Hinge plates horizontal, with rounded inner edge, well differentiated from inner socket ridges.

*Remarks* — The main distinctions from *Platythyris* are the very straight beak, the bulbous convexity of the extreme posterior part of the brachial valve and the absence of capillation.

SARDOPE SARDOA sp. nov.

Pl. 35, fig. 9 and Pl. 36, figs. 1-3;  
text-fig. 15

*Holotype* — IGPSB 31, from the basal Aptian, Badde Funtana Morta, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

<i>Dimensions of Holotype</i>				
	L.	B.	T.	
	23.8	19.0	14.2	
<i>Paratypes</i>				
	L.	B.	T.	
IGPSB 36	23.2	17.6	12.4	
» 33	24.2	21.0	15.2	
» 38	24.3	—	13.4	
» 27	24.3	—	14.4	
» 25	24.9	18.5	14.3	
» 37	29.6	26.0	18.0	

From the basal Aptian, Badde Funtana Morta, Orosei. Dep. Institute of Geology, University of Padua.

*Name* — The name is taken from *sardous*, adjective for the people of Sardinia.

*Diagnosis* — As for genus.

*Description* — The distinctive features of this species, immediately recognizable, are the very short, straight ventral umbo and the bulbous convexity of the posterior part of the brachial valve which, with its incurved dorsal umbo, causes the brachial valve in

some specimens to bulge almost as far posteriorwards as the ventral umbo.

*Material* — 16 specimens from the basal Aptian, Badde Funtana Morta, Orosei, Sardinia.

*Remarks* — The elongate oval shape and bulbous brachial valve clearly distinguish this species from previously described members of the *Pygopidae*.

*Distribution* — Specimens which appear to belong to this species are known from the Middle Albian of la Balme-de-Rencurel (Isère, France). An apparently related undescribed species occurs very rarely in the Chalk (Upper Cretaceous) of Northern Ireland.

Family CANCELLOTHYRIDAE Thomson, 1926

Genus « TEREBRATULINA » *sensu lato*

« TEREBRATULINA » MARTINIANA d'Orbigny  
Pl. 36, figs. 4-5

1829 *Terebratula striatula* - PHILLIPS, pl. 2, fig. 28.

+ 1849 *Terebratulina Martiniana* - D'ORBIGNY, p. 59; pl. 502, fig. 8-12.

v pars 1852 *Terebratulina striata* Wahl. - DAVIDSON, p. 35; pl. 2, fig. 26 (non fig. 18-25, 27-28).

1866 *Terebratulina Martiniana* (sic) Orb. - SCHLOENBACH, p. 276; pl. 38, fig. 1-2.

1874 *Terebratulina Martiniana* d'Orb. - DAVIDSON, p. 31.

v 1971 *Terebratulina* cf. *martiniana* d'Orb. - SCHMID, p. 69; pl. 1, fig. 1-7.

*Description* — Elongated pentagonal shape, triangular in the posterior half of the shell; depressed dorso-ventrally. The brachial valve is flat, the pedicle valve gently arched. The anterior commissure is very gently uniplicate; the lateral commissure straight posteriorly, gently arched anteriorly. The ornamentation consists of fine radiating ribs, rounded in cross section, of unequal width,

which gradually increase in number towards the anterior by bifurcation (fascicostellate). At the anterior margin there are about fifty ribs. The ribs intersect the growth lines, which are particularly frequent in the anterior part of the shell, to form a generally reticulate ornamentation.

*Material* — 1 specimen (IGPS 42) from the Clansayesian, Badde Funtana Morta, Orosei.

Dimensions	L.	B.	T.
	14.6	12.2	5.5

*Remarks* — The specimen agrees closely with d'Orbigny's type, especially in the inconspicuous nature of the granulation of the ribs. It agrees closely also with specimens from the highest part of the Speeton Clay (Aptian) of England (Davidson 1874), of which we figure an example (Pl. 36, fig. 5) from Knapton, Yorkshire. The specimens from the Aptian part of the Speeton Clay show granulation of the ribs near the sides of the umbo of the pedicle valve, but Schmid (1971) makes a convincing case for regarding this as a variable character in *T. martiniana* as that species is at present understood.

*Distribution* — The species, according to the literature, occurs from the Middle Aptian to the Upper Albian, inclusive, of France, England and northern Germany.

« TEREBRATULINA » INSUETA sp. nov.  
Pl. 36, figs. 6-7

*Holotype* — IGPSB 431, from the lowermost Aptian, Badde Funtana Morta, Orosei, Sardinia. Dep. Institute of Geology, University of Padua.

Dimensions of Holotype	L.	B.	T.
	17.1	16.0	9.5

Paratype	L.	B.	T.
IGPSB 432	14.5	13.1	—

Same locality.

*Name* — The name is derived from the Latin *insuetus* = unusual.

*Diagnosis* — In dorsal profile triangular in posterior half, semi-circular in anterior. Umbo straight. Ornamented by fine radiating ribs, clearly separated from one another by flat areas. Ribs increase by intercalation, mainly in posterior half of shell, rarely in anterior half; ribs not interrupted at growth lines. About fifty ribs present at anterior margin. Anterior commissure very gently sulcate, with very shallow sulcus occupying anterior half of brachial valve.

*Material* — 2 specimens from the lowermost Aptian of Badde Funtana Morta, Orosei. One is a pedicle valve only.

*Remarks* — Although only two specimens are known of this species, they differ

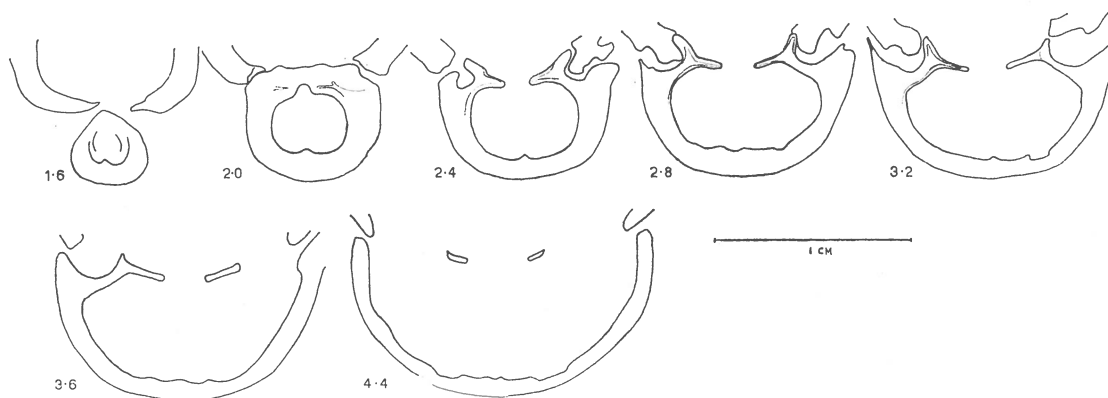


Fig 15 · Transverse sections through *Sardope sardoa* gen. nov., sp. nov. IGPSB 25, basal Aptian, Badde Funtana Morta, Orosei.



from all previously described species of «*Terebratulina*» in the distinct separation of the ribs by narrow flat areas. The nearest among previously described species appears to be *Terebratulina chrysalis* (Schlottheim, 1813), a very variable species, as witnessed by the large number of synonyms to which it has been referred (Davidson 1852, p. 35; Schloenbach 1866, p. 277; Steinich 1965, p. 53; Popiel-Barczyk, 1968, p. 63). «*T.*» *insueta* differs from *T. chrysalis* in being wider compared with its length, with a more sub-circular dorsal profile, and in the morphology of the ribs which are fewer in number and clearly separated by flat areas. In addition, *T. chrysalis* seems never to have been recorded from strata older than the Cenomanian.

«*TEREBRATULINA*» sp.  
Pl. 36, fig. 8

*Description* — Small, circular shell, brachial valve more convex than the pedicle valve. The anterior commissure is gently uniplicate, the lateral commissure broadly arched towards the pedicle valve. The hinge line is straight. The ornamentation consists of radiating ribs, apparently fascicostellate in arrangement, with about fifty ribs at the anterior margin.

*Material* — 1 specimen (IGPSB 430) from the Hauterivian, near Cuile Giobbe

(about 500 m north of «Grotta de sa Oche»), Lanaitto, Dorgali, Sardinia.

<i>Dimensions</i>	L.	B.	T.
	5.8	5.2	2.7

*Remarks* — Although this is a solitary specimen, it is of considerable interest in view of the great rarity of the cancellothyrids in the pre-Aptian Cretaceous in western Europe.

Suborder TEREBRATELLIDINA (\*)  
Muir-Wood, 1955

Superfamily ZEILLERACEA Allan, 1940  
Family ZEILLERIIDAE Allan, 1940

Genus TAMARELLA Owen, 1965

Type-species: *Terebratula tamarindus*  
J. de C. Sowerby, 1836

TAMARELLA TAMARINDUS  
(J. de C. Sowerby)  
Pl. 38, fig. 7

- + 1836 *Terebratula tamarindus* - J. DE C. SOWERBY, p. 338; pl. 14, fig. 8.  
1843 *Terebratula tamarindus* Sowerby - MORRIS, p. 137.

(\*) I. DIENI & E. F. OWEN.

#### EXPLANATION OF PLATE 35

Figs. 1-8 - *Platythyris floresana* sp. nov.

1 a-d IGPSB 71, 2 a-d IGPSB 76, 3 a-d IGPSB 89, 4 a-d IGPSB 99, 5 a-d IGPSB 100, 6 a-d IGPSB 110, 7 a-d IGPSB 115, 8 a-d IGPSB 116.

All from Upper Albian, Cuccuru 'e Flores, Orosei.

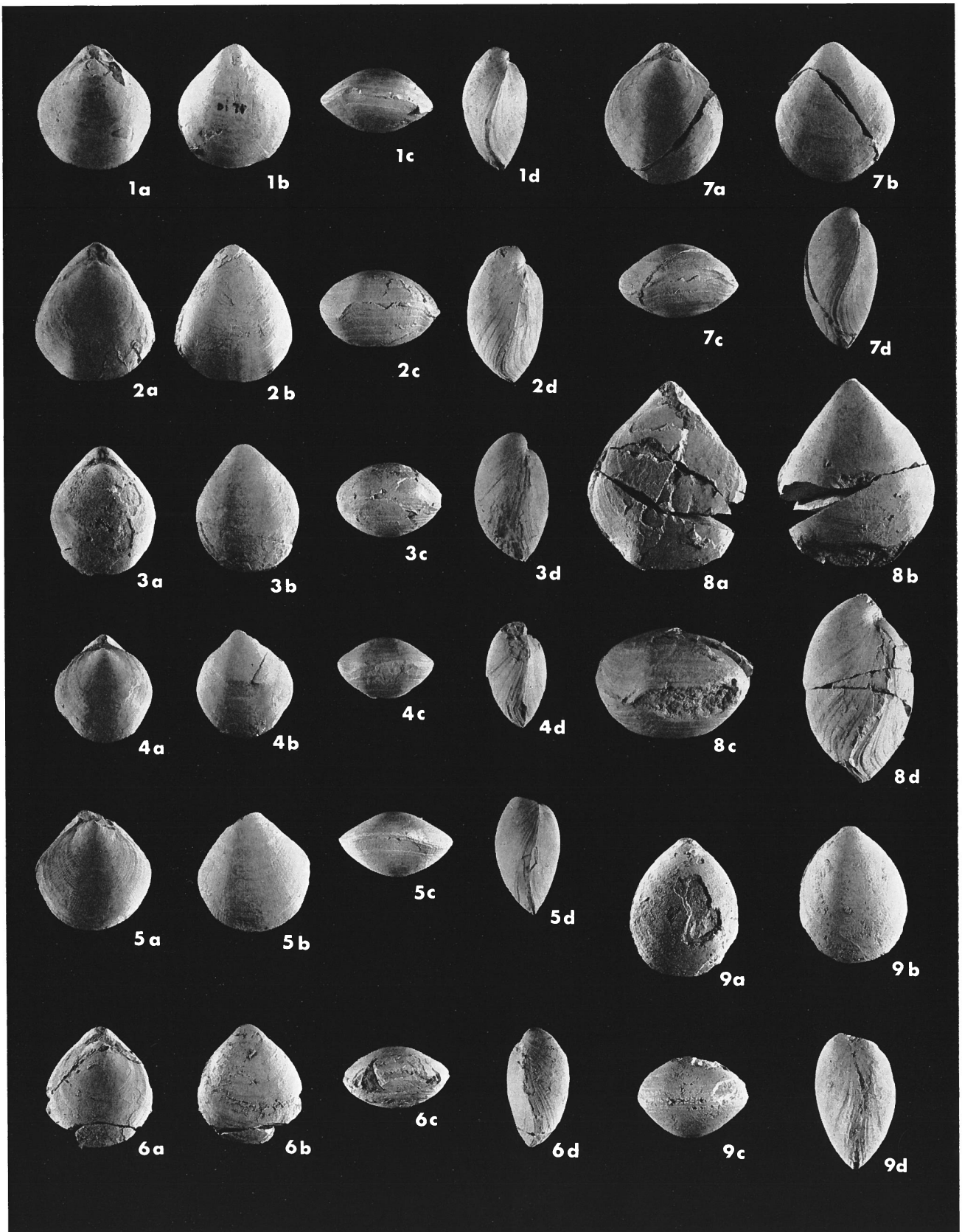
Fig. 9 a-d - *Sardope sardoa* gen. nov., sp. nov.

IGPSB 31. HOLOTYPE.

Basal Aptian, Badde Funtana Morta, Orosei.

All figures at natural size.

I. DIENI - F.A., MIDDLEMISS - E.F. OWEN  
THE LOWER CRETACEOUS BRACHIOPODS OF EAST-CENTRAL SARDINIA





- 1855 *Waldheimia tamarindus* (J. de C. Sowerby) - DAVIDSON, p. 74; pl. 9, fig. 26-31.
- 1868 *Terebratula tamarindus* var. *magna* - WALKER, p. 465; pl. 19, fig. 10.
- 1874 *Waldheimia tamarindus* var. *magna* (Walker) - DAVIDSON, p. 49; pl. 6, fig. 16-19.
- 1955 *Psilothyris tamarinda* (Sowerby) - COOPER, p. 14; pl. 3, fig. 25.
- v 1965 *Tamarella tamarindus* (J. de C. Sowerby) - OWEN, p. 57, fig. 5-6; pl. 1, fig. 2, 8, 10; pl. 3, fig. 5-6.
- non 1966 *Psilothyris tamarindus* (Sowerby) - BOGDANOVA & LOBACHEVA, p. 63; pl. 7, fig. 1-2.
- 1968 *Tamarella tamarindus* (J. de C. Sowerby) - MIDDLEMISS, p. 21, fig. 11; pl. B, fig. 7-10.

*Neotype* — In the Davidson Collection, British Museum (Natural History), no. BB. 42907, from the Upper Aptian of Shanklin, Isle of Wight. Proposed by E. F. Owen, 1965, p. 50.

*Description* — An emended description was given for this species by Owen (1965, p. 50) who figured a specimen from the type locality of Shanklin, Isle of Wight, together with two other specimens from different localities.

The dimensions quoted for the specimen from the type area was as follows: length 11 mm, breadth 10 mm, thickness 8 mm. These dimensions accord favourably with the dimension of the single specimen (IGPSB 39) from the Clansayesian of Badde Funtana Morta, Orosei, Sardinia, assigned here to *Tamarella tamarindus* (J. de C. Sowerby): length 12.5 mm, breadth 10 mm and thickness 7.9 mm. The general outline and specific features of this specimen, agree in detail with those of the neotype.

*Remarks* — Although there is some degree of variability within the species, particularly as regards to size, it was thought

prudent at the time of description (Owen 1965) not to split the species on this arbitrary morphological feature. The species, from its original description, is well founded and easily recognizable and consequently is of some stratigraphical importance. It occurs at no other geological horizon inside the European Lower Cretaceous and was thought to have been restricted to a geographical distribution of England, France and northern Spain. The occurrence of *Tamarella tamarindus* in beds of Upper Aptian age in Sardinia is, therefore, a new record for its distribution.

*Material* — One specimen from the Clansayesian of Badde Funtana Morta, Orosei, Sardinia.

« RUGITELA » sp.  
Pl. 38, fig. 8

*Description* — Uniplicate, semisphaeroidal in general outline. Of terebratulid aspect but with median septum and dental lamellae.

*Material* — One specimen from the Lower Hauterivian of the Orudè Valley, Dorgali, Sardinia.

<i>Dimensions</i>	L.	B.	T.
IGPSB 396	8.0	7.0	3.7

Superfamily TEREBRATELLACEA King, 1850  
Family KINGENIDAE Elliott, 1948  
Subfamily KINGENINAE Elliot, 1948  
Genus KINGENA Davidson, 1852  
Type-species: *Terebratula lima*  
DeFrance, 1828

KINGENA SPINULOSA (Davidson & Morris)  
Pl. 38, figs. 14-15

- v + 1847 *Terebratula spinulosa* - DAVIDSON & MORRIS, p. 253, fig. 6; pl. 18.
- 1852 *Kingena lima* DeFrance - DAVIDSON, p. 42; pl. 4, fig. 24 (non DEFRANCE, 1828).

- 1868 *Kingena lima* DeFrance - DEFRANCE, p. 163 (non DEFRANCE, 1828).  
 1869 *Kingena lima* (DeFrance) - WILTSHIRE, p. 185 (non DEFRANCE, 1828).  
 1874 *Kingena lima* DeFrance - PRICE, p. 353 (non DEFRANCE, 1828).  
 1900 *Kingena lima* DeFrance - JUKES-BROWNE, p. 79 (non DEFRANCE, 1828).  
 non 1930 *Kingena spinulosa* (Davidson & Morris) - MUIR-WOOD, p. 34; pl. 5, fig. 6 (= *Kingena muirwoodae* OWEN, 1970).  
 1961 *Kingena* sp. - PEAKE & HANCOCK, p. 303.  
 v 1970 *Kingena spinulosa* (Davidson & Morris) - OWEN, p. 52; pl. 2, fig. 1-6; pl. 3, fig. 1-7.

*Holotype* — In the Davidson Collection, British Museum (Nat. Hist.) no. B. 5260, from the Upper Albian of Folkestone, Kent. By original designation.

*Description* — The specimens from the Upper Albian of Cuccuru 'e Flores, Orosei, Sardinia, show most of the characteristic features given in the emended diagnosis (Owen 1970, p. 52), but depart from the typical form in having more rounded beak-ridges and slightly less extensive interarea. They nevertheless show a very marked resemblance to variants which occur in the Upper Albian limestone « Red Chalk » of Hunstanton, Norfolk and from an equivalent horizon at North Grimston, Yorkshire. These variants, figured by Owen (1970; pl. 2, fig. 1-2) show the same degree of convexity of the valves and the same general outline as specimens from the Upper Albian of Orosei figured here and fall within the limits of variation described for *Kingena spinulosa* (Davidson & Morris).

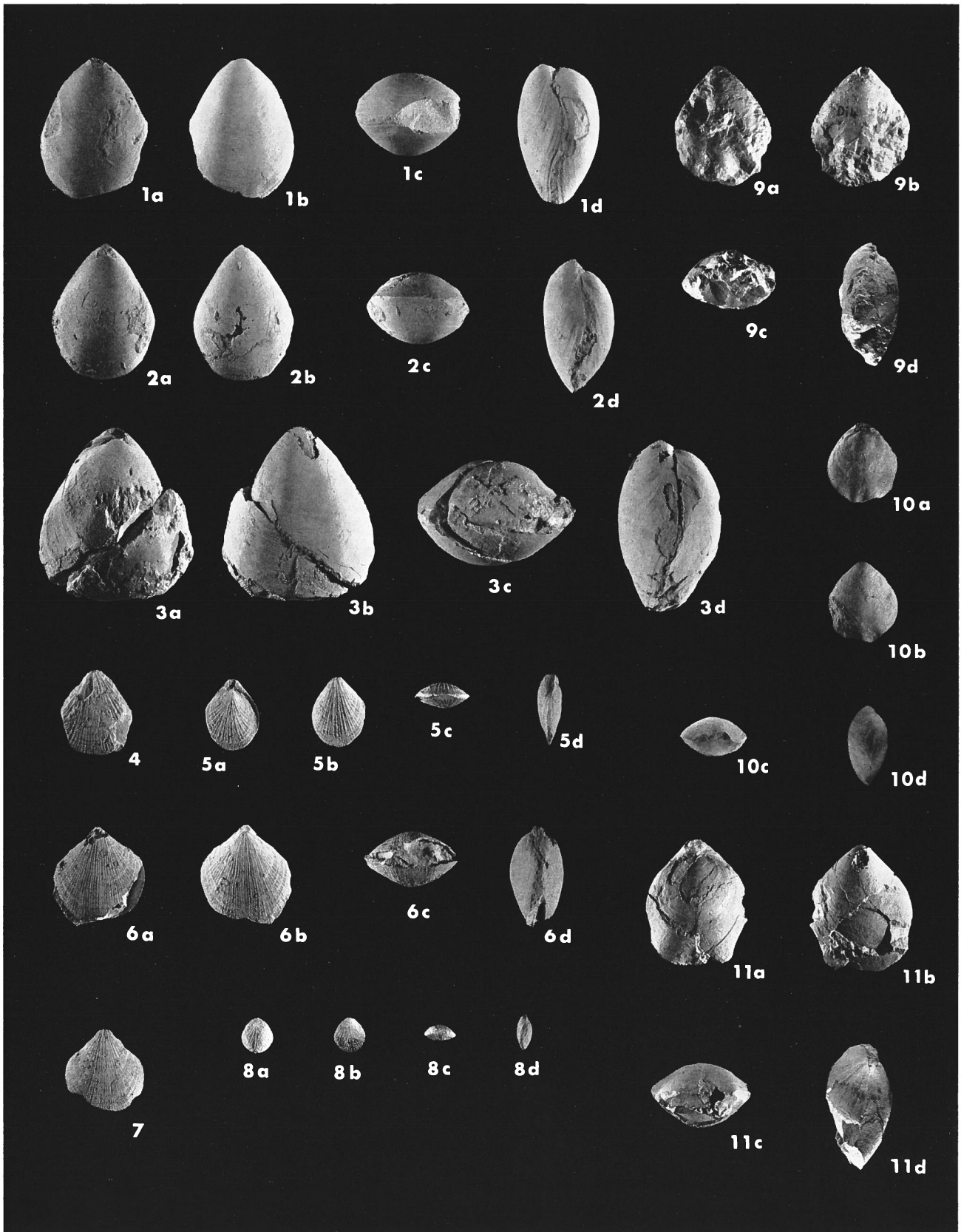
Both the Sardinian specimens examined were decorticated but from the small fragments of shell left on the specimens it was possible to see the fine ornament of pustulation and underlying radiating striae on the shell which are characteristic of the genus.

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#### EXPLANATION OF PLATE 36

- Figs. 1-3 - *Sardope sardoa* gen. nov., sp. nov.  
 1 a-d IGPSB 27, 2 a-d IGPSB 36, 3 a-d IGPSB 37.  
 Basal Aptian, Badde Funtana Morta, Orosei.
- Figs. 4-5 - « *Terebratulina* » *martiniana* d'Orbigny  
 4 IGPSB 42. Clansayesian, Badde Funtana Morta, Orosei.  
 5 a-d BM B 26658. Speeton Clay, Knapton, Yorkshire, England.
- Figs. 6-7 - « *Terebratulina* » *insueta* sp. nov.  
 6 a-d IGPSB 431. HOLOTYPE.  
 7 IGPSB 432.  
 Basal Aptian, Badde Funtana Morta, Orosei.
- Fig. 8 a-d - « *Terebratulina* » sp. IGPSB 430. Hauterivian, near Cuile Giobbe, Lanaitto.
- Figs. 9-10 - *Loriolithyris valdensis* (de Loriol)  
 9 a-d IGPSB 4, 10 a-d IGPSB 1.  
 Upper Valanginian, Badde Funtana Morta, Orosei.
- Fig. 11 a-d - « *Terebratula* » cf. *moutoniana* d'Orbigny  
 IGPSB 26. Basal Aptian, Badde Funtana Morta, Orosei.  
 All figures at natural size.

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A median septum in the brachial valve of each shell extends to approximately half the length of the specimen. The dental lamellae are clearly visible as subparallel plates in the pedicle umbo.

*Material* — 2 specimens from the Upper Albian of Cuccuru 'e Flores, Orosei, Sardinia.

<i>Dimensions</i>		L.	B.	T.
IGPSB	82	16.1	16.0	12.1
»	103	15.4	14.0	11.1

*Remarks* — The presence of this species in Sardinia extends the record to include the Mediterranean region. Hitherto, the species had been regarded as being confined to Britain. French records of the genus within the Albian and Cenomanian have been almost exclusively referred to *Kingena lima* (Defrance), an Upper Cretaceous species, and were thus unreliable.

Taking into account the fairly wide degree of variation within the species, *Kingena spinulosa* (Davidson & Morris) can be distinguished from other species within the genus, chiefly by its constant elongate-oval to broadly pentangulate outline, large foramen, distinct beak-ridges, and characteristic shell ornament of a mixture of both large and small pustulate spinules.

#### Genus BELOTHYRIS Smirnova, 1960

Type-species: *Belothyris plana*  
Smirnova, 1960

#### BELOTHYRIS PSEUDOJURENSIS (Leymerie) Pl. 38, figs. 4-6

- + 1842 *Terebratula pseudo-jurensis* - LEYMERIE, p. 12; pl. 15, fig. 5-6.
- 1847 *Terebratula pseudo-jurensis* Leymerie - D'ORBIGNY, p. 74; pl. 505, fig. 11-16.
- 1861 *Terebratula pseudojurensis* Leymerie - DE LORIO, p. 121; pl. 15, fig. 19-21.

- non 1868 *Waldheimia pseudo-jurensis* Leymerie - WALKER, p. 405; pl. 18, fig. 8-11 (= *Tamarella vesta* OWEN, 1965).
- 1872 *Terebratula (Waldheimia) pseudojurensis* Leymerie - PICTET, p. 93; pl. 203, fig. 11-15.
- non 1874 *Waldheimia pseudo-jurensis* Leymerie - DAVIDSON, p. 48; pl. 7, fig. 12-14.
- 1896 *Zeilleria pseudojurensis* Leymerie - DE LORIO, p. 160, pl. 6, fig. 23.
- 1907 *Waldheimia pseudojurensis* Leymerie - DENINGER, p. 468.
- v 1970 *Belothyris pseudojurensis* (Leymerie) - OWEN, p. 70; pl. 9, fig. 1-5, 7.

*Neotype* — In the Davidson Collection, British Museum (Nat. Hist.) No. B. 35033, from the Hauterivian of Marolles (Aube), France. Proposed by E. F. Owen 1970.

*Description* — A description of this species was given recently by Owen (1970) who proposed a neotype for a specimen originally described by Leymerie (1842) which is presumed lost.

The Sardinian specimens fall well within the limits of variation for the species as interpreted by d'Orbigny (1847), de Loriol (1861, 1896) and Pictet (1872). They differ from the typical form only in their considerably smaller size; nevertheless they are proportionately the same as the original specimens of Leymerie (1842). Size in itself is not regarded here as of any specific significance and, as such, is not a criterion for differentiation. It is noticeable that, in Switzerland and some parts of southern France, specimens of *Belothyris pseudojurensis* (Leym.) vary from small, as in the case of the Sardinian material, to large, as in the case of the typical form from Marolles (Aube) and districts of Auxerres, France. This character is considered to be of ecological significance only.

*Material* — Over 65 specimens from the Lower Hauterivian of Su Codulone, near



P.ta Doronè, Lanaitto, and from the Orudè Valley and Costas d'Ossu, Dorgali, Sardinia.

*Dimensions of figured specimens*

	L.	B.	T.
IGPSB 354	10.7	8.9	5.9

Lower Hauterivian, Su Codulone, near P.ta Doronè, Lanaitto.

» 370	12.7	10.0	7.3
» 371	13.4	8.8	6.6

Lower Hauterivian, Orudè Valley, Dorgali.

*Remarks* — As details of the original locality and horizon given by Leymerie (1842) were vague by modern standards, the neotype was selected from specimens collected from beds within the Hauterivian of Marolles (Aube), France and were presented to Thomas Davidson by d'Orbigny.

Family DALLINIDAE Beecher, 1893

« OBLONGARCULA » sp.  
Pl. 38, fig. 3

*Description* — Small acutely biconvex terebratellid ornamented by strong deeply

incised costae, probably averaging 10-12 on each valve. Median septum about half the length of shell. Anterior commissure plain.

*Material* — One fragmentary specimen (IGPSB 123) from the Lower Hauterivian of Badde Funtana Morta, Orosei. Dimensions unobtainable.

Order RHYNCHONELLIDA Kuhn, 1849

Superfamily RHYNCHONELLACEA

Schuchert, 1896

Family RHYNCHONELLIDAE Gray, 1848

Subfamily CYCLOTHYRIDINAE Makridin, 1955

Genus LAMELLAERHYNCHIA Burri, 1953

Type-species: *Terebratula rostriformis*

Roemer, 1836

LAMELLAERHYNCHIA ROSTRIFORMIS

(Roemer)

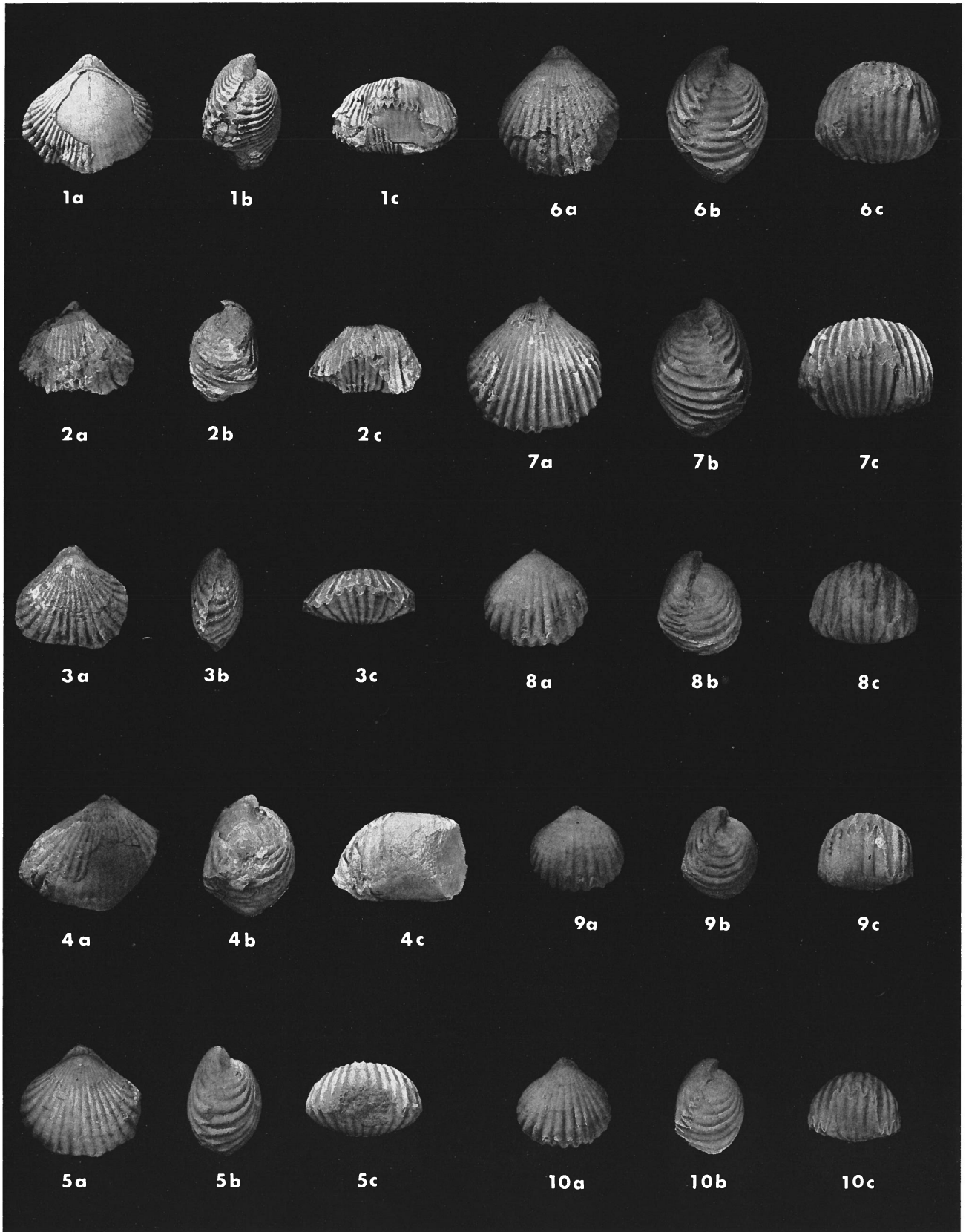
Pl. 37, figs. 1-3

+ 1836 *Terebratula rostriformis* -  
ROEMER, p. 40; pl. 2, fig. 22.  
1839 *Terebratula multiformis* -  
ROEMER, p. 19; pl. 18, fig. 8.

EXPLANATION OF PLATE 37

- Figs. 1-3 - *Lamellaerhynchia rostriformis* (Roemer)  
1 a-c IGPSB 11, 2 a-c IGPSB 15.  
Lower Hauterivian, Badde Funtana Morta, Orosei.  
3 a-c IGPSB 440.  
Lower Hauterivian, Orudè Valley, Dorgali.
- Figs. 4, 6, 7 - « *Lamellaerhynchia* » *renauxiana* (d'Orbigny)  
4 a-c IGPSB 13, 6 a-c IGPSB 19.  
Lower Hauterivian, Badde Funtana Morta, Orosei.  
7 a-c IGPSB 7.  
Upper Valanginian, Badde Funtana Morta, Orosei.
- Figs. 5, 8-10 - *Belbekella rotundicosta* (Jacob & Fallot)  
5 a-c IGPSB 14.  
Lower Hauterivian, Badde Funtana Morta, Orosei.  
8 a-c IGPSB 481.  
Lower Hauterivian, base of eastern cliff of M. Tundu, Dorgali.  
9 a-c IGPSB 609, 10 a-c IGPSB 553.  
Lower Hauterivian, Costas d'Ossu, east of Sedda Artanule, Dorgali.
- All figures at natural size.

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- 1839 *Terebratula rostralina* - ROEMER, p. 20; pl. 18, fig. 7.
- 1841 *Terebratula multiformis* Roemer - ROEMER, p. 37.
- 1842 *Terebratula rostralina* & *rostrata* Roemer - LEYMERIE, p. 18,30; pl. 15, fig. 11.
- pars 1863 *Rhynchonella multiformis* (Roemer) - DE LORIO, p. 113; pl. 15, fig. 23.
- pars 1864 « *Rhynchonella depressa* Credner » - CREDNER, p. 549; pl. 18, fig. 5-12.
- pars 1871 *Terebratula depressa* Quenstedt - QUENSTEDT, p. 155; pl. 41, fig. 2, 6, 10 (non SOWERBY, 1825; non d'ORBIGNY, 1847).
- pars 1872 *Rhynchonella multiformis* (Roemer) - PICTET, p. 10; pl. 195, fig. 5-8.
- 1913 *Rhynchonella multiformis* (Roemer) - JACOB & FALLOT, p. 52; pl. 7, fig. 5-7.
- 1953 *Lamellaerhynchia multiformis* (Roemer) - BURRI, p. 275, fig. 3-7; pl. 15, fig. 2.
- v 1956 *Lamellaerhynchia rostriformis* (Roemer) - BURRI, p. 652, fig. 17; pl. 7, fig. 1; pl. 10, fig. 3.
- v 1968 *Lamellaerhynchia rostriformis* (Roemer) - OWEN & THURRELL, p. 108, fig. 3, 4; pl. 1, fig. 1-6; pl. 2, fig. 1-9; pl. 3, fig. 2.

*Neotype* — In the Roemer Museum, Hildesheim, Germany, No. 781a, from the Neocomian of Elligser Brink, near Hanover. Proposed by F. Burri, 1956.

*Description* — Broadly triangular *Lamellaerhynchia*, slightly wider than long with both valves equally convex. Dorsal valve with low median fold. Corresponding shallow sulcus in ventral valve with moderately extensive linguiform extension. Uniplicate anterior margin with tendency to asymmetry of commissure. Both valves covered with

ornament of sharp, deeply incised radiating costae, averaging about twenty-six on each valve. Suberect umbo with clearly defined or sharp beak-ridges. Foramen large, circular; conjunct deltidial plates well exposed.

*Material* — Two specimens (IGPSB 11, 15) from the Upper Valanginian or Lower Hauterivian of Badde Funtana Morta, Orosei; one specimen (IGPSB 440) from the Lower Hauterivian of Orudè Valley, Dorgali, Sardinia.

<i>Dimensions</i>		L.	B.	T.
IGPSB	11	22.3	24.0	14.7
»	15	19.3	21.5	13.3
»	440	19.7	21.1	10.0

*Remarks* — This species was originally described by Roemer (1836, p. 40) for specimens collected from the Neocomian beds of the Hanover and Brunswick areas of North Germany, but confusion arose from this original quotation of the species due to the lack of reference to a specimen from any known horizon or definite locality. Further confusion arose when Roemer appeared to describe the same species under two different names (Roemer 1939, pp. 19, 20). The subsequent interpretation of the species was as *Terebratula multiformis* (Roemer 1839, p. 19) and this name was widely used for species of rhynchonellid brachiopods from the Lower Cretaceous of Germany, France, Switzerland and England, until Burri (1956, p. 652) corrected the broad interpretation by proposing a neotype from the Roemer Collection. This interpretation was the one accepted by Owen & Thurrell (1968, p. 108) in their description of the species from the north of England and northern Germany. It is also the interpretation used here for the specimens figured, from the Upper Valanginian or Lower Hauterivian of Orosei and the Lower Hauterivian of Orudè Valley, Dorgali, Sardinia.

As no duplicate specimens were available for serial sections, the three specimens mentioned above were assigned to *Lamellaerhynchia rostriformis* (Roemer) entirely on consideration of external morphological features.

The distribution of the species is based largely upon data obtained from Roemer (1836-41), Jacob & FalLOT (1913), and Burri (1953, 1956). The present description, therefore, increases the range of distribution to include possible Upper Valanginian localities and definite Lower Hauterivian localities in Sardinia.

« LAMELLAERHYNCHIA » RENAUXIANA

(d'Orbigny)

Pl. 37, figs. 4, 6-7

- + 1847 *Rhynchonella Renauxiana* - d'ORBIGNY, p. 23-24; pl. 492, fig. 5-8.
- 1863 *Rhynchonella Renauxiana* d'ORBIGNY - OOSTER, p. 53; pl. 18, fig. 23.
- v 1872 *Rhynchonella irregularis* Pictet - PICTET, p. 18; pl. 196, fig. 4-13.
- 1905 *Rhynchonella Renauxiana* d'ORBIGNY - GUEBHARD & JACOB, p. 92; pl. 13, fig. 1-5; pl. 14, fig. 1-4.
- 1913 *Rhynchonella irregularis* Pictet - JACOB & FALLOT, p. 61.
- 1916 *Rhynchonella Renauxiana* d'ORBIGNY - BRUN in BRUN, CHATELET & COSSMANN, p. 44; pl. 4, fig. 49-51; pl. 5, fig. 17-18, 22-23.
- 1956 *Lamellaerhynchia renauxiana* d'ORBIGNY - BURRI, p. 671; pl. 10, fig. 1-2.

*Lectotype* — Assigned by Burri (1956) from d'Orbigny (1847, pl. 492, fig. 5-7). From the Barremian of Martigues (Bouches-du-Rhône), France.

*Description* — Acutely biconvex, elongate-oval rhynchonellid broadly assigned to *Lamellaerhynchia sensu lato*. Subpentagonal in general outline with ornament of approximately 28-30 well defined, simple costae on each valve. Broad, low incipient fold on

dorsal valve becoming more apparent anteriorly. Slightly produced pedicle umbo with sharp suberect beak and small circular foramen. Conjunct deltidial plates well exposed. Broad shallow sulcus in ventral valve with extensive trapezoidal linguiform extension. Anterior commissure low arcuate, uniplicate with occasional asymmetrical development.

*Material* — Ten specimens from the Upper Valanginian to Lower Hauterivian of Badde Funtana Morta, Orosei, Sardinia.

<i>Dimensions</i>	L.	B.	T.
Upper Valanginian			
IGPSB 2	—	20.5	15.0
» 3	22.5	22.3	14.4
» 7	26.6	25.5	19.3
» 8	—	23.7	17.7
» 9	—	24.9	18.9
Lower Hauterivian			
IGPSB 13	23.0	—	17.0
» 19	25.6	23.9	19.1
» 20	—	—	18.0

*Remarks* — D'Orbigny's original specimen was stated to have been collected from the Upper Neocomian of Martigues (Bouches-du-Rhône), a locality which falls within the *Requienia ammonia* Zone of the Barremian. Burri (1956, p. 671) selected d'Orbigny's figured specimen as lectotype of the species without stating whether or not the specimen was extant. He assigned several specimens which he described from Mormont and Ste. Croix district of Switzerland to this species, including them in his new genus *Lamellaerhynchia*. Burri's figured specimens (pl. 10, fig. 1-2), while possessing most of the characters described by d'Orbigny for *Rhynchonella renauxiana*, differ in having slightly finer costae. The serial sections given by Burri (1956, p. 673, fig. 24) for a specimen from the Lower Barremian of Mormont, as *Lamellaerhynchia renauxiana* (d'Orbigny) do not appear to accord with those given for the type species, *L. rostriformis* (Roemer) on page 655, fig. 17. Consequently, although the specimens described here from Orosei

are assigned to the species *renauxiana*, they can only be broadly assigned to the genus *Lamellaerhynchia*.

*Lectotype* — The specimen figured by Jacob & Fallot (1913), pl. 7, fig. 8a-c, from the Barremian of Brudoux (Gard), now in

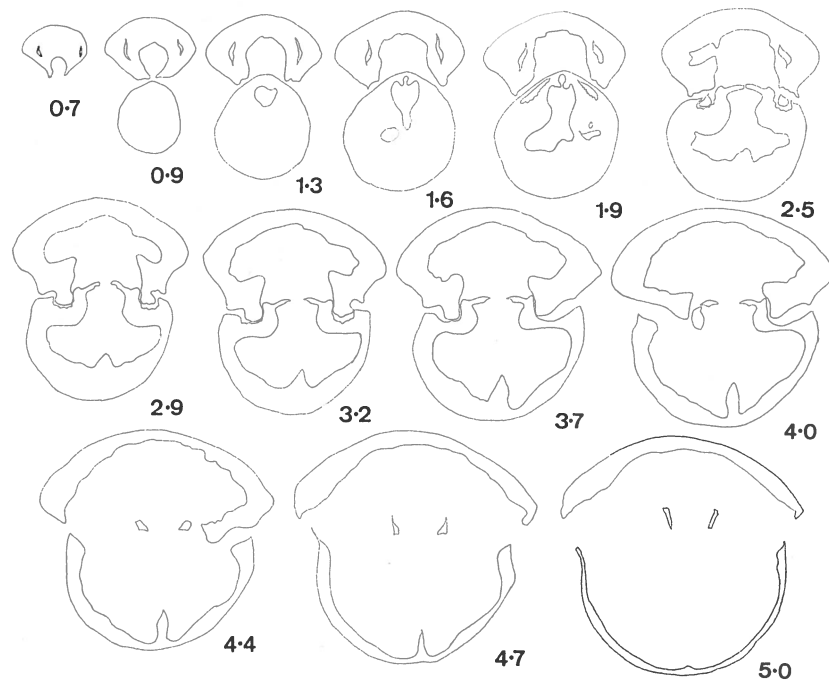


Fig. 16 - Thirteen transverse serial sections of a specimen of *Belbekella rotundicosta* (Jacob & Fallot) from the Lower Hauterivian, Costas d'Ossu. X 2.

Genus BELBEKELLA Moisseev, 1939

Type-species: *Belbekella airgulensis* Moisseev

BELBEKELLA ROTUNDICOSTA (Jacob & Fallot)

Pl. 37, figs. 5, 8-10; text-fig. 16

- ? 1907 *Rhynchonella parvirostris* Sow. - DENINGER, p. 469 (non J. DE C. SOWERBY, 1836).
- + 1913 *Rhynchonella multiformis* Roemer var. *rotundicosta* - JACOB & FALLOT, p. 56; pl. 8, fig. 6-13.
- 1960 *Belbekella multiformis rotundicosta* Jacob et Fallot - SMIRNOVA, p. 383; pl. 5, fig. 4.

the collections of the University of Grenoble, is here selected as lectotype for the species *Belbekella rotundicosta* which is raised to specific rank and assigned to the genus *Belbekella*.

*Description* — *Belbekella* subcircular in outline. Brachial valve acutely convex with low, narrow, median fold. Pedicle valve moderately convex with shallow sulcus and extensive trapezoidal linguiform extension. Ornament of fifteen strong but rounded costae on each valve with five on the fold and a similar number in the sulcus. Umbo short, massive with sharp suberect beak and small circular foramen. Beak-ridges well defined with extensive concave interarea. Anterior commissure with narrow trapezoidal uniplication.

*Internal structure* — The thirteen transverse serial sections shown here in figure 16 should be compared to the series of sections

feature has been proved to be a somewhat variable character in other rhynchonelloid species within the Mesozoic.

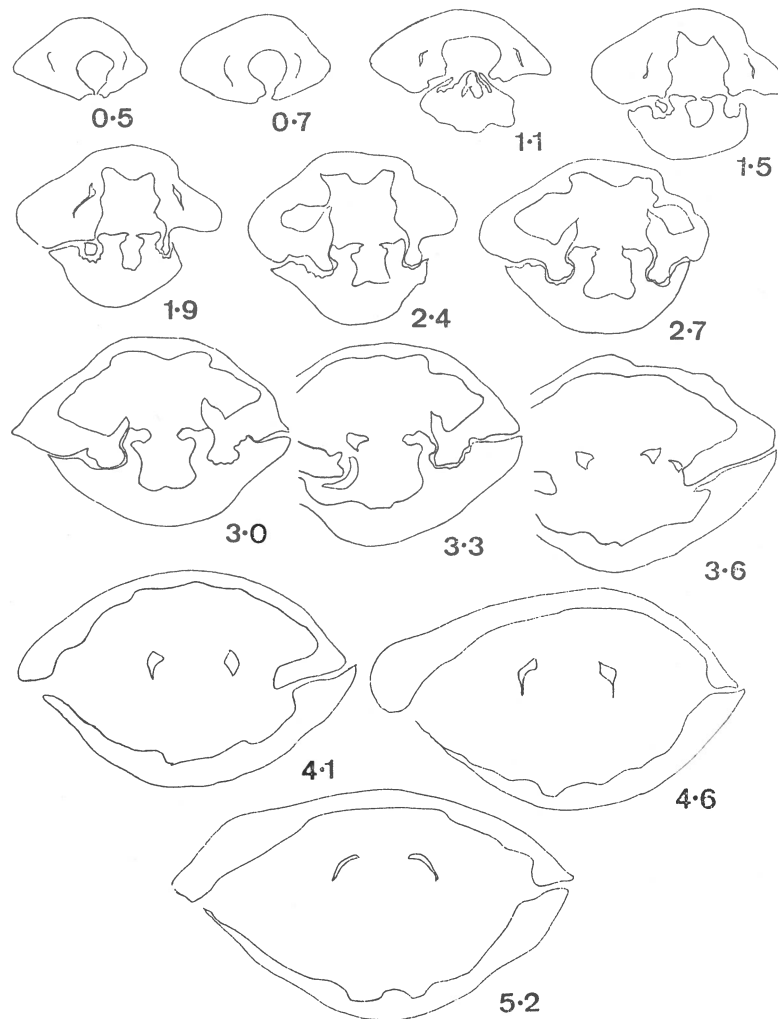


Fig. 17 - A series of thirteen transverse serial sections through the umbo of a toptype of *Belbekella airgulensis* Moisseev, from the Hauterivian of River Bel'bek Crimea, U.R.S.S. X 3.

of *Belbekella airgulensis* Moisseev shown in fig. 17, the type-species of the genus originally described from the Hauterivian of Bel'bek, Crimea, USSR. In all but one feature the two specimens agree in structures diagnostically generic. The median septum of *B. rotundicosta* is, however, slightly more persistent than in the type-species, but this

*Material* — One specimen (IGPSB 14) from the Lower Hauterivian of Badde Fun-tana Morta, Orosei, and 245 specimens from the Lower Hauterivian of the base of eastern cliffs of M. Tundu and also from Costas d'Ossu, east of Sedda Artanule, Dorgali, Sardinia.

Dimensions of figured specimens

	L.	B.	T.
IGPSB 481	19.3	19.4	15.0
From eastern cliffs of M. Tundu.			
IGPSB 553	18.0	17.5	13.0
» 609	17.3	18.4	12.7
From Costas d'Ossu.			

Genus *SULCIRHYNCHIA* Burri, 1953

Type-species: *Rhynchonella valangiensis*  
de Loriol, 1864

*SULCIRHYNCHIA ARDESCICA* (Jacob & Fallot)  
Pl. 38, figs. 1-2; text-fig. 18

+ 1913 *Rhynchonella multiformis*  
var. *ardescica* - JACOB & FALLOT, p. 55; pl. 8, fig. 1-5.

Remarks — Deninger (1907, p. 469) recorded, without figuring, « *Rhynchonella parvirostris* Sow. » from the neighbourhood

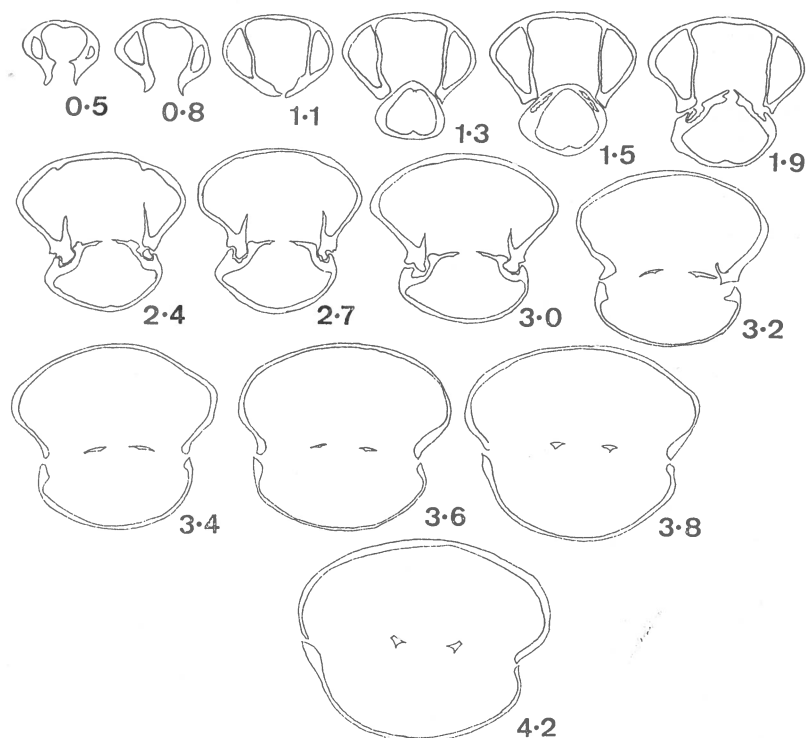


Fig. 18 - A series of fourteen serial sections of *Sulcirhynchia ardescica* (Jacob & Fallot), from the Lower Hauterivian, Costas d'Ossu. X 3.

of Dorgali (« ... an dem Pfad, welcher von N.S. del Buon Cammino zum Ovile Sinicolai hinaufführt, mit *Exogyra Couloni* zusammen in Bacu de Bobboi und südlich Costas d'Ossu »), where « ist das häufigste Fossil im Neocom ». This very probably refers to *Belbekella rotundicosta*, since the species is very common in this region.

*Lectotype* — The specimens figured by Jacob & Fallot 1913, pl. 8, fig. 2a-c, is here selected as lectotype of *Sulcirhynchia ardescica* which is raised to specific rank. The original specimen was collected from the Hauterivian of Samzon (Ardèche) and is in the Gevrey Collection, University of Grenoble.



*Description* — Small *Sulcirhynchia* broadly triangular to elongate-oval, with ornament of 25-27 fine, even radiating costae on each valve, with 5 in the sulcus and a similar number on the incipient median fold. The produced, suberect umbo has clearly defined or sharp beak-ridges and moderately extensive plain interarea. The uniplicate anterior commissure has a high arcuate trapezoidal linguiform extension.

*Material* — 13 specimens from the Lower Hauterivian of the M. Doronè district, Lanaitto, Sardinia.

*Dimensions of figured specimens*

	L.	B.	T.
IGPSB 454	—	17.2	11.3
» 451	—	17.8	11.8

*Remarks* — The assignment of this species to the genus *Sulcirhynchia* is based lar-

gely upon consideration of the internal structures as seen in fig. 18. They compare favourably with a series of transverse serial sections given by Burri (1953, fig. 1) for *Sulcirhynchia valangiensis* (de Loriol), the type-species.

Family WELLERELLIDAE

Likharev in Rzhonsnitskaya, 1956

Subfamily LACUNOSELLINAE Smirnova, 1963

Genus ORBIRHYNCHIA Pettitt, 1954

Type-species: *Orbirhynchia orbignyi*  
Pettitt, 1954

ORBIRHYNCHIA PARKINSONI Owen  
Pl. 38, figs. 10-11

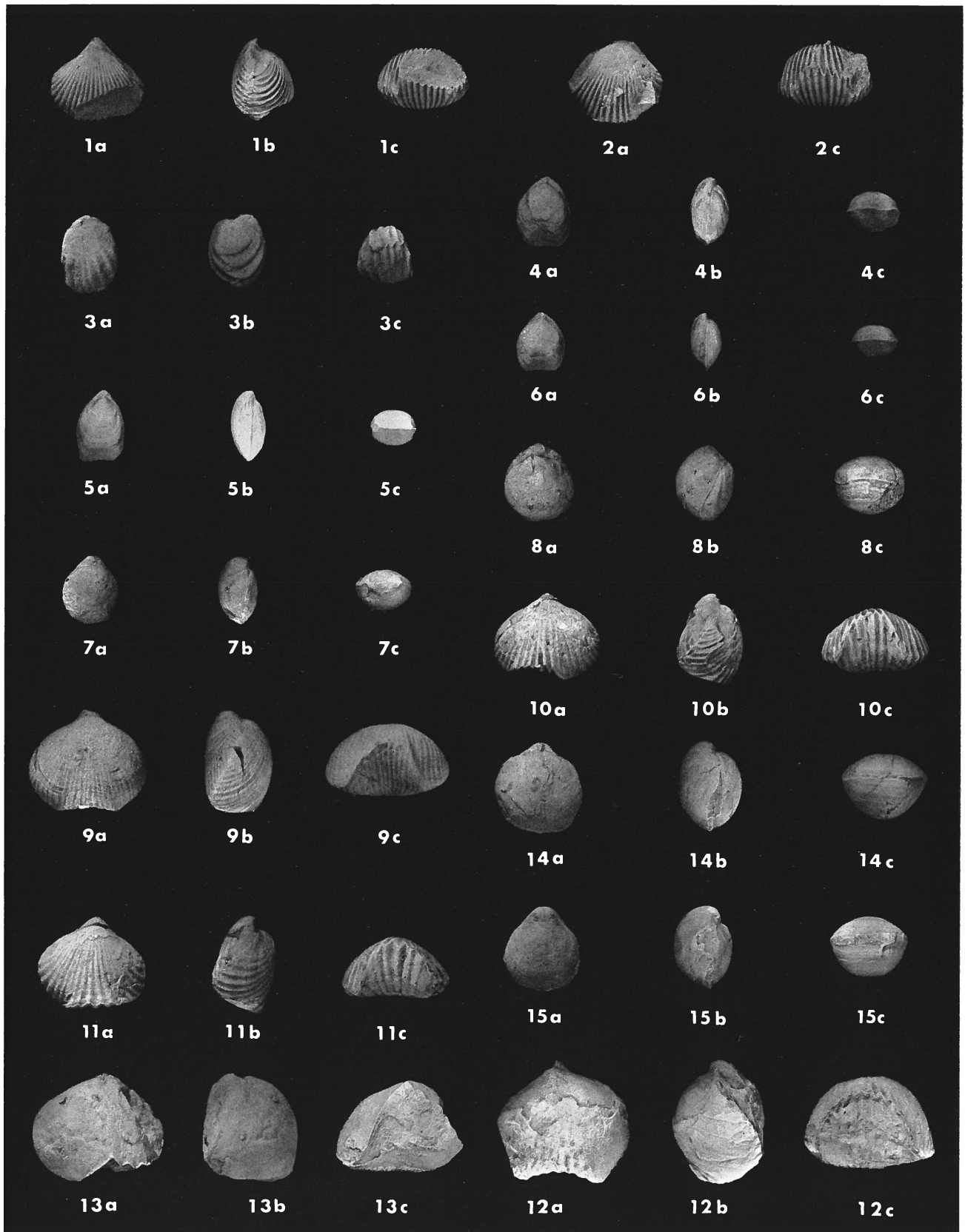
pars *Rhynchonella sulcata* (Parkinson): *auct.*

EXPLANATION OF PLATE 38

- Figs. 1 and 2 - *Sulcirhynchia ardescica* (Jacob & Fallot)  
1 a-c IGPSB 454, 2 a-c IGPSB 451.  
Lower Hauterivian, near P.ta Doronè, Lanaitto.
- Fig. 3 a-c - « *Oblongarcula* » sp. IGPSB 123. Lower Hauterivian, Badde Funtana Morta, Orosei.
- Figs. 4-6 - *Belothyris pseudojurensis* (Leymerie)  
4 a-c IGPSB 370, 5 a-c IGPSB 371.  
Lower Hauterivian, Su Codulone, near P.ta Doronè, Lanaitto.  
6 a-c IGPSB 354.  
Lower Hauterivian, Orudè Valley, Dorgali.
- Fig. 7 a-c - *Tamarella tamarindus* (J. de C. Sowerby). IGPSB 39.  
Clansayesian, Badde Funtana Morta, Orosei.
- Fig. 8 a-c - « *Rugitela* » sp. IGPSB 396. Lower Hauterivian, Orudè Valley, Dorgali.
- Fig. 9 a-c - *Orbirhynchia parkinsoni* f. *rencurelensis* (Jacob & Fallot). IGPSB 56. Upper Albian, Cuccuru 'e Flores, Orosei.
- Figs. 10 and 11 - *Orbirhynchia parkinsoni* Owen  
10 a-c IGPSB 111, 11 a-c IGPSB 119.  
Upper Albian, Cuccuru 'e Flores, Orosei.
- Fig. 12 a-c - *Orbirhynchia parkinsoni* f. *paludensis* (Jacob & Fallot). IGPSB 122. Upper Albian, Cuccuru 'e Flores, Orosei.
- Fig. 13 a-c - « A » gen. nov., sp. nov. IGPSB 52. Vraconian, Cuccuru 'e Flores, Orosei.
- Figs. 14 and 15 - *Kingena spinulosa* (Davidson & Morris)  
14 a-c IGPSB 82, 15 a-c IGPSB 103.  
Upper Albian, Cuccuru 'e Flores, Orosei.

All figures at natural size.

I. DIENI - F.A., MIDDLEMISS - E.F. OWEN  
THE LOWER CRETACEOUS BRACHIOPODS OF EAST-CENTRAL SARDINIA





- non 1847 *Rhynchonella sulcata* - D'ORBIGNY, p. 26; pl. 495, fig. 1-7.
- pars 1852 *Rhynchonella sulcata* (Parkinson) - DAVIDSON, pl. 10, fig. 18-20.
- pars 1872 *Rhynchonella sulcata* (Parkinson) - PICTET, p. 35; pl. 199, fig. 1-6.
- pars 1913 *Rhynchonella sulcata* (Parkinson) - JACOB & FALLOT, p. 66; pl. 9, fig. 14-15.
- non 1950 *Rhynchonella sulcata* Davidson - FABRE in COLLIGNON, p. 26; pl. 1, fig. 9.
- v + 1960 *Orbirhynchia parkinsoni* - OWEN, p. 250; pl. 5, fig. 2.
- 1969 *Orbirhynchia parkinsoni* Owen - PANOW, pp. 567, 598; pl. 109, fig. 5-8.

*Holotype* — In general collections of British Museum (Natural History), No. BB. 39276, from the Upper Albian, Cambridge. By original designation.

*Description* — *Orbirhynchia* broadly triangular in general outline with twenty-three strong angular radiating costae originating from a low, massive, suberect umbo. The foramen is small and the beak-ridges are not well defined and often rounded. The interarea is very short. A low median fold on the brachial valve becomes more marked towards the anterior margin but remains undeveloped. There is a corresponding shallow sulcus in the pedicle valve. A high broadly arcuate anterior commissure with a fairly extensive linguiform extension is sometimes given to asymmetrical development.

*Material* — Two specimens from Upper Albian of Cuccuru 'e Flores, Orosei, Sardinia.

<i>Dimensions</i>	L.	B.	T.
IGPSB 111	17.5	19.8	12.0
» 119	18.6	20.2	11.3

*Remarks* — The original description of this species under the name *Terebratula sulcata* Parkinson was shown to be invalid

(Owen 1960) on two counts. Firstly, the species was unrecognizable from the description given by Parkinson (1804), and secondly, no definite horizon was quoted for the typical form. Consequently, the species was redescribed (Owen 1960) and assigned to *Orbirhynchia parkinsoni*.

The description of a specimen under the name of *Rhynchonella sulcata* by d'Orbigny (1847) did little to rectify the poor interpretation of the species by Parkinson, nor did it specifically fix either a type specimen or quote a definite geological horizon for the specimen he described.

As *Rhynchonella sulcata* (Parkinson) the species has been widely quoted by various authors and was the subject of much confusion. Jacob & Falloit (1913, pl. 9, fig. 14-15) using Davidson's interpretation of the species from the Upper Albian of Cambridge, described it together with four varieties from Upper Albian deposits from the South of France. Two of these varietal names have been assigned to forms described here.

ORBIRHYNCHIA PARKINSONI  
f. RENCURELENSIS (Jacob & Falloit)  
Pl. 38, fig. 9

- + 1913 *Rhynchonella sulcata* (Parkinson) var. *rencurelensis* - JACOB & FALLOT, p. 68; pl. 9, fig. 18-24.

*Description* — Somewhat more circular in general outline than the typical form with less massive or slightly more produced umbo. Ornament of costae are fainter or less deeply incised than on the type-species. They average about 28-30 on each valve. There is approximately the same degree of folding and sulcation of the valves but the anterior commissure is less broadly arcuate than in the typical form.

*Material* — Twelve specimens from the Vraconian and Upper Albian of Cuccuru 'e Flores, Orosei, Sardinia.

Dimensions		L.	B.	T.
IGPSB	56	19.1	22.2	12.8
»	57	—	—	10.7
»	58	17.5	17.5	10.5
»	62	15.0	15.6	9.8
»	79	—	—	—
»	80	14.2	15.2	9.7
»	83	—	16.4	—
»	92	16.1	18.5	13.3
»	94	—	—	—
»	96	—	—	9.6
»	104	16.6	17.0	11.1
»	106	—	—	—

16.8 mm thick. Umbo short, massive, suberect. Beak-ridges rounded, indistinct; interarea short. Deltidial plates obscured. Anterior commissure with acute pedicle sulcus corresponding to sharp acumination of brachial fold, asymmetrical.

*Material* — One specimen (IGPSB 52), dimensions given here, from the Vraconian of Cuccuru 'e Flores, Orosei, Sardinia.

*Remarks* — The specimen figured here is unlike anything previously described or figured from the Vraconian. It probably belongs to the *Lacunosellinae* although the internal structures are completely unknown.

ORBIRHYNCHIA PARKINSONI f. PALUDENSIS  
(Jacob & Fallot)  
Pl. 38, fig. 12

+ 1913 *Rhynchonella sulcata* (Parkinson) var. *paludensis* - JACOB & FALLOT, p. 70; pl. 10, fig. 10-13.

*Description* — Subquadrate in general outline with acute biconvexity of the valves, broad pedicle sulcus and slightly more extensive linguiform extension than in the nominate form. The umbo is slightly produced with more extensive interarea. The anterior commissure is broadly arcuate with little tendency to asymmetrical development. An ornament of fine costae averaging thirty to thirty-two on each valve.

*Material* — One specimen from the Vraconian (IGPSB 122) and one from the Upper Albian (IGPSB 121) of Cuccuru 'e Flores, Orosei, Sardinia.

Dimensions		L.	B.	T.
IGPSB	121	12.2	13.0	7.6
»	122	23.6	24.8	17.6

« A » gen. nov., sp. nov.  
Pl. 38, fig. 13

*Diagnosis* — Acutely biconvex rhynchonellid, 21.0 mm long, 24.6 mm broad and

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