THE DISTRIBUTION, ECOLOGY AND STRATIGRAPHICAL SIGNIFICANCE OF SOME CRETACEOUS BRACHIOPODS WITHIN THE UNITED KINGDOM AND PART OF WESTERN EUROPE.

BY

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DECEMBER 1982

A THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE UNIVERSITY OF LONDON AND FOR THE DIPLOMA OF MEMBERSHIP OF THE IMPERIAL COLLEGE

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POCKET RANGE CHART AND FACIES

ABSTRACT

This thesis is divided into four parts. Part I gives a brief historical account of Cretaceous brachiopod work over the past one hundred and twenty years or more. Part II explains the distribution of the Cenomanian outcrops in Britain and the European continent. It describes,in some detail, the various facies within the Lower Chalk and mentions the control that certain substrates had in the distribution of faunal assemblages. It explains the manifestation of these controls in terms of change in lithologies.

Part III deals exclusively with the description and updating of certain established taxa and introduces several new species where these are considered to be stratigraphically important. It also discusses distribution of brachiopod species in relation to lithologies. Transverse serial sections are given for some of the established species for the first time and also accompany the new descriptions where possible. Shell ornament of certain species is described using photomicrographs from the scanning electron microscope. Part IV is a summary and general explanation of the significance of brachiopods within the Cenomanian of Britain and northwestern Europe. An explanation is also given of the main lithological units in vertical sections visited during the course of the study and explains the main ecological aspects as seen in terms of different sediments.

ACKNOWLEDGEMENTS

There are many names I would wish to record here, but to do so would require more space than I have available. The following names, therefore, are important but a mere token of a great debt that I owe to so many colleagues and friends who generously gave their time and expertise to enable me to complete a work which I hope will stand as a memorial to their devotion.

I would like to express my most sincere thanks to colleagues at the British Museum (Natural History), in particular, Drs Howard Brunton and L.R.M.Cocks, Mr Adrian Rissoné, Miss Lois Cody, Drs Noel Morris, Paul Taylor and Richard Jefferies, to the staff of the photographic studio; Mr Don Claugher and Miss Susan Barnes of the Electron Microscopical Unit, to Dr H.G.Owen, to Messrs Christopher J.Wood and Adrian Morter of the Institute of Geological Sciences, to the officers and staff of the Sedgwick Museum, Cambridge, to Drs Phil Drummond and Rory Mortimore of the Polytechnic,Brighton; to Mr Felix Whitham, Hull for time and material, to Messrs Andrew Gale and Keith Holdaway, for kind advice, to Mr Simon Hurt, Eastbourne, to Dr Annie Dhondt, Belgium, Dr Eduard Lanterno, Museum d'Histoire Naturelle, Geneva; to Dr Ewa Popiel-Barczyk,Museum Ziemi,Warsaw, to Dr Olga Nekvasilova, Prague,Czechoslovakia.

My special thanks go to the following whose skill

and knowledge have been a constant inspiration throughout the research period; Dr J.M.Hancock, King's College, London, Dr F.A.Middlemiss, Queen Mary College, to Dr W.J.Kennedy for innumerable acts of kindness and sound advice, to Mr C.W.Wright for exceedingly good company and wise counsel.

Lastly, I wish to thank Dr John Ferguson and some members of the staff of Imperial College, for great kindness and help.

FRONTISPIECE



THE SEVEN SISTERS

FROM SEAFORD HEAD, EAST SUSSEX

But on and up, where Nature's heart

Beats strong amid the hills.

Richard Monkton Milnes

PART I

INTRODUCTION

INTRODUCTION

Few records exist of any notable works on Cretaceous brachiopods beyond those of Northern Europe and the United Kingdom and most of the important works have been confined to comparatively sparse local faunas. The following account,therefore, deals mainly with British,French and German species, except for a few forms which have been described from outside this area.

It is important to note that,while the work here is chiefly concerned with species of Cenomanian age,it has been necessary to include a brief mention of some Albian species. These are,in the main, long ranging forms,such as those from the Upper Greensand or facies controlled species of Cenomanian aspect as occur in the Shenley Limestone,Leighton Buzzard, Bedfordshire,which are of undoubted Lower Albian age.

GREAT BRITAIN

In Britain many Cretaceous brachiopods were named and described for the first time by James Sowerby (1815-1818) and later,his son,James de Carl Sowerby (1826-1845),usually under the single generic title of Terebratula. Cenomanian species described by the Sowerbys and considered to be valid include T.lyra,

T.pectita,T.ovata,T.obesa,T.mantelliana,T.obtusa, T.subundata,and T.megatrema. These and several other species have been revised here and provide the major part of the systematic section of this thesis.

At the time that the Sowerbys were writing,very little information regarding the age of the stratigraphical horizons was available and many specimens described and figured by them were accompanied by only a brief lithological description of the beds from which they came. Many of their species were based upon young stages of growth and it is sometimes impossible to trace original material,especially since the Sowerby Collection, now in the British Museum (Natural History), is far from complete. Subsequent authors have often identified specimens by comparison with the Sowerby illustrations alone and,consequently,many species which they have described are not always accurately recorded.

The work of the Sowerbys was largely superceded by the publication of Thomas Davidson's monographs (1852-54,1874) published by the Palaeontographical Society,London,illustrating,among otherthings, the very profound comprehension which he had of the phylum generally. His contribution to the Cretaceous still holds a very high place in the study and most of the species which he described are currently accepted.

Several decades elapsed before a work of any significance was produced on British Cretaceous brachiopods. Sahni (1929) began a work on British Chalk Terebratulidae with a discussion on previous research in which he concludes, "...it is doubtful if any value except historical attaches to the works cited above." The works of Davidson and the French palaeontologist d'Orbigny were among those especially selected for critical discussion. Sahni ends his comments with the rather startling announcement that, "The confusion which has obtained in the nomenclature of the Chalk terebratulid species for over a hundred years has now been cleared."

It is a pity that Sahni is so critical because his own work is based almost entirely on poorly documented museum collections. He created a vast number of new names,largely based upon minor morphological variations. His attitude to the palaeontological opinions of previous workers contrasts strangely with his acceptance of museum labels as a key to stratigraphy, and,at best, his horizons are very vague. Where definite horizons are given, they are often very inaccurate, e.g. Terebratula abrupta (Tate) from the Upper Campanian of Northern Ireland is cited as Cenomanian. In fact it is very difficult to discuss Sahni's work, as any criticism is bound to be destructive.

Nevertheless,his work does represent the first attempt to separate Cretaceous terebratulidae into generic groups and for this we must be grateful.

Pettitt(1949,1954) produced two monographs on Chalk rhynchonellidae, dealing largely with species from Turonian and Senonian localities. To a certain extent this was an advance on the work of both Davidson and d'Orbigny in that it separated the two main generic groups within the Cretaceous, the Cretirhynchia group and the Orbirhynchia species. Pettitt's work was not complete and is not fully representative of the Chalk rhynchonellidae,especially those within the Lower Chalk.

The most intensive study of Cretaceous terebratulidae in recent years has been conducted by Dr.F.A.Middlemiss whose researches have been concentrated largely around Lower Cretaceous species,although he has recently referred the Belgian Tourtia species Terebratula tornacensis d'Archiac to his genus Sellithyris, originally described from the Aptian (Middlemiss,1959), suggesting that there might be some generic link between the two forms. Since this work, Middlemiss has shown that several genera and species thought to have been confined to the Lower Cretaceous, in fact, range beyond.

During the course of my own research, I have dealt

with several genera which have similarly long stratigraphical ranges and appear well established in both Aptian and Cenomanian facies. One of these is the the rhynchonellid Cyclothyris which was discussed in a revision of the genus (Owen,1963).

The dallinid Kingena Davidson was also the subject of a review (Owen,1970) and was shown to have a stratigraphical range from the Lower Albian to Upper Campanian, two species having been recognized with the Lower Chalk. Since then, a paper dealing with certain morphological similarities in the internal structure of the Terebratellacea was published (Owen,1977) in which it was suggested that there might be an evolutionar link between some genera and species.

FRANCE

The French Cretaceous was intensively studied towards the middle and end of the nineteenth century and many stratigraphical works,which include original descriptions of brachiopod species,appeared.

The volume on brachiopods by Valenciennes in Lamarck's monograph of the fossils of France appeared as early as 1819, and was thus partly contemporaneous with the work of the Sowerbys. Some of the taxa suggested by Valanciennes were incorrectly used because of confusion resulting from lack of stratigraphical details and poor illustrations. Among those which can be applied

correctly to Cenomanian species are T.menardi, T.phaseolina,T.difformis and T.compressa.
A lot of these points of confusion were cleared up by Davidson (1850) who revised and figured many of the Lamarck specimens and established their specific definitions.

d'Archiac's description of the Belgian Tourtia species (1847) was quickly followed by d'Orbigny's monumental work (1848-51). This included chapters on stratigraphical sequences and led to the production of an interesting scheme for the classification of the Cretaceous strata as a whole. In fact it is to d'Orbigny that we owe our thanks for the major stage name of the Cenomanian, having been derived from the Roman name for Le Mans in the Sarthe where the beds were first studied.

The significance of brachiopod faunas within beds of the Lower Chalk was quickly realized by stratigraphers of the time and many lists of species described by d'Orbigny appeared in their works. Barrois (1875,1876) and Bigot (1893) were among those who acknowledged the importance of brachiopods at this level,especially where where ammonites were scarce or absent.

GERMANY

About this time there was also considerable interest growing in the Cretaceous of Germany. Early

German monographs included those of Schlotheim (1813,1820) in which he described many Upper Cretaceous brachiopods including some of Cenomanian age. Later, Roemer (1840) was to describe the brachiopod faunas of the Hilsconglomerat and the Essen Greensand.

Additional German species were erected by Quenstedt (1868-71),Geinitz (1872), Dames (1874) and Tiessen (1895), all accompanied by clear descriptions. Further taxa were added to the list by Deicke(1878),who described brachiopods of Cenomanian age. The one name which stands paramount among German workers,however, is that of Schloenbach (1867) whose concise and detailed descriptions were enhanced by equally good illustrations.

This early interest in the Cretaceous brachiopods was not maintained and, in keeping with most of the countries within western Europe, no notable works specifically devoted to Cenomanian brachiopod species has appeared from Germany since before the first World War.

DENMARK

Although the Lower Chalk is poorly exposed in Denmark, Ravn (1916,1925) monographed the fauna from the Lower Cenomanian of Bornholm. Two species of Terebratella, T. kofoedi and T. bornholmensis ~~were~~

were described as new and the following species reviewed, listed and some figured from the Arnager Greensand. In his 1916 paper, Ravn figured specimens which he identified as Rhynchonella martini, a rather poor example of a finely costate rhynchonellid, Terebratula biplicata, a specimen which might be a small example of Moutonithyris dutempleana, a crushed specimen of a Capillithyris cf. capillata, a convincing example of Arcuatothyris arcuata and a poor specimen of an Ovatathyris sp. A good example was given of Platythyris squamosa (Mantell) but was slightly more inflated than the typical form. A specimen of Arcuatothyris sp., and Arenaciarcula beaumonti and a good example of Modestella geinitzi very similar to the form occurring in the marly facies of the Lower Chalk, rhotomagense Zone of Folkestone and Dover.

In 1925, Ravn published a further paper on the Cenomanian beds of Bornholm and figured more examples of the brachiopod fauna with Rhynchonella sigma , a biplicate terebratulid similar to the Tropeothyris vectis sp. nov. described here from the Lower Cenomanian of the Isle of Wight, a rather inflated example of Terebratula biplicata Sowerby (now Boubeithyris diploplicata sp. nov.) A specimen identified as Terebratula tornacensis was figured as a steinkern.

PART II

DISTRIBUTION OF CENOMANIAN ROCKS

1. DISTRIBUTION OF CENOMANIAN ROCKS

1.1 UNITED KINGDOM

1.2 SOUTHEASTERN FACIES

1.3 THE WEALD

Although there are many accounts of the geology of the Weald ranging from the works of W.W.Topley (1875) to the more detailed account by Jukes-Browne & Hill (1866,1900-04), perhaps the most detailed of all descriptions in recent years of the Chalk of Sussex is that published by Christopher Gaster in a series of papers in the Proceedings of the Geologist's Association from 1929-1951. During this period Gaster visited numerous localities in East and West Sussex where the Lower Chalk is well represented and, at that time,was well exposed in many working quarries. Few of these localities are still available but Gaster recorded brachiopod species from most of the small sections he visited. His collection was presented to the British Museum (Natural History) in 1957 and has been used during the course of the present study.

Classic sections,such as those recorded by Mantell (1822) from the Lewes district, have long been overgrown and lost to the observer but there are still some exposures in large working quarries southeast of Lewes which present good sections through most of the Cenomanian. Some of these sections were among those cited by Kennedy (1969) during his work on the

correlation of the ammonite zones of southeast England. Kennedy's work has been closely followed here and many of the brachiopods collected during his field survey are used in the present study with the most up to date stratigraphical information available. Among the many exposures described in Kennedy's work is an excellent account of the sections then available from extensive workings for the Cement industry in the Southerham and Glynde areas. Eastwood's Cement Co., pit, Southerham Grey pit, Newington's pit, Rodmill Cement Works pit near Asham and the Balcombe pit are among those which have yielded many fine brachiopod specimens. As a result of his work on the coastal section at Folkestone and Eastbourne, Kennedy was able to zone the discontinuous sections inthese pits, at the same time recording and early Hypoturrilites carctanensis assemblage in a thin glauconitic spongiferous limestone in the top of the Glauconitic Marl at 'Beddingham'. He also recorded both phosphatized and non-phosphatized ammonites of the carcitanensis assemblage from the lower part of the Glauconitic Marl at Eastbourne, but subsequent microfaunal studies (Carter & Hart,1977) have suggested that the sediment of the Glauconitic Marl at this locality is significantly younger.

The coastal sections,however,are poorly exposed and,somewhat surprisingly,one finds no continuous or clear section from Eastbourne town end towards Beachy Head due to numerous faults and superficial slumping.

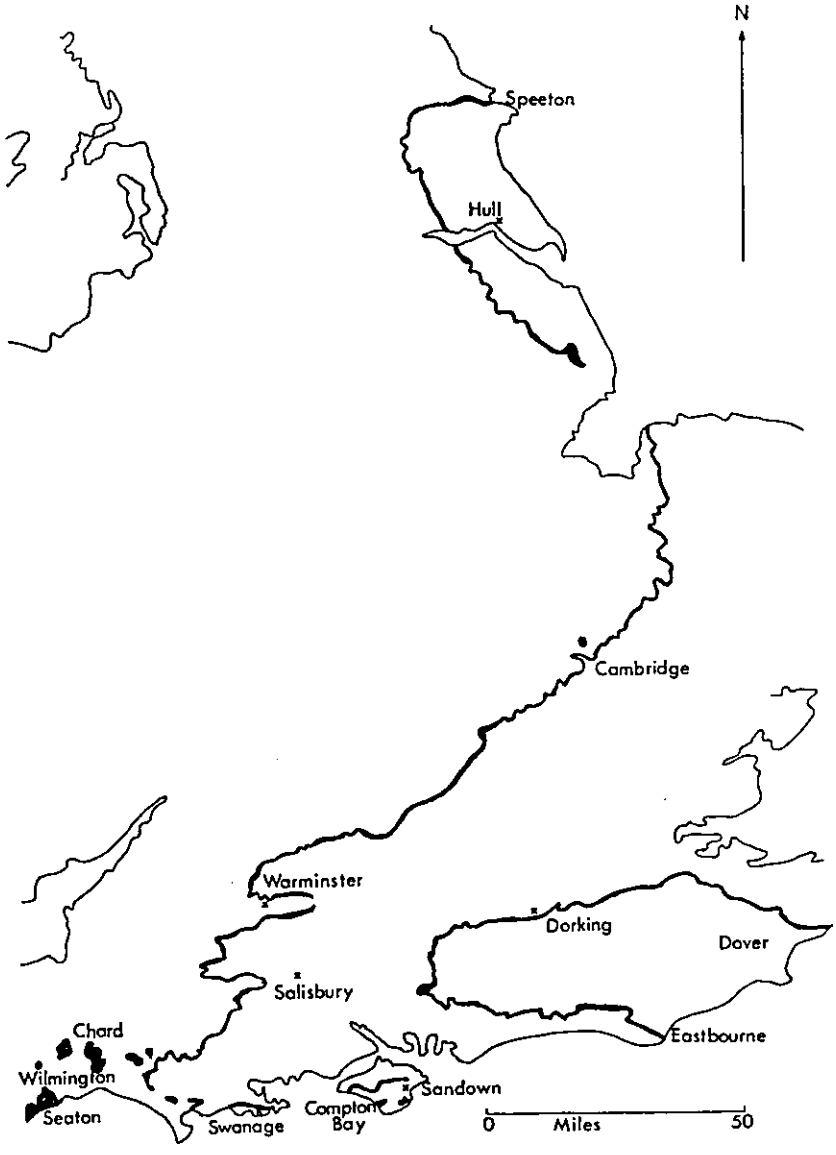
At the western end of the beach the Upper Greensand is exposed in the offshore reefs running parallel to the cliffs and at places the Lower Chalk rests unconformably upon these beds. The basement bed of the Cenomanian at this locality is represented by the Glauconitic Marl which is about 2-3 metres in thickness. It consists of a highly glauconitic marl with phosphatized nodules, a varied molluscan fauna and indigenous brachiopods with well preserved shells. They include the typical Grasirhynchia grasiana, G. martini and Kingena concinna which is essentially similar in constitution to the fauna in beds of equivalent age at Folkestone and some parts of the Isle of Wight.

Above these beds at Eastbourne, the Lower Chalk includes beds which are not particularly fossiliferous, although a bed approximately 12 metres above the basement bed, contains the rhynchonellid brachiopod Orbirhynchia mantelliana forming a recognizable band which can be better seen where the beds are at beach level in the foreshore on a platform east of Beachy Head. This band (Band 6 of Kennedy 1969) which occurs at the top of the Turrillites costatus assemblage within the Acanthoceras rhotomagense Zone, may be traced across the Weald to Kent.

The chalky facies above this band include many ammonite assemblages with large ammonite species

TEXT-FIG. 1.

Sketch-map to show the major outcrops of the Lower Chalk in England. Only the major towns in each area are noted.


N
Speeton
Hull
Cambridge
Warminster
Dorking
Dover
Salisbury
Chard
Wilmington
Seaton
Swanage
Compton Bay
Sandown
Eastbourne
0
Miles
50

gradually diminishing towards the top where massive chalk yields few fossils. At the top of Band 9 of Kennedy, the jukesbrownei Zone, the terebratulid Concinnithyris subundata (Sowerby) occurs with a marked variant C. burhamensis Sahni,but specimens from this locality appear smaller in proportion than do those from the type localities of Wiltshire and Burham,Kent.

During the course of a more detailed study of coastal and inland areas in preparation for a Ph.D. thesis, Miss Helen Anderson measured sections previously studied by Kennedy. In some cases she found a measure of difference in their respective results and in a drawn section (not yet published) she marks two distinct Orbirhynchia mantelliana bands which she identified. This confirms the results obtained by Mr C.J.Wood, Institute of Geological Sciences (pers. comm.) from the Channel Tunnel no.1 (Aycliff) borehole,near Dover,Dover Pier borehole and Fetcham Mill borehole,Leatherhead,Surrey.

INLAND EXPOSURES ALONG THE NORTH DOWNS

The general succession remains very much the same as that seen in the coastal section at Folkestone, although exposures of Glauconitic Marl are not so readily available in this area. The Chalk Marl is well represented with transition to the more massive

Grey Chalk rather better defined than on the coast. The best localities are those in the Medway Valley where a series of quarries described by Dibley (1918) were more recently figured as part of a revision of the area by Kennedy (1969). The brachiopod faunas remain essentially the same, although the taxa have been in need of revision for some time. The present work, in addition to a re-appraisal of Kennedy's work, is aimed at updating and redescribing some of the brachiopod species thought to be of stratigraphical importance. These are,in the main, to be found listed in Kennedy (1969:482,485,486) in a description of the beds exposed at Bluebell Hill,Burham,Kent.

1.4 HAMPSHIRE

Better known geologically for its sections through the Upper Chalk and numerous examples of Tertiary deposits within the basin,Hampshire also extends to the Isle of Wight where the Upper Greensand and Lower Chalk are well exposed in southern cliff sections from Compton Bay in the west to Culver and Whitecliff in the east,Fig.29 . The brachiopod fauna is again represented in bands within two distinct facies,the more marly beds containing relatively the same or similar assemblage of Grasirhynchia grasiana , G.martini,Kingena concinna, Terebratulina prostriatula sp.nov. and Orbirhynchia mantelliana as on the mainland.

The more sandy facies of the Upper Greensand and Glauconitic Marl have a similar brachiopod fauna to those at Eastbourne and more westerly localities in the Warminster and South Devon areas. As in the case of the inland exposures within the southeastern region of the Weald, some elements of the marly fauna appear to transcend the change of ecology and can be collected from beds of a more sandy and glauconitic nature, notably Grasirhynchia grasiana and Terebratulina prostriatula sp.nov. The genus Cyclothyris, however, appears to be confined to the coarser sediments, with some notable exceptions where Cyclothyris sp. and C.cf.difformis have been recorded from the chalky basement beds of Dorset and Wiltshire (Kennedy, 1970).

2. SOUTHWESTERN FACIES

In 1896 Jukes-Browne & Hill published an account of the Cenomanian outcrops in the West Country. This, in a sense, was the first work of any note on the Cenomanian deposits in that area since Barrois (1876) and De La Beche (1826). The paper by Jukes-Browne & Hill was quickly followed by another joint work, this time by Meyer & Jukes-Browne (1894) listing fossils found in beds within the Upper Greensand, and a further paper by Jukes-Browne (1898), describing an outlier of Cenomanian age in the Honiton area of Devon. Five years later the second volume in the classic series of

Geological Survey Memoirs on the Cretaceous Rocks of Britain (1903-1904) was published in which detailed lithological accounts were given of the succession from the Glauconitic Marl to the Middle Chalk with tables and lists of fossils complete with their estimated horizontal range. This work soon,deservedly, became the standard book of reference,not only for the southwestern area but for other areas in Britain, and remained so for many years.

Apart from a few local descriptions of outcrops and accounts of geological excursions, the soutwestern area of Britain remained unattended by geologists until Woodward & Usher (1911), Dewey (1957),Smith (1957,1961) and Hancock (1969) gave a more detailed account of the structural geology and stratigraphy of the area. This was soon followed by a careful and painstaking study of the lithological features and the ammonite zones in a broad correlation of the Upper Albian and Lower Chalk of Southwest England by Kennedy (1970) and is currently considered to be the foremost authority on this part of the succession.

2.1 DORSET

Except at the coast, the brachiopod faunas in Dorset occur mainly in the chalky Middle Cenomanian Basement Bed. Brachiopod species are predominantly

terebratulidae and have been collected from Evershot, Eggardon,Chilfrome,Maiden Newton, Beaminster,Askerswell, Toller Fraterum and Toller Porcorum by Kennedy (1970) who listed many of these from well marked bands within the succession,Figs. 32-34.

Apart from Beaminster and some localities in the Hooke Valley, where there is a basal conglomerate, the Basement Bed overlies the Eggardon Grit throughout the county. It is a distinctive bed consisting of phosphatized nodular chalk and pebbles of glauconitized Eggardon Grit within a glauconitic chalky matrix, varying only in the hardness of the chalk and the colour of the phosphates. Some beds yield a mixture of both phosphatized and unphosphatized fossils.

From well preserved ammonite species,Kennedy (1970) concluded that the majority of the Basement Bed localities occurred within the main Acanthoceras rhotomagense Zone. The exception to this is at Askerswell where the basement here occurs with Calycoceras naviculare and is consequently included within the naviculare Zone of the upper part of the Lower Chalk.

Kennedy's detailed account of the Cenomanian Basement Beds in Wiltshire and North Dorset was accompanied by numerous drawn sections of the sequence

indicating the exact position of the ammonite assemblages and brachiopod faunal bands. This has proved an invaluable contribution to the study since, hitherto, only the broadest outlines of horizons and zones were to be found on labels in museum and private collections. The present study,therefore, draws heavily upon the work of Kennedy (1970) in this area.

At the coast, especially in the Punfield,Swanage area,Fig.2 ; there is considerable lateral variation within the beds of Upper Albian to Cenomanian age. In the cliff section west of Ballard Point, the basal 15 cm of the Chalk Marl contains an Orbirhynchia mantellian band with associated Grasirhynchia grasiana and an undescribed Concinnithyris sp. The Cenomanian Basement Bed here is of Middle Cenomanian age and consists of 10-15 cm of dark to light-brown phosphatic pebbles in a glauconitic sandy marl. It rests on a highly complex unit containing graded small to large phosphatic nodules with intervening glauconitic sands showing evidence of piped material from the beds above. It contains both Upper Albian and Cenomanian ammonites.

A layer of waterworn limestone boulders forms a convenient marker separating the Cenomanian beds from the underlying Upper Albian beds with numerous

Exogyra spp. Just beneath this ledge of boulders is a bed containing examples of the terebratellid brachiopod Dereta cf.pectita which differs from the typical form described by J.Sowerby (1816) from Horningsham, Wiltshire in its subquadrate outline,larger foramen and coarser ornament of radiating costae. It is described here as Dereta pectita ballardensis subsp.nov. in the section on systematic descriptions.

2.2 DEVON

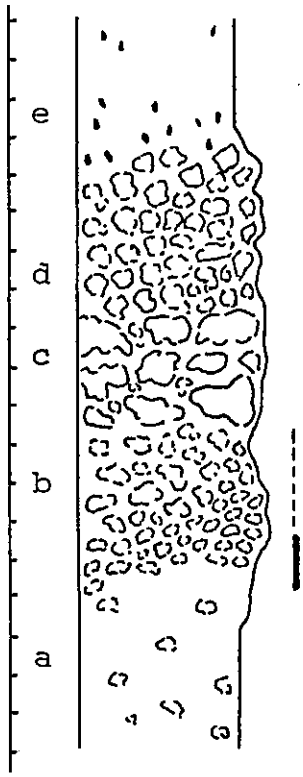
The furthest western outcrop of Cenomanian rocks occurs in the Haldon Hills but the succession can be more readily studied at the coast between Branscombe and Humble Point where this part of the succession is well exposed. Here, the four lithological units described by Jukes-Browne (1903) as divisions 'A','A 2' 'B' and 'C' can be studied. The oldest of these divisions, 'A', cosists of a fairly coarse-grained,shelly limestone with glauconite and fragments of quartz and is very fossiliferous. Although some of the ammonites show signs of reworking, the molluscan and brachiopod faunas are well preserved with specimens of Cyclothyris difformis (Val.in Lamarck),Dereta pectita (J.Sowerby) and Kingena arenosa (d'Archiac) and,according to Kennedy (1970) can be included within the Mantelliceras saxbii assemblage of the main M.mantelli Zone.

TEXT-FIG. 2.

Sketch of vertical section through part of the Upper Albian and Cenomanian at Ballard Point near Punfield Cove, Swanage Bay, Dorset, to show the unusual phophatised rubbly beds and the nodular sandstone with smooth cobbles and the Chalk basement bed with light brown phosphatic pebbles in glauconitic marl above.

The Dereta pectita ballardensis beds occur at the base of the nodular sandstone with oysters.

PUNFIELD, SWANAGE. EASTERNMOST SECTION.



Considerable lateral variation at this level, over very short distance.

Chalk basement bed - basal 10-15cm, full of dark/light brown phosphatic pebbles in a glauconitic marl.

Nodules contain phosphates, as does intervening glauconitic sand - highly complex unit - some material piped down from above.

Large, rather smooth surfaced cobbles of light sandstone with variable development.

Nodular sandstone with abundant oysters.

--------- Break in nodularity.

Glauconite sand with rather scattered nodules.

The age of the Chalk basement bed here is (e) Middle Cenomanian. The unit on which it rests is sedimentologically very complex and contains phosphatised Upper Albian and Cenomanian ammonites; according to C. J. Wood, the Albian species are always found within the nodules and the Cenomanian in the burrow-fills in between them. By superposition, (without indigenous ammonite evidence) it seems likely that a - d are Upper Albian.

Bed 'B' is of a finer,highly glauconitic,white sandy limestone containing no recorded brachiopods but having an ammonite fauna suggesting an equivalent age to that of the Mantelliceras gr.dixoni assemblage of the Weald.

Bed 'C', on the other hand, can be recognized on the coast as a hard,gritty,highly glauconitic nodular chalk,streaked with red and green veins and highly burrowed with Thalassinoides paradoxica. Among the rich ammonite fauna is the zonal index fossil Calycoceras naviculare and numerous bivalves, serpulids and bryozoans. The brachiopod fauna consists of at least two species of Orbirhynchia,O.wiesti (Quenstedt) and O.multicostata Pettitt,terebratulidae, Concinnithyris sp. and Platythyris rugulosa (Morris). This bed contains a similar brachiopod fauna to that of the Plenus Marl elsewhere.

Smith (1957,1961) gave a clear description of the extent of the lateral variations in the lithology and thickness of the coastal outcrops and some of their inland equivalents, particularly those exposed in the two sandpits in the Wilmington district further north. These pits, Hutchin's sandpit (ST 216003) and the more accessible White Hart sandpit (SY 208999), Figs.37 & 38 were also part of a review by Kennedy (1970:662,665) with additional palaeontological data and drawn sections. More recently,Carter & Hart (1977:99,100) reviewed

the work of the above authors on the basis of planktonic microfaunal evidence but their findings do not affect or alter the information regarding the position of the brachiopod bearing beds.

The beds exposed at Wilmington represent different lithological equivalents of those exposed along coastal sections but are confined to an outlier of loose-bedded sands, sandy nodular limestones and glauconitic chalk. Of these, the nodular limestone or 'Grizzle' contains a rich fauna composed of molluscs, ammonites and brachiopods. Mantelliceras spp., Schloenbachia spp., an Inoceramus virgatus are commonly associated with a fauna of brachiopods predominantly rhynchonellid in constitution. Cyclothyris difformis (Valenciennes in Lamarck) is a particularly common species, occurring with Dereta pectita, Terebrirostra lyra, Orbirhynchia wilmingtonensis sp.nov., Ovatathyris ovata and Kingena arenosa (d'Archiac) etc. In the less nodular beds, Grasirhynchia grasiana (d'Orbigny) occurs with Terebratulina prostriatula sp.nov.

2.3 EASTERN FACIES

The Cambridge Greensand was at one time more readily visible in exposures from phosphate workings

south and east of the town. Nowadays, sections are confined almost exclusively to those incidental to chalk workings, as in the Rugby Cement Co. quarry at Barrington. Here,fortunately,it is possible to see the Cambridge Greensand with the overlying Chalk Marl and Totternhoe Stone.

Brachiopods from the Cambridge Greensand occur chiefly at the base and many of the phosphatized specimens show evidence suggesting derivation from previous sediments. The age of these sediments has been the subject of much speculation and discussion but it is widely believed that most of the crushed and decorticated forms were derived from the Upper Albian, S. dispar Zone.

Peake & Hancock (1961) listed the brachiopod fauna collected from the cliff section at Hunstanton, Norfolk, from just beneath the Totternhoe Stone to the Red Rock and considered this to be essentially the same age as the idigenous Cenomanian fauna from the Cambridge Greensand. While I agree with some correlation of the species, there are others which remain very distinctly of Upper Albian origin. Not the least of these are Moutonithyris dutempleana (d'Orbigny), M. obtusa and Orbirhynchia parkinsoni. Kingena spinulosa also occurs in these beds but the Cambridge

form has never been found except as a phosphatized internal mould ,thus direct comparison is impossible.

Carter & Hart (1977) basing their dating on microfaunal evidence, conclude the age of the Cambridge Greensand to be Lower Cenomanian, equivalent to the Hypoturrilites carcitanensis assemblage Zone of Kennedy (1969).

The Plenus Marls, although represented in the Cambridge area,are reduced in thickness. The characteristic rhynchonellid Orbirhynchia multicostata Pettitt is present in moderate numbers but the zone fossil, the belemnite Actinocamax plenus is exceedingly rare in this district.

2.4 NORFOLK

The Cretaceous rocks exposed on the Norfolk coast,to some extent, reflect the succession from inland exposures. The Red Rock of Hunstanton Cliff rests on the Carstone and represents the Upper Albian, or more accurately, the upper part of the Albian in East Anglia. It can be identified as a unit consisting of three distinctly different lithologies which have been distinguished by various authors as beds A,B & C or their equivalent beds 1,2 & 3,Fig. 7 . The extreme condensed nature of these beds to within a few meters at Hunstanton makes it difficult to judge the precise horizon for correlation if the beds are followed northwards into Lincolnshire and Yorkshire where they

expand.

Above the Red Rock,correlation with northern exposures becomes a little easier, although even here there are some anomalies which still remain problematical. The hard bands of consolidated limestone known as the 'Paradoxica' Bed and the Inoceramus Beds are clearly visible at Hunstanton and can be traced northwards to Speeton on the Yorkshire coast where they again crop out. Once again,correlation with the northern succession becomes more difficult until the level of the Totternhoe Stone is reached. It is this unit,with only minor changes in lithology, which can be traced from the type locality at Totternhoe in Berkshire through northern Hertfordshire and Bedfordshire to Cambridgeshire,Norfolk,Lincolnshire to its most northern exposure at Speeton.

3.0 NORTHEASTERN FACIES

The paucity of ammonite species within the Cenomanian of the Cretaceous succession in Lincolnshire, Humberside and North Yorkshire has made direct correlation with beds of equivalent age in the Southern Province of England very difficult. Certain well-marked lithological horizons have been recognized throughout the Northern Province and can be equated to some extent with beds in eastern and southern England. Brachiopod faunas which occur within or between these lithological bands have become more important since Bower & Farmery (1910),Jefferies (1963) and Jeans (1973) have indicated

brachiopod bands which appear to be common to both northern and southern areas.

Bower & Farmery (1910) established a numerical system for the beds throughout the Lower Chalk of Lincolnshire which was broadly applicable to the entire northern province. Their Bed I comprised the 'Paradoxica' Bed and the two Inoceramus Beds. Between these and the Grey Bed (Totternhoe Stone), a series of hard bluish grey chalk beds occur within which a band of the rhynchonellid brachiopod Orbirhynchia sp. is well developed. It was this band which Jeans (1968) recognized as his Lower Orbirhynchia Bed.

The same authors,Bower & Farmery (1910), attached a great deal of importance to the existence of two bands occurring within their Beds V - IX. These are the Lower and Upper Pink Bands occurring above the level of the Totternhoe Stone. Of these,the most fossiliferous is the Lower Pink Band which contains the brachiopod species Grasirhynchia martini, Kingena concinna and Terebratulina ornata (described here as Terebratulina imbricata sp.nov.). The presence of large numbers of Terebratulina ornata suggested to Bower & Farmery that, in the event of any subdivision of the zones, the Lower Pink Band would certainly serve as a subzone, for which T.ornata would supply a suitable name.

Wright & Wright (1942) state that the inland exposures of the Lower Pink Band in Yorkshire yield many Terebratulina specimens like its Lincolnshire counterpart

Biostratigraphical division in the northern succession has been chiefly on the presence of two echinoid zones. Holaster subglobosus, equal to Bower & Farmery's Beds I - VII (Nettleton Stone of Wood pers. comm.) and Holaster trecensis being the equivalent of Beds VIII & IX. Above these two main zones can now be added a third biostratigraphical entity, the ammonite zone formerly represented by Sciponiceras gracile and now possibly equated with Neocardiceras juddi and equal to Bower & Farmery's Bed X. At the base of this zone is a burrowed errosion surface equivale to the Sub-Plenus Marls erosion surface of southern England. This is overlain by a bed of laminated marls known as the Black Band which was formerly thought to be the correlative of the Plenus Marls of the south. This misconception was due largely to records of the belemnite Actinocamax plenus from beds thought to have been within the Black Band from localities in Yorkshire and Lincolnshire. It now seem clear that these records probably referred to the conglomeratic bed that occurs in most localities above the burrowed surface. This conglomeratic bed is highly fossiliferous, including the brachiopods Monticlarella jefferiesi, Orbirhynchia

multicostata and Ornatothyris sp., an assemblage referred to by Jefferies (1963) who concluded that it characterized the upper part of the Plenus Marls.

3.1 NORTHERN IRELAND FACIES

There is a considerable outcrop of Upper Cretaceous sediment around the margins of the Antrim basalt plateau, but Cenomanian deposits are restricted to the southeast in Co. Antrim. Here they consist of a series of sands forming part of the Hibernian Greensands running from the south of Belfast area to Portmuck in the north of Island Magee.

Papers by McGugan (1957),Reed (1958a,b),Hancock (1961), Fletcher (1977) and Fletcher & Wood (1982) have revised the stratigraphy and a summary of the latest ideas is given here.

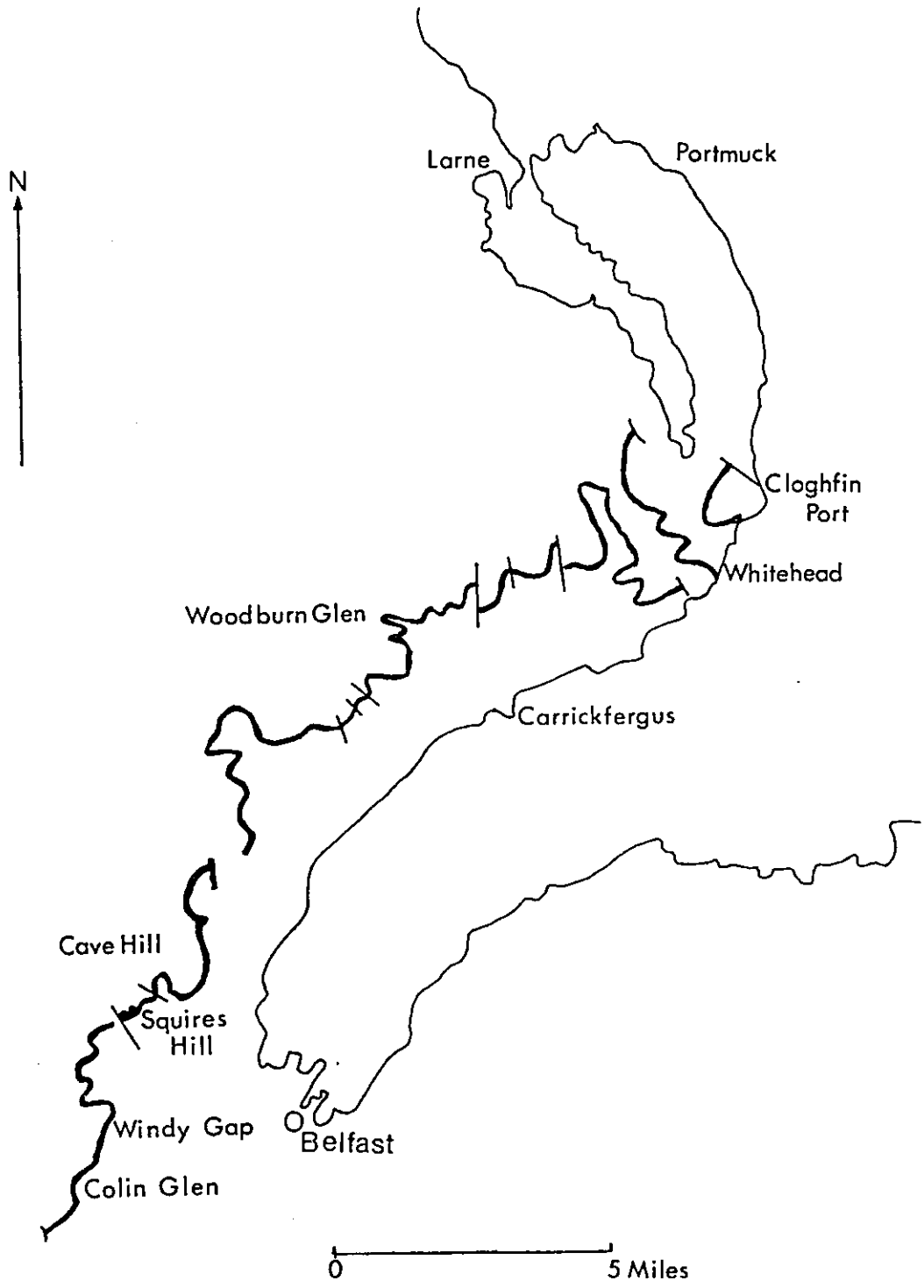
Fletcher (1977) and Fletcher & Wood (1982) considered the entire sediments of Northern Ireland as a twofold subdivision. The lowest part of this sequence included beds from the Cenomanian to the Middle Santonian and were included in the lowest part of the two units as the Hibernian Greensands Formation. Of this formation, the lower part, Cenomanian to Turonian Greensands include the Belfast Marls (a new name for the Glauconitic Sands), dark green glauconitic marl pebbly beds forming the base, which are considered to

be of Mantelliceras mantelli Zone age. The succeeding beds consist of a grey argillaceous sandstones with hard calcareous banding, up to a break in the succession marked by an unconformity in the sediments. Evidence from ammonite and Inoceramus spp. indicates that this unit is of upper Acanthoceras rhotomagense Zone age, overlain non-sequentially by the Colinwell Sands (Fletcher & Wood 1982). The Cenomanian age of the Colinwell Sands given by Hancock (1961) is not proven because of the presence of the characteristic oyster Rhynchostreon suborbiculatum which is known to be from the Upper Cenomanian or Turonian deposits and is a facies fossil.

Fletcher's revision of the stratigraphy alters previous ideas on the succession quite considerably. The Island Magee Siltstones member is a new name for Grey Marls and Yellow Sandstones of Tate (1865), the Yellow Sandstones and Marls of Hume (1897) and the Yellow Sandstones of Hancock (1961). These beds are the only ones considered here to be of Cenomanian age.

TEXT-FIG. 3

Sketch-map showing the major outcrops of Cenomanian rocks in the Belfast and Co.Antrim districts.


N
Larne
Portmuck
Cloghfin
Port
Whitehead
Woodburn Glen
Carrickfergus
Cave Hill
Squires
Hill
Windy Gap
Belfast
Colin Glen
0
5 Miles

3.2 CONTINENTAL FACIES

3.3 NORTHERN FRANCE

At Cap Blanc Nez in the Boulonnais the succession is relatively the same as that which exists at Dover and Folkestone. The grey marly chalk which represents the Lower Chalk, although somewhat more compact than on the English coast, contains an identical brachiopod fauna. Amedro et al. (1976,1978) divided this part of the succession into ten parts to which each part was given a letter and a numeral,from C - L and 1 - 27, to denote its position relative to the main ammonite zones within the uppermost part of the Albian and the Cenomanian. Although faunal lists were compiled , brachiopod species played no part in the scheme. Nevertheless, special mention was made of numerous specimens of Orbirhynchia mantelliana occuring in Bed H towards the top of band 19. This was near the top of the T.costatus subzone at the time and corresponds exactly with the position of the Orbirhynchia mantelliana Band of Kennedy (1969) within our own succession at Dover and Folkestone and elsewhere in the Weald.

I have collected specimens of O.mantelliana from a similar band at Cran d'Escalles and,from a bed just below this band, have collected examples of Kingena concinna Owen, Modestella geinitzi (Schloenbach), Grasirhynchia grasiana (d'Orbigny),G. martini (Mantell)

and Platythyris squamosa (Mantell). These specimens form part of the E.F. & M.M.Owen collection in the British Museum (Natural History).

At Octeville and Cap de la Heve, where the glauconite is more concentrated, there is a predominance of rhynchonellidae. Here,as in the West Country of England,Cylothyris difformis (Val.in Lamarck) is a comparatively common fossil occurring with other species of rhynchonellidae and terebratellidae in the coarser sandy facies.

The classic coastal section at St.Jouin, reviewed by Juignet & Kennedy (1976),provides a good series of beds almost representative of those throughout the northern European Cenomanian. Lithological variations amount to more siliceous cherty bands with sponge spicules and fragments, hard limestones with intermittent bands of more marly beds and sandy limestones. The brachiopod fauna also seems somewhat representative of the inland localities and changes in faunal constitution,likewise reflect a change in the lithology. Kingena arenosa (d'Archiac), though somewhat smaller than the typical form from the Tourtia of Belgium,occurs in the Lower and Middle Cenomanian limestones associated with Terebrirostra lyra (J.Sowerby) and Dereta pectita (J.Sowerby) which also appear smaller at this locality than in England and elsewhere.

3.4 ROUEN

The Cretaceous beds in the Rouen area are affected by the Vernon,Rouen,Pavilly anticlinal axis and the basal Cenomanian is visible only in the anticline of Rouen where it appears as a bioturbated glauconitic sandy bed resting on the grey clays of the Upper Albian. Above this basement bed are twenty meters of the Craie glauconieuse with bands of black chert and evidence of hardground. This part of the succession falls within the main Mantelliceras mantelli Zone and has yielded specimens of Cyclothyris cf.difformis (Val.in Lamarck) and Grasirhynchia grasiana (d'Orbigny).

Immediately above the Craie glauconieuse are two meters of Craie de Rouen, the lower part of which is rich in ammonites, particularly the zonal fossil Acanthoceras rhotomagense. It is just above this level that the large terebratulid brachiopod Concinnithyris obesa (J.de C.Sowerby) occurs in association with Arcuatothyris rugulosa (Morris) and Platythyris squamosa disparilis (d'Orbigny) and Orbirhynchia cf. paucicosta (Roemer).

This area was also the subject of detailed survey and stratigraphical revision by Juignet & Kennedy (1976)

who gave a series of sections through beds exposed, including one at the well known quarry of Cote Sainte-Catherine.

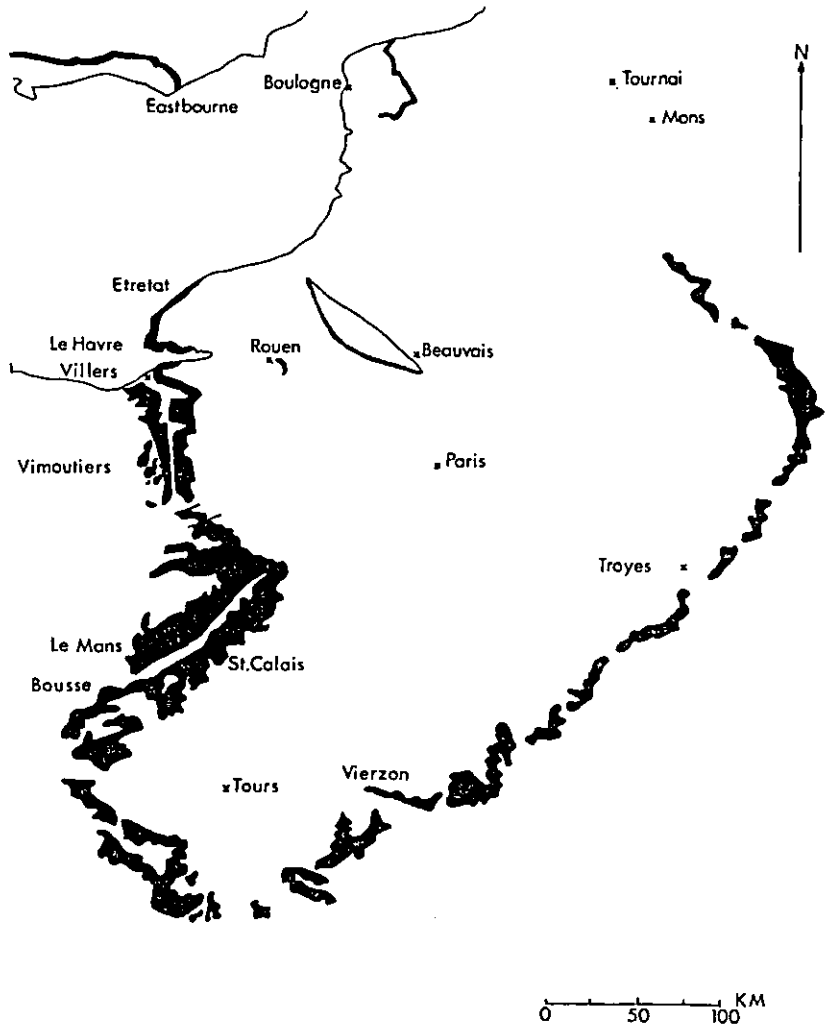
The chalky facies of Rouen can be traced eastwards through the department of Orne where it can be seen to interdigitate with the sandy facies in the Sarthe at Le Mans. Here the fauna changes once more; the rhynchonellidae represented by Cyclothyris compressa (Val.in Lamarck) characterizing the Upper Cenomanian, Sables du Perche, where it occurs with Gemmarcula menardi (Lamarck), Sellithyris tornacensis (d'Archiac) and S.phaseolina (Lamarck). Similar assemblages occur at Briollay,Mayet and at Mezieres-sous-Ballon.

At Bousse, the finer grained chalky facies support a fauna of Sellithyris phaseolina (Lamarck) and an Orbirhynchia species,described here as Orbirhynchia boussensis sp.nov., in the Sables de Bousse. In the Charente, where the sediments are of a finer,more compact chalk,Sellithyris phaseolina once again occurs, often in association with Gemmarcula carantonensis (d'Orbigny) in the Craie a Terebratella carantonensis.

East of the Paris Basin,few exposures of Cenomanian age yield brachiopods. At Vitry in the Marne, Concinnithyris obesa (J.de C.Sowerby) is found as a rare fossil in the chalky facies,and in the Aube,

TEXT-FIG. 4

The distribution of major outcrops of Lower Chalk age in northwestern France.


Eastbourne
Boulogne
Tournai
Mons
N
Etretat
Le Havre
Villers
Rouen
Beauvais
Vimoutiers
Paris
Troyes
Le Mans
St.Calais
Bousse
Tours
Vierzon
0
50
100
KM

at Brienne-le-Chateau, an Orbirhynchia sp., similar in form to the typical O. mantelliana (J.de C.Sowerby) has been found in a comparable facies to the type locality.

Within the more highly glauconitic facies in the extreme southeastern sector of France, a more variable fauna occurs which does not depart greatly from the fauna from glauconitic limestones in the north and in some parts of Britain. Although no large collections of well documented specimens exist, there are individual specimens which can be equated with those from northern areas. Examples of Ornatothyris sp., Kingena cf.arenosa (d'Archiac) and Orbirhynchia parkinsoni Owen,with local variants have been collected from the Nice district,while at Cassis and Bedoule (Bouche du Rhone) Orbirhynchia spp.,Cyclothyris sp., Terebrirostra lyra (J.Sowerby) and T. bargesana (d'Orbigny) are not uncommonly associated with large biplicate terebratulidae of the Moutonithyris group in the Lower Cenomanian limestone facies.

4.0 BELGIUM

The Cenomanian deposits from Tournai and Gussignies present a somewhat anomalous situation from that which occurs in other areas so far described. In some ways the faunal contents of the beds represented by the

Tourtia in this area is similar to that of Wilmington in Devonshire,England and almost analogous to the fauna of the more compact limestone facies at Essen in the Munster Basin,North Germany. All three localities are of arenaceous,highly calcareous deposits,but, whereas the balance of the brachiopod fauna is distinctly in favour of the rhynchonellidae at Wilmington,the balance at both the Belgian localities and that of Essen is,if anything,more favourable to the terebratulidae and the terebratellidae. A more realistic analogy is that which exists between the Belgian Tourtia and the finely arenaceous limestone occurring at Leighton Buzzard,Bedfordshire. Here, a similar balance of terebratulidae and rhynchonellidae exists,with the terebratulidae just tipping the balance in their favour.

Most of the Cenomanian Tourtia is concentrated around Tournai and Mons and has a very distinctive and varied brachiopod fauna. Although some of the specimens which d'Archiac described from these deposits as representing new species are considered to be young individuals or variants of main stock, there are many well established forms which are recognizable valid species.

4.1 GERMANY

Within the Munster Basin, the Cenomanian is

represented by many different facies varying from highly calcareous-arenaceous to completely calcareous or chalk,with intermediate glauconitic marly bands. The outcrops of the more fossiliferous limestones occur mainly in the southern part of the basin at Essen, where a similar fauna to that which exists in the Belgian Tourtia occurs. Additional species,which have not been accounted for in the Belgian deposits are Burrirhynchia sigma (Schloenbach),Arcuatothyris arcuata (Roemer) and a large terebratulid,similar to Concinnithyris davidsoni described here from the Warminster,Upper Greensand. At least part of this fauna with Arenaciarcula beaumonti (d'Archiac) is found in,what are probably the westerly extension of the Essen Greensand deposits, in Bornholm,Denmark.

Further east at Floteberg,Tecklenburg,Langelsheim and Wunstorf in the Lower to Middle Cenomanian marly facies,the familar Grasirhynchia grasiana (d'Orbigny), Concinnithyris subundata (J.Sowerby),Kingena concinna Owen assemblage occurs,although the lithology at these localities is of a distincly harder or more compact marly limestone than is encountered in either France or southern England.

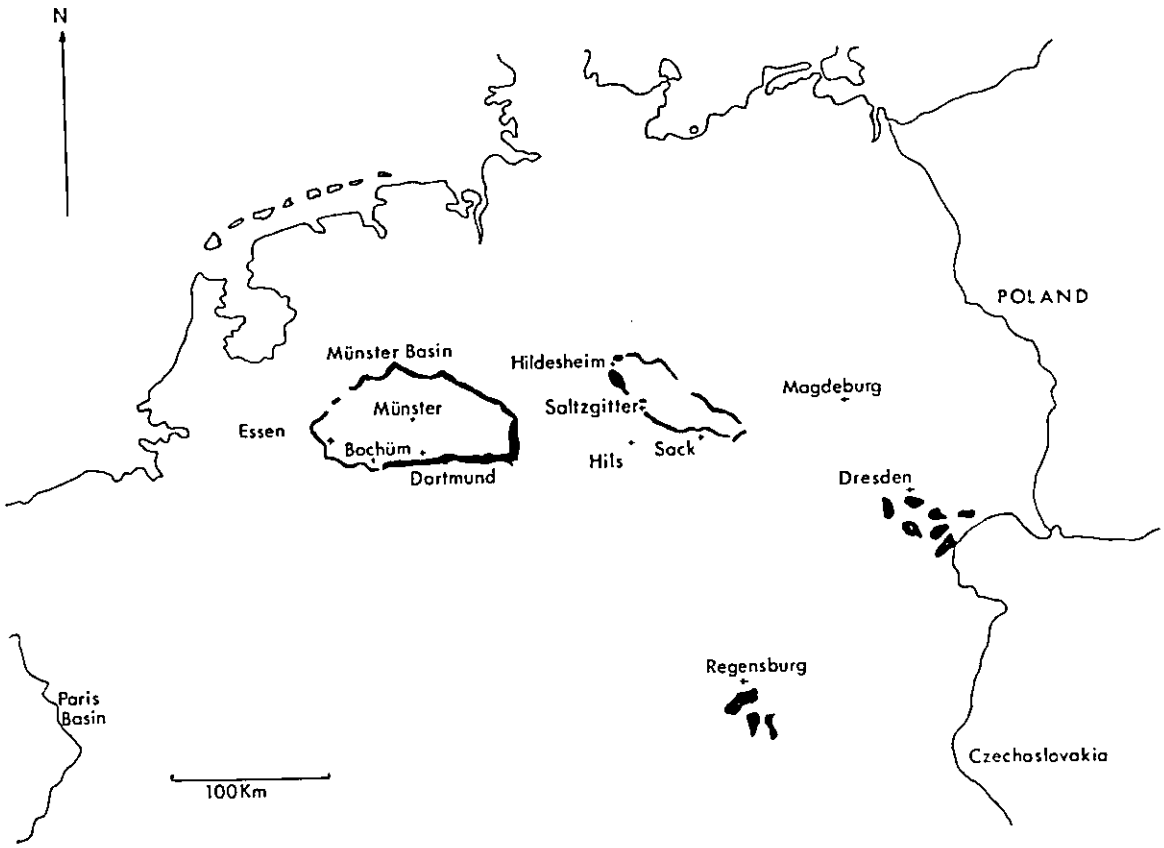
A fauna,similar to that of the Gres du Mans in the Sarthe, occurs at Morasheimer in the Bryozoensandstein Lehner (1937) listed Gemmarcula menardi (Lamarck), Sellithyris phaseolina (Lamarck) and Cyclothyris

compressa (Lamarck). The Upper Cenomanian is also represented at Kassenberg,Mulheim,in the Rhur where Orbirhynchia sp., similar to O. boussensis sp.nov., occurs as it does in the Sables de Bousse,Sarthe.

In the basal conglomerate of the Actinocamax plenus Zone at Ratsteinbruch,Dresden, large Cyclothyris sudetica (Geinitz) occur in pockets of softer rock at the exposure. The same species also occurs in the Lower Sandstone of the Regensburger outcrops further south. Associated faunas include undescribed terebratulidae probably of the Sellithyris group and smaller forms which have not been recently investigated or described.

TEXT-FIG. 5

The major Cenomanian outcrops of North Germany, Dresden and Regensburg districts.


N
POLAND
Münster Basin
Hildesheim
Magdeburg
Münster
Saltzgitter
Essen
Bochüm
Hils
Sack
Dortmund
Dresden
Regensburg
Paris
Basin
100Km
Czechoslovakia

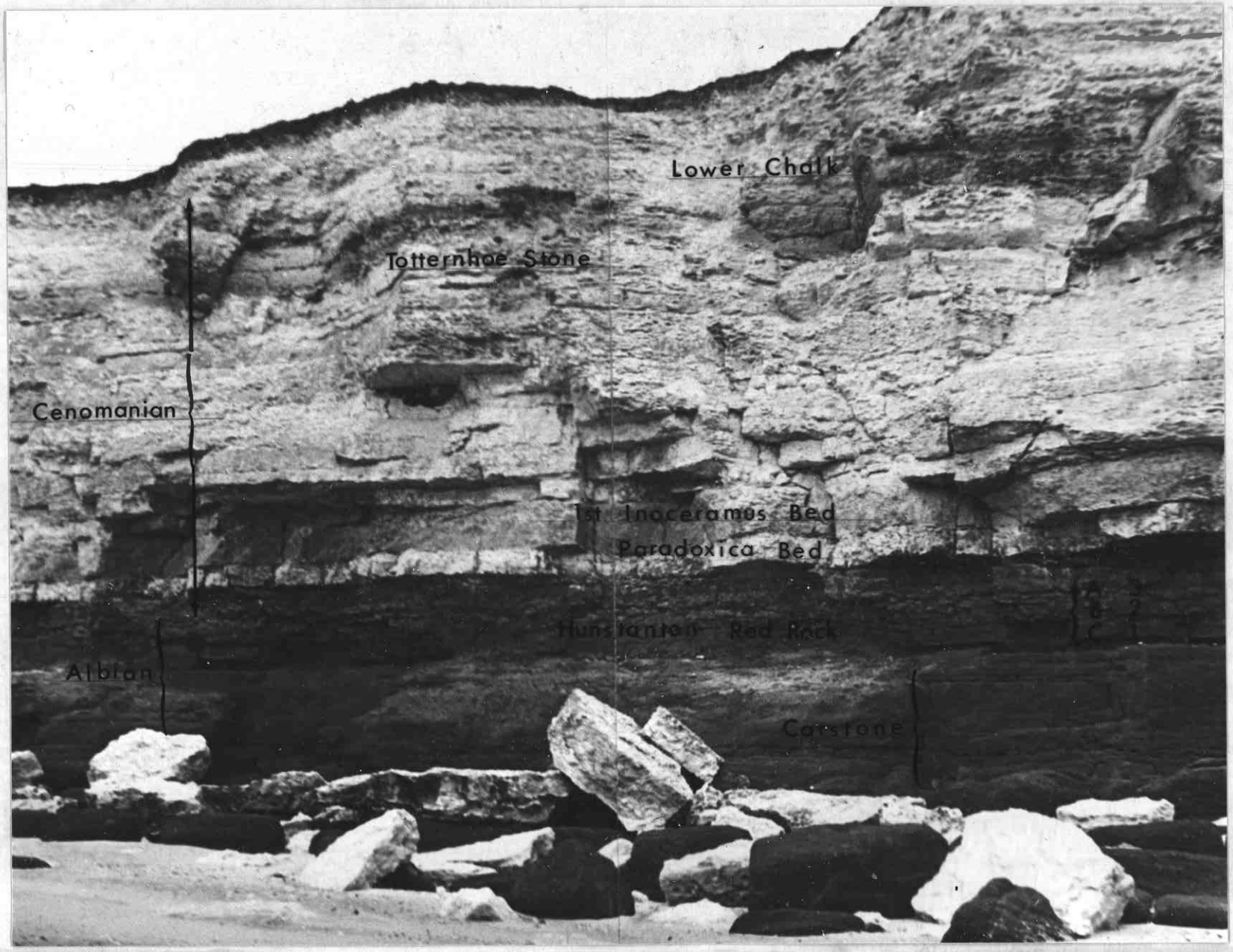
TEXT-FIG. 6.

Table showing the latest suggestions for the formation of a zonal scheme for the European Lower Chalk.

SUGGESTED ZONAL SCHEMES FOR EUROPEAN LOWER CHALK

		North Germany Wiedmann, 1979	Braunschweig -Hannover Ernst & Schmid, 1979	Putative zonal scheme in Lower Chalk Monograph; Wright, Hancock & Kennedy	Putative subzones in Lower Chalk Monograph; Wright, Hancock & Kennedy	Boulonnais Amedro et al., 1976	S.E. France Thomel, 1965
TURON.	LOWER			Watinoceras coloradoense		Watinoceras coloradoense	
CENOMANIAN	UPPER			Neocardioceras juddi			Fagesia superstes
		Metoicoceras geslinianum	plenus Zone	Metoicoceras geslinianum		Metoicoceras gr. geslinianum	Calycoceras naviculare
		Metoicoceras muelleri					
		Lotzeites lotzei		Calycoceras guerangeri		Calycoceras naviculare	Calycoceras crassum
							Calycoceras robustum
	MIDDLE	Eucalycoceras spathi	rhotomagense Zone	Acanthoceras jukesbrownei		Acanthoceras jukesbrownei	Acanthoceras rhotomagense
		Euomphaloceras cunningtoni		Acanthoceras rhotomagense	Turrilites acutus	Acanthoceras rhotomagense	
					Turrilites costatus		Acanthoceras praecursor
	LOWER	Mantelliceras mantelli	Mantelliceras mantelli	Mantelliceras orbignyi		Mantelliceras gr. dixoni	Mantelliceras mantelli
				Mantelliceras mantelli	Mantelliceras saxbii	Mantelliceras cantianum	Mantelliceras saxbii
		Utaturiceras vicinale	Neohibolites ultimus		Neostlingoceras carcitanense		

FIG. 7. Photograph of cliff section at Hunstanton, Norfolk to show Beds A,B. and C of the Red Rock, the Inoceramus Bed and the Totternhoe Stone.


Lower Chalk
Totternhoe Stone
Cenomanian
1st Inoceramus Bed
Paradoxica Bed
Hunstanton Red Rock
Albian
Carstone

PART III

SYSTEMATIC DESCRIPTIONS

SYSTEMATIC DESCRIPTIONS

This section of the present research was never intended to be presented as a comprehensive monograph of all known species within the Lower Chalk, since a great many of these have been adequately described or revised within the last fifteen years and are in need of very little additional remarks. Where necessary, problematic subjects have been more thoroughly investigated and the results and current interpretation fully explained. The liberal use of transverse serial sections revealing the internal structures of Chalk Terebratulidae in basic plan view has somewhat altered the established or more conventional interpretation, based on dissected specimens, engendered by Dr.M.R.Sahni (1929).

The value of full synonymies, in my opinion, is limited where there is no demonstrably reliable horizontal correlation and no convincing illustration accompanying a description of a species and,therefore, such synonymies have been restricted in the present work. Where possible,however,full use is made of synonymies built up from reliable records in the works of widely accepted authorities.

The accompanying systematic section,while dealing with a large proportion of already described genera and species,adds further new descriptions and taxa where these are considered to be stratigraphically important.

Class INARTICULATA Huxley, 1869

Order LINGULIDA Waagen, 1885

Superfamily LINGULACEA Menke, 1828

Family LINGULIDAE Menke, 1828

Genus LINGULA Brugiere, 1797

Lingula subovalis Davidson
Pl.5, fig.32

1852 Lingula subovalis Davidson: 7, pl.1, figs.29,30

LECTOTYPE. Here selected from three syntypes in the Davidson Collection, British Museum (Natural History), B.M. B 8291. Dimensions of lectotype. Length 12.6 mm, width 7.5 mm.

EMENDED DESCRIPTION. The general ventral outline is regularly oval, the shell being slightly convex with an umbonal carina not extending more than one third of the length of the shell. The surface is smooth, marked only by numerous concentric growth-lines. Although oval in outline the flanks are, to a great extent, subparallel.

REMARKS. The pattern of life in the living species of Lingula suggests that it is restricted in its habitat. It lives as a gregarious burrower, usually on sandy or muddy shorlines, often near river estuaries. It has a limited tolerance to depth and temperature and, if it can be assumed that its habits to-day are comparable to those of fossil times,it can provide a useful climatic and depth indicator.

Apart from the Craniidae, families of inarticulate brachiopods are rare within the Mesozoic as a whole. Species of Lingula have been recorded from the Lower Cretaceous, Speeton Clay from time to time and also occur, though somewhat sporadically, within the Lower Greensand in southern England and the Isle of Wight. Lingula truncata (J.de C.Sowerby) has been collected from the Upper Aptian of Sandown and specimens from the Hythe Beds of Kent can be seen in the collections of the Sedgwick Museum, Cambridge. In France a species described by d'Orbigny (1847) as L. rauliniana from probable Upper Aptian clays of Grandpre (Meuse), is possibly a synonym of Sowerby's L. truncata.

Records from the Albian are sparse but include a specimen identified by Dr W.D.Lang (1904) from the 'Gault' of Black Venn, near Lyme Regis, Dorset. Donovan (1949) recorded Lingula subovalis from the Albian of Geographical Society Island, Greenland, but this is probably not of that species.

Cenomanian records are slightly more rewarding. Most specimens have been identified as Lingula subovalis or Lingula sp. and include the localities of Butser, Hampshire, Halton, Cambridgeshire, Burwell Rock, of Burwell, Cambridgeshire. The youngest species recorded from the Cenomanian was identified and figured as Lingula sp.from the Plenus Subzone, Bed 1 of the Standard succession at Merstham, Surrey, by Jefferies (1962).

Superfamily RHYNCHONELLACEA Schuchert, 1896

Family RHYNCHONELLIDAE Gray, 1848

Subfamily CYCLOTHYRININAE Makridin, 1955

Genus CYCLOTHYRIS M'Coy, 1844

Cyclothyris difformis (Valenciennes in Lamarck)
Pl. 2, figs.4-6. 10-12.

1819 Terbratula difformis Valenciennes in Lamarck: 255, indicated Encl.Meth., 1789,pl.242,fig.5.

1821 Terebratula dimidiata J.Sowerby: 138, pl.277, fig.5.

1822 Terebratula gallina Brongniart: 8_, pl.9,fig.2.

1828 Terebratula difformis Lamarck; Defrance: 160, pl.5, fig.3

1847 Rhynchonella compressa (Lamarck); d'Orbigny: 35,pl.497,

1850 Terebratula difformis Lamarck; Davidson : 433, pl.15, fig.48.

1852 Terebratula compressa Lamarck; Davidson: 80, pl.11, figs. 4 & 5.

1885 Terebratula difformis Lamarck; Quenstedt: 696, pl.54,

1900 Rhynchonella difformis (Lamarck); Jukes-Browne: 65, figs.41, 42.

1918 Terebratula difformis Valenciennes in Lamarck; Clerc & Favre, pl.15, fig.84.

1962 Cyclothyris difformis (Valenciennes in Lamarck); Owen: 51, pl.5, figs.1-7.

LECTOTYPE. In Museum d'Histoire Naturelle, No.48, Lamarck Collection, from the Lower Cenomanian, Normandy coast.

This species was reviewed and redescribed by Owen (1962:51) in a general revision of the genus Cyclothyris M'Coy. In that work, a pictograph was figured, illustrating thirteen morphological variants within the species C. difformis (Valenciennes in Lamarck). The present work while adding little to the range of variation, confirms the variability of this species with additional examples from several different localities. On Pl.2, figs.1-3 represent the acutely triangulate form from the Glauconitic Marl of Compton Bay,Isle of Wight and figs.4-6 show an example of a rarely occurring form from the Lower Chalk Basement Beds of Snowdon Hill,Chard, Somerset. It has an anterior commissure which has a right lateral asymetry. It sometimes follows that this condition alternates among an assemblage of specimens from right to left. The specimen figured as figs. 10-12 on the same plate is from the Lower Cenomanian of High Melcombe, Dorset and shows a specimen with the oposite bias of asymetry of commissure and also a greater number of costae and more numerous concentric growth-lines.

Cyclothyris formosa sp. nov.
Pl.3, figs. 1-6.

DIAGNOSIS. Distinctly triangulate in ventral outline, trilobate. Umbo short, massive; beak slightly incurved. Beak-ridges sharp, deltidial plates exposed; interarea fairly extensive. Median brachial fold well developed. Ventral valve flat to slightly convex, anteriorly sulcate. Anterior commissure with high arcuate linguiform extension.

DESCRIPTION. This species is distinguished by its consistent trilobate aspect and regular morphology, variation amounting to a less well developed median fold on the brachial valve and a flatter ventral valve. The degree of convexity of the brachial valve is maintained. The high arched linguiform extension produces a late development of the anterior bracial fold and is responsible for the trilobation of the valves. The surface ornament of 34-36 rounded radiating costae are not interrupted by concentric growth-lines. An average of six to eight costae adorn the median fold with a corresponding number within the pedicle sulcus.

HOLOTYPE. Specimen in British Museum (Natural History), B.M. BB 82206, from the Middle Cenomanian, (Lennier's Bed 10) St.Juin, Normandy. Figured here Pl.3, figs. 1-3.
Dimensions. 22.2 mm long, 24.5 mm wide, 16.7 mm thick.
Paratypes. B.M. BB 82207, BB 82300-31.

REMARKS. Cyclothyris formosa can be distinguished from C. difformis (Val. in Lamarck) by its trilobate outline, short massive umbo, smaller foramen, lack of asymetrical development of the anterior commissure and consistent biconvexity. It can be distinguished from C. juigneti sp. nov., C. compressa (Val in Lamarck) and Cyclothyris lamarckiana (d'Orbigny) in general outline, more highly developed median brachial fold and narrower pedicle sulcus, more rounded or less deeply incised costae and more consistent biconvexity.

Cyclothyris juigneti sp. nov.
Pl.3, figs. 16-21.

DIAGNOSIS. Acutely triangulate in ventral ouline. Umbo short, beak suberect, pointed. Foramen large auriculate. Brachial valve convex, median fold poorly developed. Pedicle valve flat. Linguiform extension short, anterior commissure,low arcuate.

DESCRIPTION. Although somewhat resembling C. compressa (Val. in Lamarck) in general outline it can be distinguished from this species in having different costae and less inflated brachial umbo.The umbo, though short, allows a moderately extensive interarea which is bounded by sharp beak-ridges. Both valves are ornamented with approximately 23-25 sharp, deeply incised radiating costae with four on the median fold and three in the sulcus. There is no marginal thickening

of the valves and no visible concentric growth-lines.

HOLOTYPE. In the collections of the British Museum (Natural History) B.M. BB 82208 from the Middle Cenomanian, Turrilites costatus Zone, La Perriere Orne), France. Figured here, Pl.3, figs. 16-18.

Paratypes. B.M. BB 82209-82211.

Dimensions of holotype. Length, 17.0 mm, width, 22.2 mm and thickness, 9.8 mm.

REMARKS. The species has been named in honour of Dr.P.Juignet,University of Caen, Normandy. It can be distinguished from C. compressa, C. difformis and C. lamarckiana by its consistently smaller dimensions more deeply incised and fewer radiating costae, flatter valves and more acute triangular outline. The median fold on the brachial valve shows about the same degree of development as seen in C. compressa but remains narrower at all stages of growth.

Cyclothyris compressa (Val. in Lamarck)
Pl.3, figs.22-27.

1819 Terebratula compressa Valanciennes in Lamarck: 256, No.54.

1850 Terebratula compressa Lamarck; Davidson: 455,pl.15, fig.54.

1918 Terebratula compressa Valenciennes in Lamarck; Clerc & Favre ,pl.19, figs.117,119.

1962 Cyclothyris compressa (Valenciennes in Lamarck) Owen: 54, pl.5, fig.8.

This species was reviewed and figured (Owen,1962)

when it was stated to characterize the Sables du Perche of the Upper Cenomanian in the Le Mans district (Sarthe), France. At the time it was thought to be distinct from related forms in the zones above and below the Sables du Perche, i.e. Marnes à Ostrea biauriculata above and the Sables et Grès du Mans below. It is now considered to have a more extensive range, that of all three zones mentioned above and shows some variation which is explained here.

The very marked marginal thickening seen on the valves of specimens collected from the Sables du Perche is somewhat misleading and suggests a more generalised thickening of the valves altogether. This is now thought to be due to local preservation and that, in reality, the valves are very much thinner. Comparison with material collected from other localities within the Upper Cenomanian zones mentioned here confirms the accepted opinion of a more widely ranging species.

Specimens figured here from Mayet (Sarthe), Pl.3, figs. 22-27, show the slightly more rounded costae, less acute triangulate outline and wider median fold and sulcus than those of C. difformis or C. juigneti.

Cyclothyris lamarckiana (d'Orbigny)
Pl.3, figs.7-15.

1847 Rhynchonella lamarckiana d'Orbigny:32,pl.496,figs. 5-13.

Originally described from the Cenomanian of the

Le Mans district, the species characterises the Marnes à Ostracées of the Briollay area (Sarthe). It is a comparatively large species with almost equal biconvexity of valves. The costae are strong and angular and average 30 on each valve with six on an almost imperceptible fold on the anterior part of the brachial valve and an equivalent number in the low arched trapezoidal linguiform extension. There is a tendency to asymetry of the anterior commissure, although this is not shown on the specimens figured here,Pl.3, figs. 7-15.

Dimensions of figured specimens.

B.M. BB 82203 Length, 21.9 mm, width, 24.9 mm, and thickness, 13.7 mm.

B.M. BB 82204 Length, 21.3 mm, width, 22.5 mm, and thickness, 14.0 mm.

B.M. BB 82205 Length, 22.6 mm, width, 25.7, and thickness, 16.0 mm.

Subfamily Uncertain

Genus GRASIRHYNCHIA Owen, 1968

Type species. Rhynchonella grasiana d'Orbigny, 1847

Grasirhynchia grasiana (d'Orbigny)

Pl.5, figs.20-23

1847 Rhynchonella grasiana d'Orbigny: pl.497,figs.7-10

1852 Rhynchonella grasiana d'Orbigny; Davidson: 96, pl.12, figs.17-19

1867 Rhynchonella grasana (sic) d'Orbigny; Schloenbach: 496, pl.2, figs.8,9

1878 Rhynchonella grasana (sic) d'Orbigny; Deicke: 26, figs.20,21

1895 Rhynchonella grasiana d'Orbigny; Tiessen:459

1968 Grasirhynchia grasiana (d'Orbigny); Owen: 20, pl.2,figs.7a,b,c.

1969 Rhynchonella grasiana d'Orbigny; Panow: 578,pl.110, fig.1

1977 Grasirhynchia grasiana (d'Orbigny); Popiel-Barczyk: 36,pl.3,figs.3-7, text-figs.10,11

LECTOTYPE. Selected (Owen,1968) from 22 specimens in the d'Orbigny Collection and housed in the Museum d'Histoire Naturelle,Paris, No.6497 in the d'Orbigny catalogue. It was collected from the Cenomanian of Le Hâvre,Normandy.

Dimensions of lectotype. Length 13.4 mm, width 15 mm and thickness 10 mm.

REMARKS. The species was exhaustively studied and

described with transverse serial sections (Owen,1968) taken from a British specimen from Sussex which had been carefully matched with the lectotype. Since that time, Dr Ewa Popiel-Barczyk of the Museum Ziemi, Warsaw, has published a series of transverse sections through a specimen from the Lower Cenomanian of Annopol,Poland, which can be equated with the series published by me in 1968. Popiel-Barczyk (1977:37) figured two series as fig.10 and 11; of these, fig.10 is considered to be closer to the typical form.

Apart from its geological range which is estimated as Lower to Middle Cenomanian, the species exhibits a remarkable ecological tolerance and is found in various lithologies from highly glauconitic sandy limestones, such as those that occur in the Upper Greensand of Warminster, Wiltshire and in the Lower Cenomanian Limestone of Wilmington,Devon to the more marly and chalky facies of the Middle Cenomanian which occur in some parts of Dorset, Sussex and Kent.

Morphological variation within the species amounts to difference in size, the smaller and more finely costate varieties appearing to prefer the more highly calcareous and chalky facies. Both small and large specimens do occur within the same beds,however,the smaller variety forming the bulk of collections made from the western provinces. Further eastwards, in

Sussex and Kent, the larger more coarsely costate variety becomes more commonplace, particularly within the marly chalk of the rhotomagense Zone in the coastal sections.Even here, there appears to be a mixture of both large and small varieties although the smaller variety seems less common.

As a general rule, the smaller form with finer costation is more acutely convex,having a domed dorsal valve, a moderately highly arched anterior fold and extensive linguiform extension. A broad shallow sulcus is maintained in the anterior part of the ventral valve in all varieties.

The foramen is characteristically large for a small rhynchonellid and is guarded by auriculate extensions of the deltidium which partially surrounds it. This feature is shown here,Pl.5,fig.23, on a specimen from the Lower Cenomanian of Le Hâvre, Normandy. This structure is not confined to G. grasiana and is seen on well preserved specimens of G. martini, figured here, Pl.5, figs.24-26, and also occurs in Cyclothyris.

Geographically the species has a wide distribution, numerous examples having been collected from Wilmington, Whitecliff,Haldon Hills and Chardstock, Devon where it occurs in the Upper Greensand and Lower Cenomanian Limestone and from the Popple Bed at Mere, Witshire, Melcombe Bingham,Doset. A large, coarsely costate form has been collected from Heytesbury and Chute Farm , Wilts.

The species is not common on the Isle of Wight but examples have been obtained from the Glauconitic Marl of Compton Bay, Gore Cliff and Rocken End, Undercliff and Culver. A fine specimen was collected from the Lower Cenomanian, mantelli Zone, carcitanense Subzone, West side of Woody Bay, by Dr W.J.Kennedy.

Continental collections have been made from the type locality in Normandy, St.Jouin on the same coast, from the more marly beds at Cran d'Escalles near Cap Blanc Nez as well as from Rougefort,Pas de Calais, Octerville and Vimoutier (Orne). One large specimen is said to have been collected from the Basses Alpes, in South France and some near perfect examples were collected by Dr W.J.Kennedy from the Middle Cenomanian, Sables de Lamnay, at a disused roadside pit near Courgenard, Sarthe.

Several fine examples of the typical form collected by Dr R.Marcinowski from the Lower Cenomanian of Czestochowa and some from the same horizon from Julianka in Poland together with numerous examples from the Lower Cenomanian of Annopol are in the Museum Ziemi, Warsaw,Poland.

The species also occurs in beds considered to be of Middle Cenomanian age in Brochterbeck and Wünstorf, North Germany, although it is very rare.

The following list of British and some French examples is given with dimension.

LOCALITY	LENGTH	WIDTH	THICKNESS	REGD.No.
Warminster	11.7 mm	13.3 mm	10.4 mm	B.M. 2326
Chute Farm	9.4	10.7	6.8	B.M. 98057
	10.8	11.4	7.3	
	10.4	11.4	6.6	
	9.2	9.8	6.5	
	9.9	10.0	5.8	
	9.1	9.5	7.9	
	8.7	8.9	7.7	
Chardstock	9.0	10.8	7.2	B.M. B.8145
	9.6	8.9	7.7	
	8.4	8.3	6.4	
Undercliff	11.5	11.9	7.7	
I.o.Wight	9.1	9.7	6.5	
Rougefort Pas de Calais	9.0	8.5	6.8	
	13.4	8.9	5.8	
	12.2	7.9	6.2	
	7.5	8.1	4.9	

Grasirhynchia martini.(Mantell)
Pl.5, figs.24-26.

1822 Terebratula martini Mantell: 31

1826 Terebratula pisum J.de C.Sowerby: 70,pl.536,figs.6,7.

1838 Terebratula pisum Sowerby; Von Buch: 148,pl.15,fig.18.

1852 Rhynchonella martini (Mantell); Davidson: 94,pl.12, fig.15 only.

1867 Rhynchonella martini (Mantell); Schloenbach : 499, pl.23,fig.10

1895 Rhynchonella martini (Mantell); Tiessen: 458

1968 Grasirhynchia martini (Mantell); Owen: 22, pl.2, fig.8a,b,c.,text-fig.2

LECTOTYPE. Specimen selected Owen (1968) in the Sowerby Collection,British Museum (Natural History) B.M. B 61480. This specimen is the one figured here,Pl.5,figs.24-26.

REMARKS. This species is included here because a certain amount of confusion has arisen between examples identified as G. martini and pecimens of a species here assigned to Monticlarella brevirostris (Roemer) originally described from the Planer near Sarstedt, North Germany (Roemer 1840). Davidson (1852) figured three specimens, pl.12,figs.15,16,[a-d] of these one, fig.15 is a true representation of G. martini while one other,fig.16, is an example of Monticlarella brevirostris from the Chalk Detritus from Charing, Kent and a third specimen is said to have been collected from the Upper Greensand of Chute Farm, Warminster.

Monticlarella brevirostris (Roemer) is thought to

be a senior synonym of Rhynchonella rectifrons Pictet from the Cretaceous (uncertain horizon) of Ste.Croix, Vaud, Switzerland and is to be the subject of a future paper shared between myself and Mr C.J.Wood of the Institute of Geological Sciences. In Britain it appears to be of stratigraphical significance and occurs at a restricted horizon within the Lower Chalk. It does occur with G. martini and has been collected from Folkestone, Eastbourne and localities on the Isle of Wight.

Grasirhynchia martini has a much more limited ecological tolerance than G.grasiana and appears to be restricted to the marly beds within the upper part of the Lower and the Middle Cenomanian. Records of its occurrence in the Lower Cenomanian sandy deposits in the Annopol district of Poland by Popiel-Barczyk are doubtful as the specimens figured by her, pl.4,figs. 1-3, are less than typical. Nevertheless, there is no doubt that the series of transverse sections through a specimen from Iwanowice, fig.12, belongs to the genus Grasirhynchia and is very much like the series published earlier ~~given by me~~ (Owen,1968, text-fig.2) through a specimen from the Chalk Marl of Hamsey,Sussex.

Family WELLERELLIDAE Licharev in Rzhonsnitskaya,1956

Subfamily LACUNOSELLINAE Smirnova,1963

Genus ORBIRHYNCHIA Pettitt,1954

TYPE SPECIES Orbirhynchia orbignyi Pettitt,1954

Pettitt (1954: 29) described the genus Orbirhynchia for a rhynchonellid from the Middle Chalk, Labiatus Zone, of Reigate, Surrey, which he described as Orbirhynchia orbignyi. He recognized several species ranging from the Lower to Upper Chalk and included them within the genus, attempting to distinguish his type species, O. orbignyi from O. cuvieri by comparison of external morphology and type of costation. His distinctions are somewhat arbitrary, based on minor morphological differences which could be accountable by variability within the species, and cast some doubt as to the stratigraphical value of some of his taxa.

There is, in my opinion, a very strong relationship between O. cuvieri from the Middle Chalk, and O. wiesti and O. multicostata from the Lower Chalk, with O. compta and O. orbignyi as possible synonyms of O. cuvieri.

Another group of species within the genus Orbirhynchia which appears to have many morphological characters in common is represented by O. mantelliana (J.de C.Sowerby) from the Lower Chalk, Chalk Marl of Hamsey, Sussex. This group can be distinguished from

the O. wiesti group by its more robust appearance, flatter or less inflated valves, coarser or fewer costae and trapezoidal to asymetrical anterior commissure. It also differs internally from the type species in having a thicker test and fused or less well developed dental lamellae. I include the species O. obscura from the Lower Chalk of Folkestone in synonymy with O. mantelliana as it appears to be nothing more than a variant within this species. O. parva from the Lower Chalk of Cambridge is probably another synonym of this species but shows a consistency of smaller dimensions and broader general outline than the type specimen of O. mantelliana and may deserve subspecific status. O. dispansa from the Upper Chalk, however, has many features in common with other members of this group.

Orbirhynchia mantelliana (J.de C.Sowerby)

Pl.4, figs.1-3,4-6,10-12.

1826 Terebratula mantelliana J.de C.Sowerby; pl.537,fig.5.

1838 Terebratula mantelliana Sow.; von Buch: 154,pl.15, fig.26.

1855 Rhynchonella mantelliana J.de C.Sowerby;Davidson:87, pl.12,figs.20,21.

1954 Orbirhynchia,mantelliana (J.de C.Sowerby); Pettitt: 31,pl.3,figs.10a-c.

1954 Orbirhynchia obscura Pettitt: 35, pl.3, figs.1a-c, 2a-c.

1969 Orbirhynchia mantelliana (J.de C.Sowerby); Kennedy: pl.22, figs.5-7.

LECTOTYPE. In the Sowerby Collection, British Museum

(Natural History) B.M. B 61490, from the Lower Chalk of Hamsey,Sussex.

REMARKS. The species was adequately described by Pettitt (1954: 31) who gave the average dimensions as 12 mm long, 13 mm wide and 9 mm thick. He described the species as subpentagonal in outline, oval in anterior contour. The brachial valve was stated to be moderately convex, with slight, fairly broad fold on the anterior part of the valve. The linguiform extension was described as broad with the anterior margin straight, but to this can be added that several variants within the species show a marked tendency to asymetrical anterior commissure development, a feature rarely found in other species of the same genus.

There are 18 - 20 comparatively deeply incised costae on each valve, with 4 on the fold and 3 in the sulcus.

Internal structure. The thickened shell, strong, partially fused dental lamellae and falcifer crura are shown in the series of serial sections through a topotype of the species by Pettitt (1954: fig.10).

In spite of his recognition of material from Bedfordshire, Cambridgeshire , Kent, Surrey and Sussex, Pettitt's concept of the species appears to have been based largely upon the type specimen and comparatively

few additional examples used in his description. The present study takes a somewhat broader view of the species, bringing in several variants from localities other than those already mentioned here. A simple statistical analysis has been made from random samples obtained from these localities and a linear regression plotted and presented here, Fig. 8 . In addition, a pictograph illustrating the range of morphological variation is given, Fig. 9 .

The species is regarded as an important stratigraphical marker and has been the subject of discussion and speculation by Kennedy (1969) and Jeans (1968). Kennedy emphasises the importance of an Orbirhynchia mantelliana Band within the rhotomagense Zone of the Middle Cenomanian in the southeastern facies. He fixed the upper limit of his band as corresponding to the boundary between the Turrilites costatus and T. acutus assemblages and, in his correlation diagram (fig.16), he traces it right across the Weald from Folkestone in Kent to Asham, near Beddingham, Sussex.

Recently, in an unpublished summary of research on Lower Chalk stratigraphy of the Sussex coast and inland areas, Miss Helen Anderson, Brighton Polytechnic, has recognized the existence of another Orbirhynchia mantelliana Band, approximately four meters below that of Kennedy, at Beachy Head, Eastbourne and Southerham Grey Pit, near Lewes. It is not certain

whether either of these bands can be directly equated with the Orbirhynchia Beds mentioned by Jeans (1968) but it seems likely that the O. mantelliana specimens occurring in a band just above the Grey Bed, and at a level equivalent to Bed IV of Bower & Farmery (1910) within the H. subglobosus Zone in Lincolnshire and Yorkshire might be the equivalent of the Upper Orbirhynchia mantelliana Band (Band 6 of Kennedy,1969) which occurs in Sussex and Kent.

Schloenbach (1867:494) described a rhynchonellid species as Rhynchonella mantellana [Sic] from the mantelli and rhotomagense Zones of northwestern Germany. He included Sowerby's original Terebratula mantelliana and Roemer's (Roemer,1841) T. paucicosta in his synonymy. The figured specimen representing this citation (pl.23,fig.11) shows a flatter form with a more circular ventral profile and slightly produced beak. Schloenbach's concept of O. mantelliana bears only a slight resemblance to the typical form which was, admittedly, rather poorly illustrated in Sowerby's original publication. Schloenbach's specimen may, however, be closer to Roemer's T. paucicosta from the Essen Greensand and could even have been a young form of that species. It also resembles a specimen figured by Panow (1969:570,pl.109, fig.4.) and another by Popiel-Barczyck (1977:30,pl.1, figs.7-9.) under the title Orbirhynchia mantelliana

from the Lower Cenomanian of Poland. This species is more circular in ventral outline than the typical species and has flatter or less acutely convex valves with a broad arcuate anterior commissure.

Many geographical and ecological variants have now been included within the main species, largely because separation from the typical form can be seen to offer no stratigraphical advantage. The species figures prominently in lists from the Totternhoe Stone, or just above it, from the type area in Berkshire, southwards to Wiltshire and Dorset and as far north as Cambridge,Lincolnshire and Yorkshire. There are also examples which fall well within the present range of variation from Cran d'Éscalles near Cap Blanc Nez, Northern France and from Brochterbeck, north Germany. Examples which are just outside this range but not, as far as can be estimated, within the scope of O. paucicosta, occur in the Tourtia of Tournai, Belgium. This variant has also been collected from beds of a similar age at Montigny sur Roc,southern France . Specimens figured under the name of Rhynchonella mantelliana by Deicke (1878) and Wanderer (1909) are probably referrable also to Roemer's species paucicosta.

Examples from the Totternhoe Stone at Burwell, Cambridgeshire, while clearly exhibiting all the typical morphological characters, almost always maintain a robust outline with acutely inflated valves and deeply incised costae. They are proportionately much larger

than the type specimen. An example is figured here, Pl.4, figs.10-12. It is probable that this is the variant that was recorded by Bosworth (1906) in a band just above the Totternhoe Stone which he called the Rhynchonella mantelliana Band, from the frequency of large specimens of this species associated with 'Cidaris' dissimilis and Terebratulina nodulosa.

MATERIAL AND DIMENSIONS.

So much confusion surrounds this variable species that I have felt it worthwhile spending a considerable amount of time with both pictographic and statistical presentation. The following measurements are taken from random specimens in the British Museum (Natural History) and from those in the Institute of Geological Science and the Sedgwick Museum, Cambridge. It has not always been possible to quote individual registered numbers for the specimens used as this would have entailed a vast amount of re-registration of already registered specimens. Locality and stratigraphical details are quoted from the museum labels, but where this has been possible, spot checks and confirmation from Geological Survey Geologists have been made.

LOCALITY, HORIZON & REGD. NUMBER B.M.	LENGTH	WIDTH	THICKNESS
Dover, Kent.			
rhotomagense Z.			
B 93747	15.9 mm	15.0 mm	10.3 mm
B 93750	13.4	13.6	8.0
BB 37477	12.0	11.6	7.1

LOCALITY, HORIZON & REGD. NUMBER B.M.	LENGTH	WIDTH	THICKNESS
Dover, Kent.			
rhotomagense Z.			
BB 34478	11.0	11.1	8.8
BB 34479	11.1	11.6	8.1
B 22892	10.9	10.8	6.0
B 93748	14.1	11.1	7.2
B 93749	13.1	13.8	8.9
B 93750	10.6	11.5	8.1
Margett's Pit,			
Burham, Kent.			
B44670	10.9	10.8	5.9
B 44671	10.8	10.9	7.1
Folkestone.			
Grey Chalk			
B 25102	9.1	9.8	6.0
	11.0	12.0	7.5
	11.8	12.5	6.5
	11.1	10.8	8.1
	11.5	11.1	8.2
	11.1	10.8	7.9
	11.7	12.1	8.1
	11.0	11.6	7.1
	11.2	11.3	7.1
	11.0	10.4	7.8

LOCAITY,HORIZON & REGD. NUMBER IGS.	LENGTH	WIDTH	THICKNESS
Isleham,Cambridge.			
IGS 73064	13.1	12.9	9.9
73066	9.9	10.0	7.0
73067	9.9	10.0	6.5
73068	9.8	9.9	6.9
Norton Ferris,Wilts.			
Zb 968	15.2	17.0	11.0
969	14.0	16.2	10.5
970	12.1	13.1	7.1
971	12.9	13.4	8.9
972	13.0	13.9	9.2
973	13.0	13.9	9.9
974	12.5	14.3	8.0
975	12.0	12.4	7.9
Hitchin,Herts.			
Totternhoe Stone			
37017	11.0	11.2	7.8
37019	12.8	12.9	8.3
Swaffam Prior,Cambs.			
109617	10.0	9.9	7.5
109618	13.9	13.5	9.2

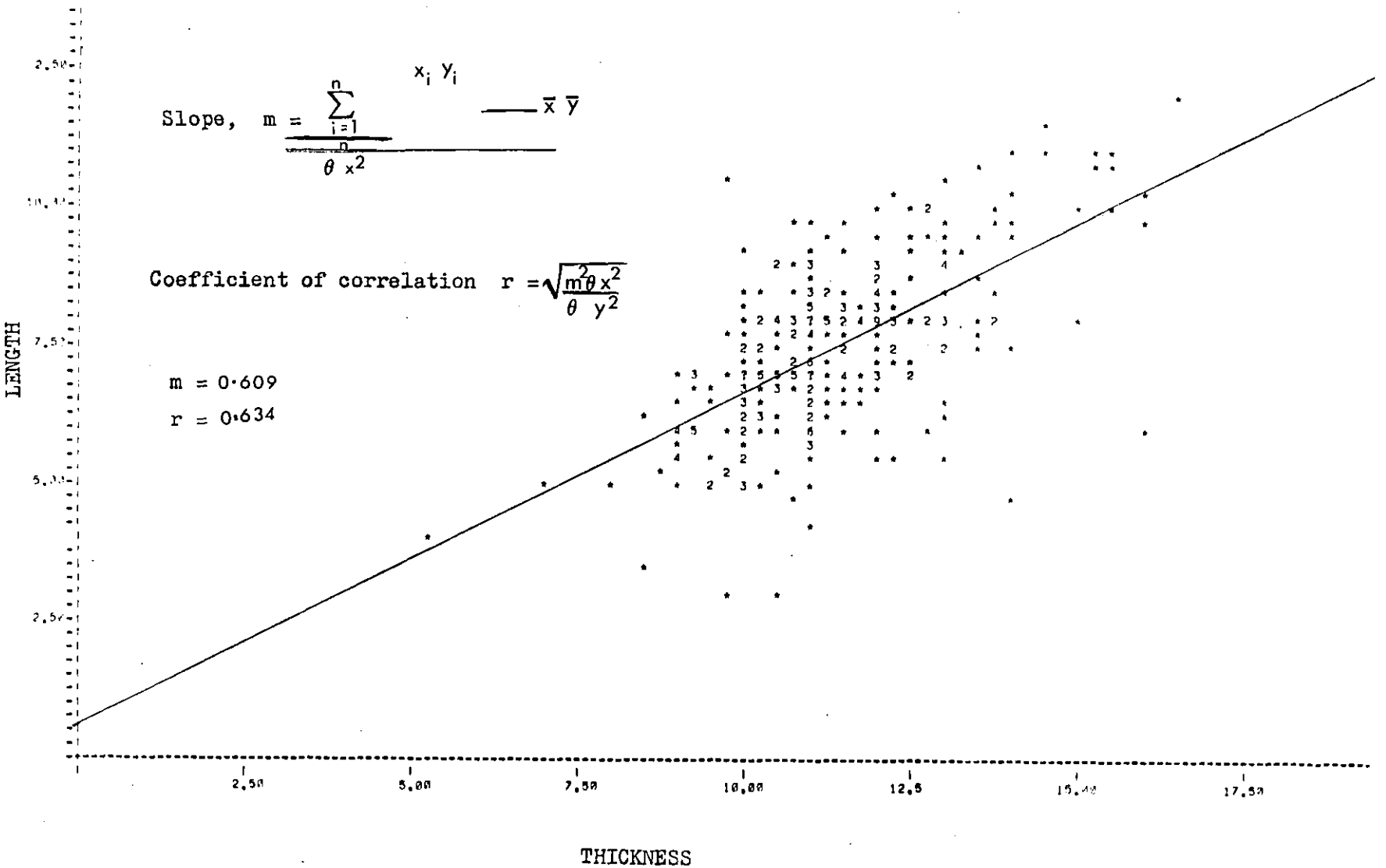
These and many other specimens have been measured and included in the statistical analysis, the plots of which are given here, Figs. 8 .

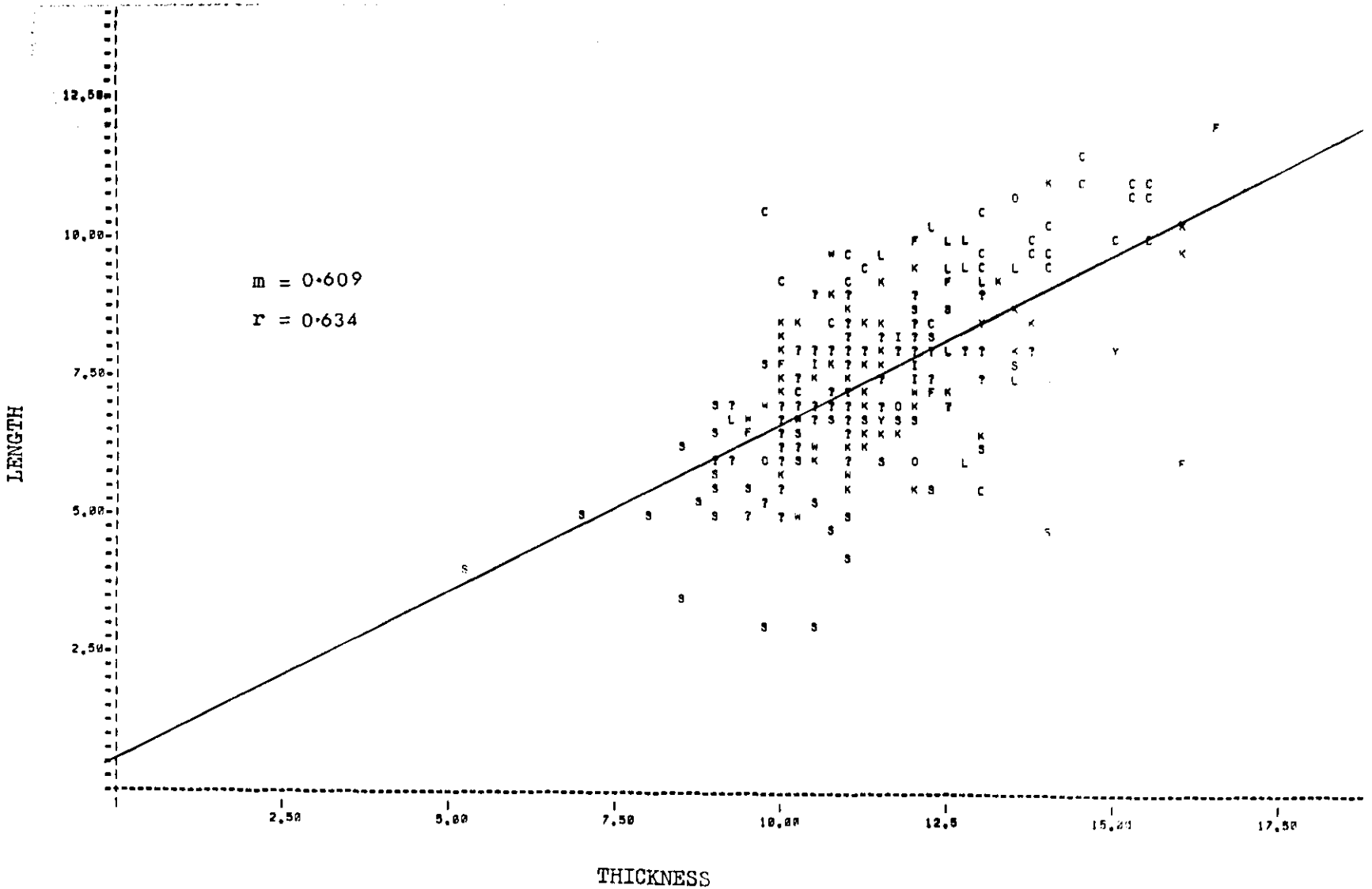
FIG. 8. Diagram illustrating the length x thicknes, length x width and width x thickness ratios within a random sample of Orbirhynchia mantelliana (J.de C.Sowerby).

Locality key. C = Cambridge
F = France
I = Isle of Wight
K = Kent
L = Lincolnshire
O = Oxfordshire
R = Sussex and Surrey
S = Sussex
W = Wiltshire
Y = Yorkshire

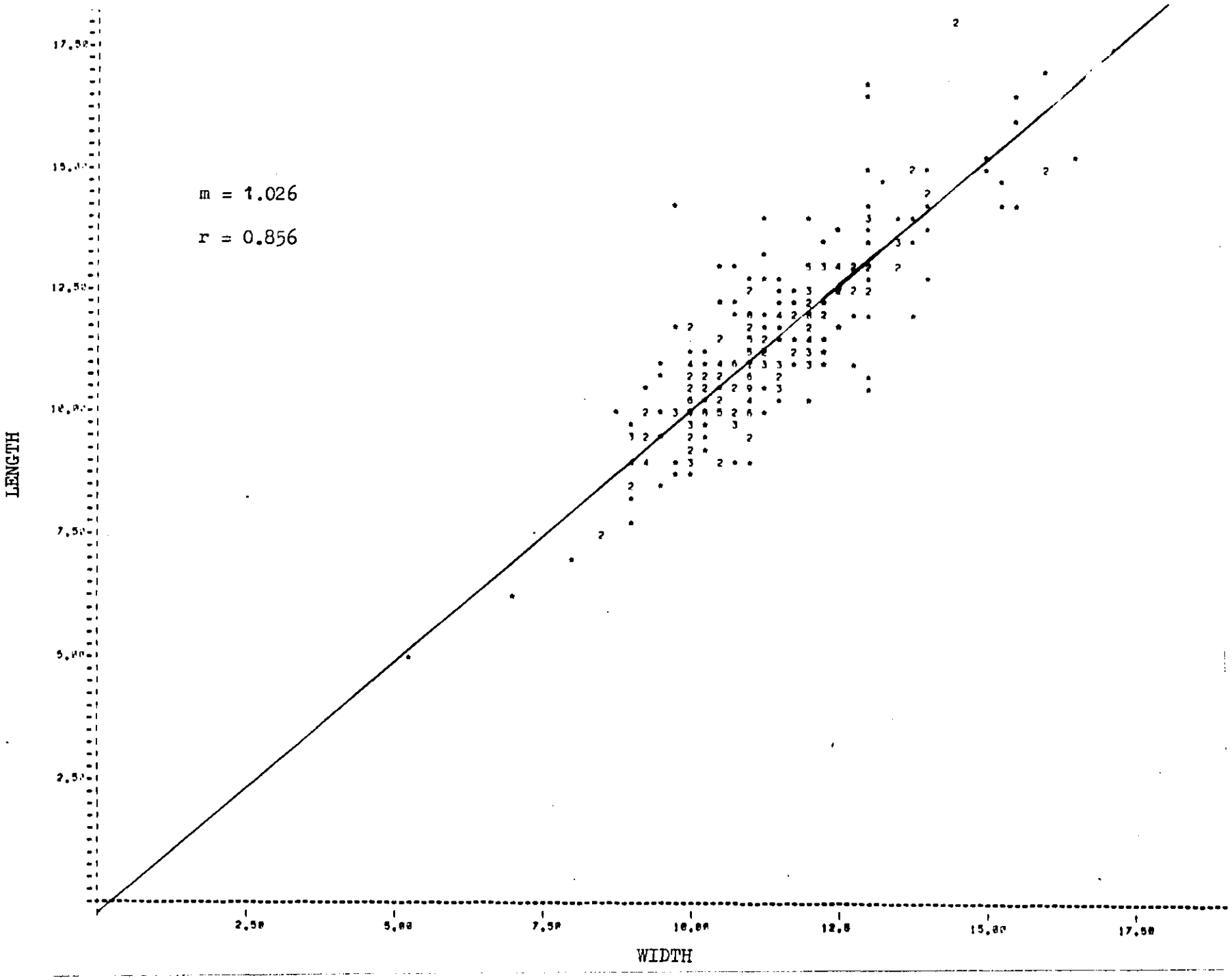
The numerals denote the number of examples from each locality.

LENGTH X THICKNESS

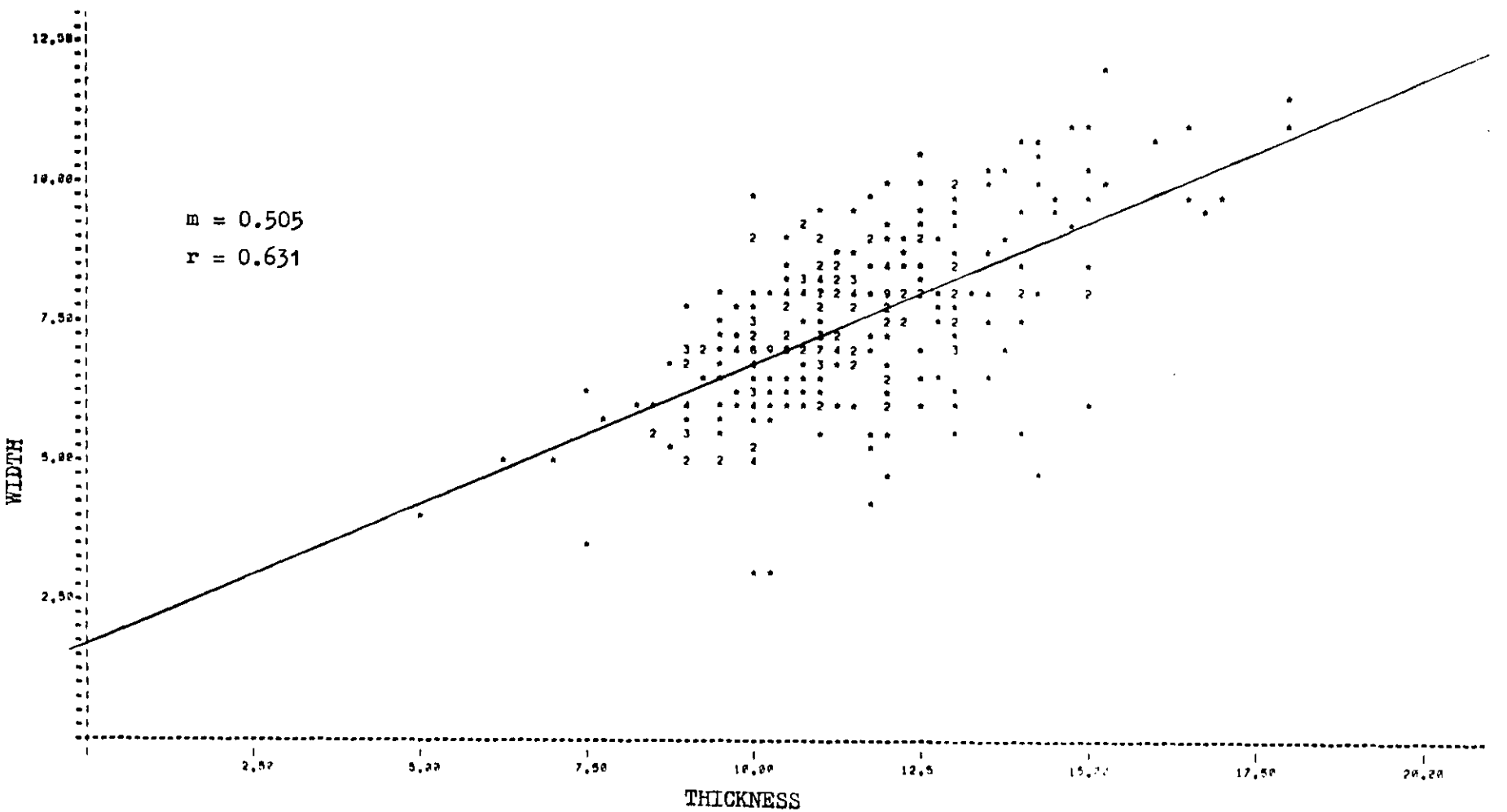

Slope, $m = \frac{\sum_{i=1}^{n} x_i y_i - \bar{x}\,\bar{y}}{\theta\, x^2}$
Coefficient of correlation $r = \sqrt{\frac{m^2 \theta\, x^2}{\theta\, y^2}}$
m = 0·609
r = 0·634
LENGTH
THICKNESS
2,50
5,00
7,50
10,00
12,5
17,50


m = 0·609
r = 0·634
LENGTH
THICKNESS
12,50
10,00
7,50
5,00
2,50
2,50
5,00
7,50
10,00
12,5
15,00
17,50

LENGTH X WIDTH


m = 1.026
r = 0.856
LENGTH
WIDTH
2,50
5,00
7,50
10,00
12,5
15,00
17,50

W I D T H X T H I C K N E S S


m = 0.505
r = 0.631
WIDTH
THICKNESS

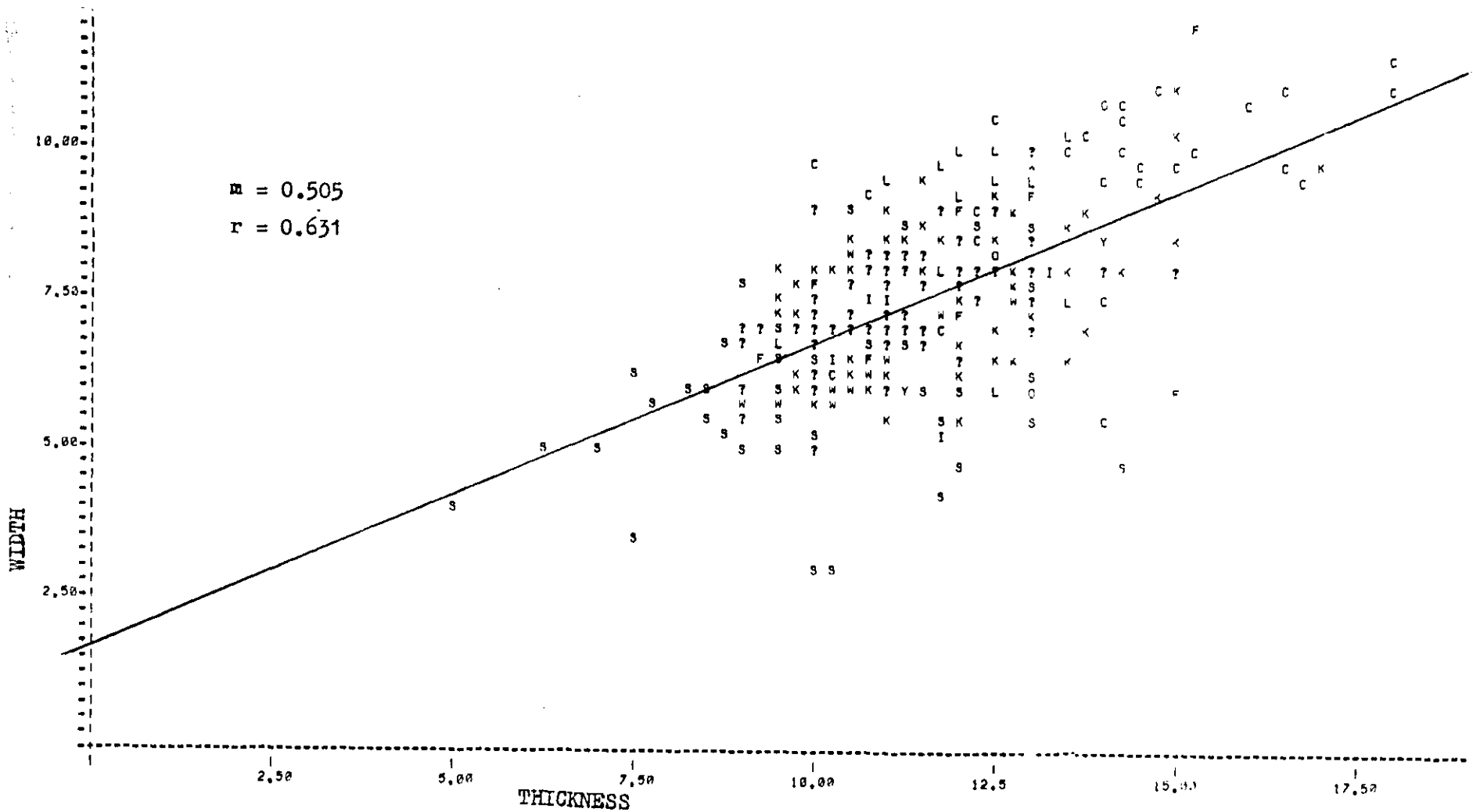
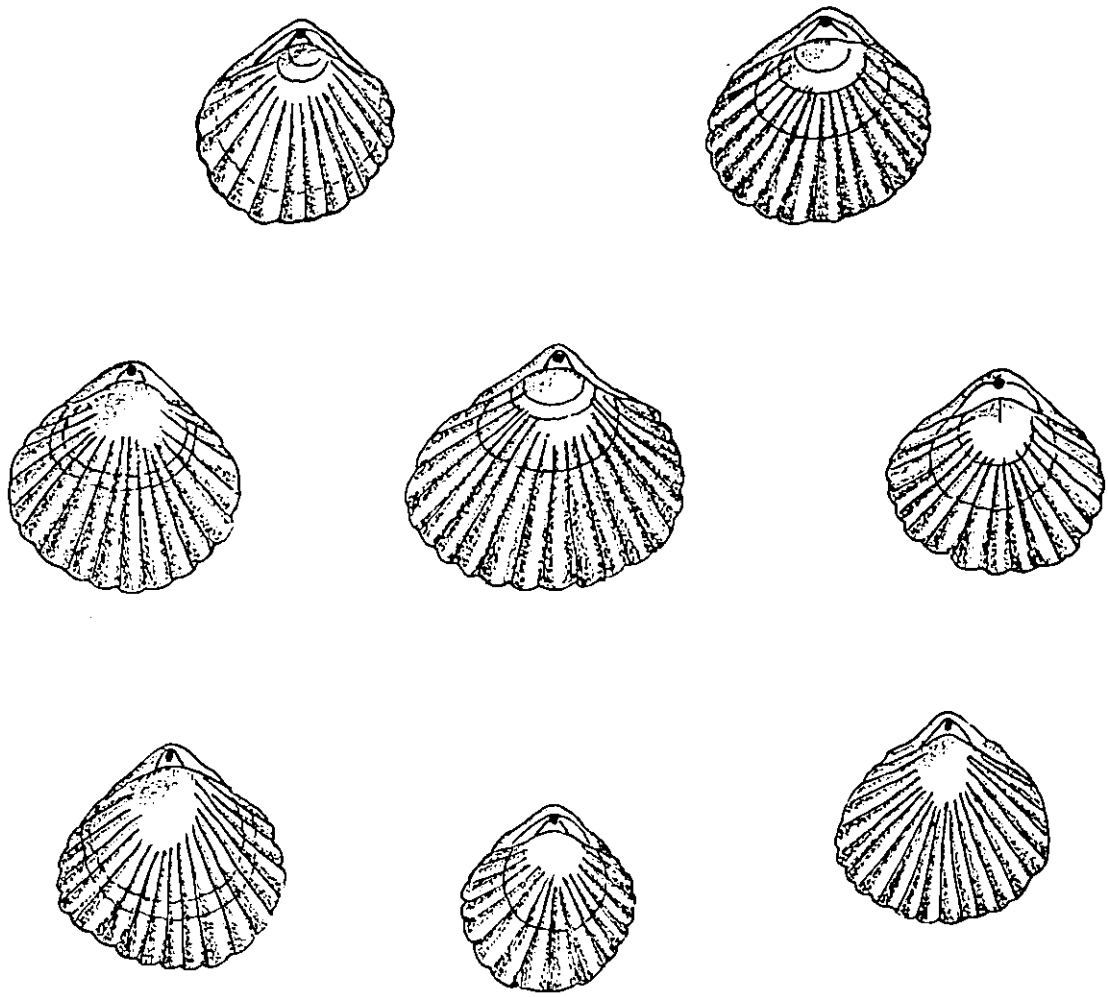

m = 0.505
r = 0.631
WIDTH
10.00
7.50
5.00
2.50
THICKNESS
2.50
5.00
7.50
10.00
12.5
15.00
17.50

FIG. 9. Diagram illustrating eight variants of Orbirhynchia mantelliana from the Lower Chalk, rhotomagense Zone, Folkestone, Kent.



TEXT-FIG.10. A series of eigth transverse sections through a specimen of Orbirhynchia mantelliana (J. de C. Sowerby) from the Chalk Marl of Hamsey, Sussex.

1·1
0·6
0·4
0·4
0·3
0·3
0·2
0·2

Orbirhynchia wiesti (Quenstedt)

Pl.4, figs.25-30

1871 Terebratula wiesti Quenstedt: 166, pl.41,fig.54.
1874 Rhynchonella wiesti (Quenstedt); Davidson: 66,pl.8, figs.31,a.
1896 Rhynchonella wiesti (Quenstedt); Jukes-Browne & Hill: 147.
1954 Orbirhynchia wiesti (Quenstedt); Pettitt: 37, pl.3, figs.14a-c, 18a-c.
1962 Orbirhynchia wiesti (Quenstedt); Jefferies: pl.77, fig.32.
1970 Orbirhynchia compta Pettitt; Kennedy : 645.

LECTOTYPE. Selected by Pettitt (1954) from three original specimens used by Quenstedt (1871) and figured as Terebratula wiesti pl.41,fig.54, from the Lower Chalk of Chardstock, Devon. This specimen is now in the Geologische Paläntologische Institut, University of Tübingen, Germany.

DIMENSIONS OF LECTOTYPE. 14.3 mm long, 12.3 mm wide and 10.6 mm thick.

REMARKS. Pettitt records this species from Beer Head, Hooken Cliff and Chardstock in Devon. His distribution of the species was based on twenty specimens from museum collections. He restricts the species to the forms which have 28 costae only and rejects Davidson's broader definition of the species to those which have 30 and 32 ribs. Jukes-Browne & Hill (1896) considered that Davidson's definition (Davidson,1874) was too narrow : "It is a much more variable species than Davidson seems

to have supposed - the average number of ribs seems to be between 24-26, but there are many forms which have as few as 18, and others which have as many as 30; the former resemble Rhynchonella mantelliana except that the ribs are not so angular, and the latter come so near to the broader varieties of R. cuvieri that when placed beside them, they are indistinguishable."

Pettitt (:31) appears to have interpreted these remarks in a general sense, but I think that Jukes-Browne & Hill were actually referring specifically to specimens from Bed 13 of Meyer (1874) which, they appear to be claiming, were all of one species.

The situation is somewhat analogous to the position of O. mantelliana where the typical Sowerby definition has been eclipsed by the numerous varieties either side of the original form and the concept has been obscured. Before 1954 when Pettitt figured his lectotype of R. wiesti , the species could only have been interpreted from the illustrations of Quenstedt (pl.41,figs.52-54) and the specimen figured by Davidson (1874,fig.31). It is not surprising,therefore,that the interpretation of Jukes-Browne & Hill (1896) should agree more with forms from Bed C of the Cenomanian which are thought to include variants of both O. wiesti and O. multicostata.

Jefferies (1962) in dividing certain faunal groups into cold water and warm water inhabitants, placed Orbirhynchia multicostata Pettitt into the cold water

group and a specimen he identifies as O. wiesti (pl.77,figs.2a,2b), which belonged to neither the the cold water group or the warm water group, was placed in a miscellaneous group. In his diagram of the standard succession at Merstham, Surrey, Jefferies (: 611) marks the point, Beds 7-8 within, what was at that time, the Metoicoceras gourdoni Zone where O. wiesti commonly occurs. He also indicated a position, Bed 1, within the Metoicoceras geslinianum Zone where the species O. multicostata (discussed here) is said to be common. The relative position of these species within the Actinocamax plenus Subzone is described by Jefferies to be maintained throughout the entire Anglo-Paris Basin. It was recently pointed out by Kennedy & Hancock (1978 in Rawson et al.) that Metoicoceras gourdoni and M. geslinianum were thought to be conspecific and that a Sciponiceras gracile Zone should be used at the top of the Cenomanian for the Zones of gourdoni and geslinianum as used by Jefferies, but because of certain affinities with a Turonian species, this was not successful. In their monograph on the ammonoidea of the Plenus Marls and Middle Chalk, Wright & Kennedy (1981) now suggest that the top part of the Upper Cenomanian be known as Neocardioceras juddi Zone, Fig. 6 .

If, as Jefferies suggests, O. wiesti enjoyed a completely different environment and temperature to

that of O. multicostata, it may seem surprising to find citations by Smith (1957,1961) recording both species within a comparatively narrow horizon, Bed C of Jukes-Browne & Hill (1896,1903) on the South Devon coast. This might be explained by the condensed nature of this bed. Kennedy & Wright (1981:8) regard this bed as the equivalent of the Plenus Marls and the top of the Cenomanian.

The species is recorded from the base of Bed 6 at Bovey Lane Sandpit by Smith (1961:117). The correlation of Bed 6 with Bed C of the coastal section is confirmed by Kennedy (1970:660) who cites O. multicostata with O. wiesti and Arcuatothyris rugulosa. Specimens collected from this pit which have been identified as O. wiesti depart from the typical in their broader and flatter valves and slightly more produced umbo.

O. wiesti has also been recorded from Bed B (Meyer, 1874; Jukes-Browne & Hill 1896) but is exceedingly rare in this bed.

MATERIAL AND DIMENSIONS.

Additional specimens from the collections of the the British Museum (Natural History) include two specimens from Bed B, Little Beach,Beer, Devon, and six specimens from Bed C, Hooken Cliff, B.M. BB 6345-54. A typical, said to have come from the Glauconitic Marl of Chardstock,is in the Davidson Collection, B.M. BB 12396. A range of variants from the Chalk Basement Bed of Askerswell is registered as B.M. BB 7127-7130.

Orbirhynchia multicostata Pettitt

Pl.4, figs.34-39

1874 Rhynchonella wiesti Quenstedt; Davidson
1903 Rhynchonella wiesti Quenst.; Jukes-Browne & Hill in part.
1954 Orbirhynchia multicostata Pettitt:38,pl.3,figs.20a,b.
1962 Orbirhynchia multicostata Pettitt.; Jefferies,pl.77, figs.2a,b.
1963 Orbirhynchia multicostata Pettitt; Jefferies: 7-18

LECTOTYPE. One of two specimens figured by Pettitt (1954:pl.3,figs.20a,b.) from the Upper Cenomanian, Plenus Subzone, Betchworth,Surrey, GSM. 92642, in the Institute of Geological Sciences,London.

REMARKS. Pettitt (:38) based the description of this species on two rather poorly preserved syntypes and mentioned a further ten specimens which he quoted from the Subglobosus and Labiatus Zones and the Plenus Subzone of the Lower Chalk in Bedfordshire,Buckinghamshire, Cambridgeshire,Surrey and Sussex.

Since its original description, the species has been widely quoted from the Plenus Subzone in Southeastern and Eastern England and from beds considered to be of equivalent age in South Devon and Dorset. As a result, the original interpretation of the species has changed and many variants, which may well have been regarded outside the original concept of the species by Pettitt, have now been included. These are seen to have a morphological range from subcircular to broadly

oval in ventral profile with a short suberect beak and wide arcuate anterior commissure. A marked concentric growth-line is nearly always present at about halfway or just anterior to half the length of the shell.

In his original description of the Plenus Subzone of the Anglo-Paris Basin, Jefferies (1962) quotes O. multicostata as a common fossil within Beds 1a, 1b, in the Standard Succession at Merstham, Surrey, and also points out the apparently wide geographical distribution of this brachiopod in the United Kingdom and in France at approximately the same horizon. He also states that the spread of O. multicostata, which he considers originated from an early ancestor in the succession at Cap d'Antifer, was influenced by a shallowing of the outer reaches of the basin. The same conditions, he maintains, probably account for the rare occurrence of Monticlarella jefferiesi (formerly quoted as 'Rhynchonella' lineolata carteri). The rise in temperature during the succeeding deposition in Bed 2, however, probably resulted in a reversal of this status when M. jefferiesi became comparatively common and O. multicostata exceedingly rare.

The association of O. multicostata with the obvious shallow water brachiopod Lingula sp. certainly appears to confirm the presence of shallow water conditions at Bed 1 level suggested by Jefferies.

This species exhibits a greater tolerance to ecological change than any Orbirhynchia species so far investigated. It appears in marls, limestones and chalky facies without losing its initial identity. Throughout its extraordinary environmental range it maintains the same robust morphological features which must have inspired its separation from other species of the same genus at the time of its description, although the specimens chosen as type specimens by Pettitt do little to clearly distinguish it from O. cuvieri and O. wiesti.

Although from the record this species does not appear to have enjoyed the same breadth of distribution on the Continent as it has in the United Kingdom, Jefferies (1963) points out its value as a marker fossil in Bed 1 from Cap Blanc Nez and other northern French localities to Cap d'Antifer on the coast and it has been collected in beds of the same age at Cernay-en-Dormois east of the Paris Basin.

It is possible that the Orbirhynchia commonly found in the Sables de Bousse in the Sarthe may be a geographical variant of this species, but it maintans a uniformity of shape and size suggesting another line of development. The umbonal characters of this form distinguish it from the typical O. multicostata and it is regarded here as a separate species.

Orbirhynchia wilmingtonensis sp.nov.
Pl.4, figs.16-18.

1852 *Rhynchonella mantelliana* Sow.; Davidson: pl.12,fig.22.
1903 *Rhynchonella mantelliana* Sow.; Jukes-Browne & Hill:129.
Orbirhynchia mantelliana auctt.

DIAGNOSIS. Distinctly triangular in ventral profile. Acutely biconvex, coarsely costate. Umbo slightly produced, deltidium exposed. Anterior profile almost circular, anterior commissure high-arcuate.

DESCRIPTION. The costae on both valves are triangular in section and deeply incised. They vary in number from 10 to 12, with two or three on the almost imperceptible median fold of the dorsal valve and with a corresponding number in the comparatively deep, broad sulcus in the ventral valve.

Variation includes a more circular ventral outline, slightly flatter valves and more produced umbo. The species is quite distinct morphologically and should not be confused with *Orbirhynchia mantelliana* (J.de C. Sowerby) with which it has been compared. It differs from that species in having fewer and more deeply incised costae, an altogether more triangular ventral profile and more acutely convex valves. It also has a produced umbo which exposes the deltidium, a feature not often seen in other species of the same genus. It differs in this way also from *O. wiesti* and

O. multicostata both of which have more numerous and less deeply incised costae and a shorter or more truncated umbo.

HOLOTYPE. Specimen collected by E.F.Owen in the British Museum (Natural History),B.M. BB 82132 from the Lower Cenomanian, Mantelliceras mantelli Zone, White Hart Sandpit, Wilmington, South Devon.

DIMENSIONS OF HOLOTYPE. Length,11.6 mm, width 11.4 mm, thickness, 9.4 mm.

PARATYPES. BB 82133-143.

MATERIAL. Numerous specimens in the British Museum (Natural History) from the type locality.

DISTRIBUTION. This species appears to be confined to south Devonshire.

REMARKS. Although the species has been compared to O. mantelliana by various authors it can be more readily compared to a similarly robust form which occurs in the Craie de Rouen and possibly also from the Lower Cenomanian of the Sarthe. The French species, however, is consistently more circular in ventral profile and has a less marked anterior ~~anterior~~ sulcus than the Devon species.

The paucity of costae in O. wilmingtonensis has prompted comparison with the rhynchonellid described by Roemer as Terebratula paucicosta from the Essen

Greensand. Although the comparison is a favourable one, I have never seen a specimen from any locality within the German Cenomanian which exactly matches the illustration in Roemer (1841: pl.7,fig.6) and I feel that his drawing may have been somewhat idealized. The type material from the Roemer Collection is missing or destroyed, probably as a result of air bombardment during World War II, and there is no other way of interpreting Roemer's original concept of the species.

A specimen figured by Quenstedt(1871,pl.41,fig.24-26), from the Pläner, Essen is probably typical of Roemer's species and may have been compared with the type specimen by Quenstedt. It represents a species which, though not common, occurs in the Greensand at Kassenberg and other localities in the North German Cenomanian. An example is figured here, Pl.4, figs.4-6, and is taken from a collection of five specimens. It differs from O. wilmingtonensis in its considerably smaller size and more circular ventral profile and less produced umbo.

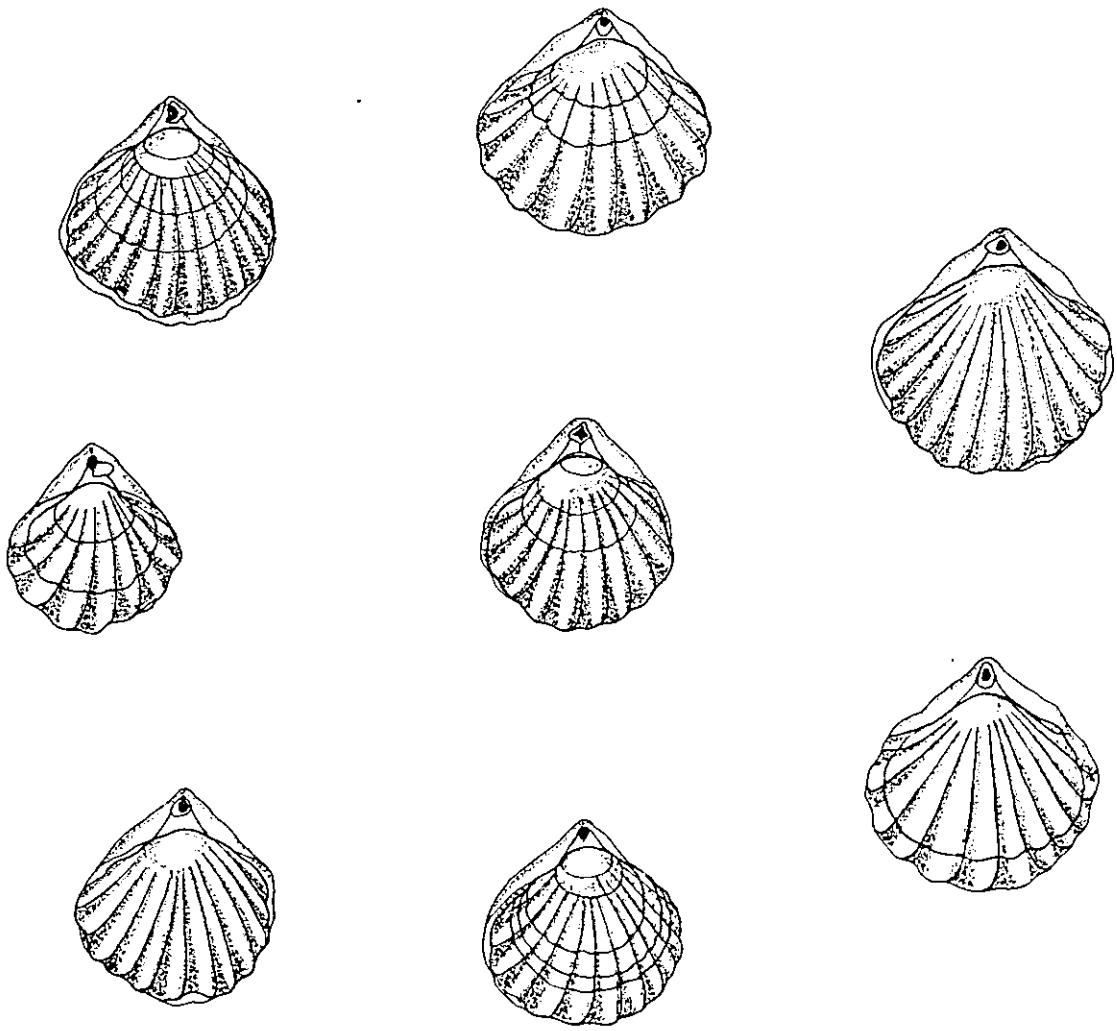
Three further specimens which also might represent Roemer's species are in the B.M. collections from the Essen Greensand and form part of the Bruckmann Collection, registered as B 15468. They are flatter than the specimen figured here on Pl.4, figs.4-6, and do not match the illustration given by Roemer (1841) but have a closer resemblance to O. mantelliana (J.de C.Sow.).

Ten specimens from the Tourtia of Tournai, Belgium show features which are reminiscent of both O.mantelliana and O. wilmingtonensis sp.nov. They have fewer costae than O. mantelliana and yet seem to suggest that species in their general morphology. The umbo, however, is more produced than the type species and is more like the type of umbo seen on O. wilmintonensis specimens. They are flatter than that species and are more circular in ventral outline.

DIMENSIONS OF PARATYPES. Registered numbers in ascending order i.e. BB 82133- BB 82143.

LENGTH	WIDTH	THICKNESS
12.6	12.0	8.5
14.1	13.2	10.5
11.6	11.4	9.1
12.3	12.0	9.3
12.9	11.8	8.9
11.2	11.4	8.9
10.5	10.7	7.2
11.4	10.3	7.4
11.6	10.7	9.4
11.4	9.8	8.5
10.6	9.7	6.6

Fig. 11 . A series of eight variants of Orbirhynchia wilmingtonensis sp. nov. from the Lower Cenomanian, White Hart Pit, Wilmington, Devon



Orbirhynchia boussensis sp.nov.
Pl.4, figs.19-21, 31-33.

DIAGNOSIS. Comparatively large Orbirhynchia, subcircular to broadly triangulate in ventral profile. Umbo slightly produced, beak suberect, pointed. Foramen small surrounded by lateral extensions of the deltidium.

DESCRIPTION. The anterior profile is characteristically oval in outline with a low arcuate linguiform extension. The dorsal fold is not developed. The species maintains a uniform size and variation extends only to minor differences in width of shell. About 26-28 rounded or subangular costae ornament each valve, with about 9 in the sulcus. This can be extended to approximately 12 costae. On some specimens a marked concentric growth-line is seen at just over half the length of the dorsal valve. A corresponding growth-line is seen on the ventral valve.

HOLOTYPE. A specimen from the W.J.Kennedy Collection in the British Museum (Natural History), B.M. BB 82131, from the Upper Cenomanian, Sables de Bousse, Sables à Catopygus obtusus, in a disused pit alongside field 180 meters West of Cemetry, S.W. of Bousse, Sarthe, France. This is locality 12 of Jefferies,1963.
Dimensions of holotype. Length, 15.0 mm, width, 15.9mm and thickness, 10.2 mm.
PARATYPES. In British Museum (Natural History), B.M. BB 61121-59, K.Evans Collection.

This species has no real equivalent in this country although the form which occurs in the Bed C of Bovey Lane, Devon, is very close morphologically. They differ, however, in certain well marked fundamental features. O. boussensis is more evenly biconvex with a more massive or slightly less produced beak than the Devon form and has a higher arcuate anterior commissure and consequently a more extensive linguiform extension. The Bovey Lane species is more obviously tranversely oval in ventral outline and is probably a local variant of O. multicostata Pettitt. It approaches some varieties of this species whcih have been collected from the Plenus Subzone of Lincolnshire.

DIMENSIONS OF PARATYPES.

B.M.REGD.No.	LENGTH	WIDTH	THICKNESS
BB 61140	15.2	16.8	11.3
BB 61141	15.3	16.2	11.7
BB 61142	14.1	15.7	10.7
BB 61143	13.8	16.2	10.2
BB 61144	13.3	15.5	10.9
BB 61145	15.2	16.8	10.6
BB 61146	13.5	16.5	10.5

Family NORELLIDAE Ager, 1959

Subfamily MONTICLARELLINAE Childs, 1959

Genus MONTICLARELLA Wisniewska, 1932

Monticlarella brevirostris (Roemer)
Pl.28, fig.4.

1841 Terebratula brevirostris Roemer: 41, pl.7,fig.7.
1852 Rhynchonella martini Mantell; Davidson, pl.12, fig. 16, 16a, 16b, 16c. and 16d.

REMARKS. This species is thought to be of stratigraphical importance and is to be the subject of a future paper with C.J.Wood of the Institute of Geological Science and myself. However, it seems that it has often been confused with Grasirhynchia martini (Mantell) which it resembles. It is found in association with this species in the Chalk Marl at Folkestone, Dover, Eastbourne, and Compton Bay and Rocken End on the Isle of Wight.

It differs from other described species of Monticlarella in having well developed costae and in not developing the characteristic parasulcate anterior commissure as seen in M. carteri and M. jefferiesi.

The species occurs with Grasirhynchia martini but it is not known as to whether it is restricted to this horizon or not. Further investigation is continuing.

MATERIAL. Numerous specimens from the Chalk Marl, rhotomagense Zone of Folkestone and Dover are in the general collections of the British Museum (Natural History).

Superfamily TEREBRATULACEA Gray, 1840

Family TEREBRATULIDAE Gray, 1840

Subfamily SELLITHYRIDINAE Muir-Wood, 1965

Genus SELLITHYRIS Middlemiss, 1959

Sellithyris tornacensis (d'Archiac)

Pl.6, figs.1-3

1841 Terebratula subundata Phillips; Roemer: 42,pl7,fig.15.

1847 Terebratula tornacensis d'Archiac: 316,pl.18, figs. 3a-e, 4a, 5a,b.

1867 Terebratula tornacensis d'Archiac; Schloenbach: 438(38), pl.21(1),figs.8,8a.

1878 Terebratula tornacensis d'Archiac; Deike: 12,fig.3a,b.

1929 Rectithyris tornacensis (d'Archiac); Sahni: 10

1959 Sellithyris tornacensis (d'Archiac); Middlemiss: 113.

HOLOTYPE. It appears that the original material used by d'Archiac (1847) in his classic description of the brachiopod fauna of the Tourtia has been lost (Dr Annie Dhondt,pers.comm.) and, in keeping with all the other types, Terebratula tornacensis is assumed to have suffered a similar fate.

A specimen which has been matched with the illustrations in d'Archiac's work has been figured here, Pl.6, figs.1-3. The dimensions are as follows. Length, 30.0 mm, width, 28.4 mm, thickness, 18.3 mm. The specimen is in the collections of the British Museum (Natural History) B.M. B 85066 and comes from the Tourtia of Tournai, Belgium.

OCCURRENCE. The species occurs in the Essen Greensand at Kassenberg, North Germany where it is a comparatively rare fossil. It also occurs in the Sable et gres du Mans at Le Mans and from the Sables du Perche, Broillay. It is possible that this species may have been recorded as Terebratula biplicata Sowerby and Sellithyris biplicata from the hardground sequences of Orbiquet and Goneville, Normandy in the Craie Glauconieuse. One record which is supported here was that of Sellithyris biplicata from the above localities by Juignet (1974). It also occurs in the greensand deposits at Aix-en-Gohelle, Artois (Parent 1893).

REMARKS. This is a distinctive species and needs little extra definition here. Morphological variation amounts to slightly more oval ventral outline or less marked pentangulate aspect and less acute biplication of the anterior commissure. In the Sables du Mans and the Sables du Perche where the species appears to be more prolific than in the Belgian type locality and Essen Greensand, specimens tend towards a less truncated umbo and slightly more erect beak.

MATERIAL AND DIMENSIONS.

LOCALITY AND B.M. REGD.No.	LENGTH	WIDTH	THICKNESS
B 85067, Tournai	25.0 mm	23.3 mm	14.8 mm
B 85068 "	27.2	21.9	14.6

LOCALITY AND BM. REGD.No.	LENGTH	WIDTH	THICKNESS
B 85069 Tournai	23.9 mm	21.0 mm	13.7 mm
B 85070 "	24.1	18.5	11.5
B 85071 "	27.3	25.0	16.3
B 85072 "	28.3	26.6	17.3
B.M. 65485			
Briollay (Sarthe)	27.4	24.6	15.9
" "	27.0	25.1	15.6
" "	28.0	26.2	16.8
" "	24.7	23.5	16.0
" "	22.7	22.8	13.7
" "	23.8	22.9	14.0

Sellithyris phaseolina (Valenciennes in Lamarck)
Pl.6, figs. 7-9

1819 Terebratula phaseolina Valenciennes in Lamarck: 251, No. 29.

1850 Terebratula phaseolina Val. in Lamarck; Davidson: 439,pl.13,fig.29.

1971 Sellithyris biplicata Gaspard: 1-10, pl.1, figs.1a-7c, pl.2, figs. 1-6.

The species was described by Valenciennes in Lamarck 1819, but like so many of the Lamarck species, there was no clear indication of a type specimen or illustration representing the species.

Davidson (1850: 439) in attempting to establish the species figured a specimen from the Lamarck collection which should have acted as a lectotype but his drawing of the specimen appears to have been a composite of several of the Lamarck specimens which were in fact a syntypic series. I have recently

examined the six remaining specimens curated under the name of Terebratula phaseolina in the department of Geology, Museum d'Histoire Naturelle, Geneva. These specimens were figured in a catalogue of the Lamarck Collection by Clerc & Favre (1918, pl.6, figs.28-33). From a total of eight specimens, Clerc & Favre figured six which were identified by lettering them from A-F. Unfortunately only four of the specimens can be positively matched and these are identified as follows.

Fig.29 = Specimen A
Fig.30 = " C
Fig.31 = " D
Fig.33 = " F

LECTOTYPE. From the remaining four syntypes in the Lamarck Collection, Museum d'Histoire Naturelle, Geneva, the specimen figured by Clerc & Favre (1918) as fig.33, specimen F on pl.6, is here selected as lectotype of the species here described as Sellithyris phaseolina (Valenciennes in Lamarck).

DIMENSIONS OF LECTOTYPE. Length, 14.1 mm, width, 12.4 mm, thickness, 8.0 mm.

REMARKS. The lectotype is characteristic of the smaller form found in the sandy, less chalky, facies of the type locality at Le Mans. It does not have the marked biplication, elongated umbo and inflated umbo of the larger form often associated with this typical small form. Both morphological forms can be recognized

in collections made from the Marnes a O. biauriculata of Briollay (Maine et Loire) and from beds within the Metoicoceras gourdoni Zone of Meziore sous Ballon (Sarthe).

DIMENSIONS AND LOCALITIES.

Mayet (Sarthe)	LENGTH	WIDTH	THICKNESS
B.M. BB 82280	17.3 mm	16.1 mm	8.8 mm
BB 82281	18.5	16.8	10.9
BB 82282	18.2	16.4	9.7
BB 82283	17.0	14.9	9.3
Meziore sous Ballon			
BB 82290	15.5	14.3	9.3
BB 82291	13.5	12.2	6.7
Port de Barques			
BB 82286	18.9	16.6	10.7
BB 82287	16.9	15.1	10.0
BB 82288	18.1	17.2	10.0
BB 82289	18.5	16.9	11.0

Genus OVATATHYRIS gen. nov.

Type species. Terebratula ovata J.Sowerby, 1812

The name Ovatothyris was suggested by Dr Margaret Cox in a thesis for the degree of Ph.D., submitted to the University of London in 1967. The diagnosis and description given here are largely from her work but have been emended in light of present knowledge. The name Ovatathyris is preferred here and is emended in order to agree with the species. It should, nevertheless, be credited to Dr Margaret Cox as a manuscript name.

EMENDED DIAGNOSIS. Ventral profile oval, beak suberect, foramen large, circular, marginate, mesothyridid; beak ridges well defined. Syphytium short, well exposed. Anterior commissure sulcate to slightly paraplicate. Folding concentrated in anterior half of shell. Cardinal process low, tapering. Crural processes high, inwardly inclined. Transverse band moderately highly arched.

EMENDED DECRIPTION. The low flat cardinal process seen in transverse serial sections of the two species described here under the name of Ovatathyris is typical within the varied range of species comprising the subfamily Sellithyridinae. The degree of concavity of the hinge-plates also follows a typical pattern. It is interesting to note that the transverse band, while maintaining a fairly uniform breadth, differs in the

extent of the arching. Some genera, such as Musculina, Platythyris, Boubeithyris, have a moderate to low arch.

Ovatathyris is consistently oval in all stages of growth but develops a marked sulcus in the anterior part of the dorsal valve which,in specimens which are anteriorly carinate, leads to paraplication of the commissure.

REMARKS. Ovatathyris differs from Boubeithyris in having an oval ventral profile, more marked or sharper beak-ridges, more highly developed and more frequently occurring concentric growth-lines and shell ornament of short radiating spinules. It differs from Boubeithyris internally in having slightly longer and more acutely concave hinge-plates, and from Walkerithyris, in the absence of piped hinge-plates and in having a sulciplicate to paraplicate anterior margin.

The genus is represented by two species only at present. One of these, the type species, Ovatathyris ovata, occurs as a comparatively common fossil in the Lower Cenomanian, Mantelliceras mantelli Zone of the Grizzle at Wilmington, South Devon and from the Glauconitic Marl of Warminster, Wiltshire. The other species, described here as Ovatathyris potternensis sp.nov. also occurs in the Glauconitic Marl at Warminster and from the type locality at the Riffle Butts,Potterne, Wiltshire. A variant of O. potternensis figures as

a rare component of the highly fossiliferous beds within the Glauconitic Marl of the Isle of Wight.

Ovatathyris ovata (J.Sowerby)

Pl.7, figs. 19-24 Text-fig. 12.

1812 Terebratula ovata J.Sowerby: 46,pl.15,fig.3.
1849 Terebratula lacrymosa d'Orbigny: 99,pl.512,figs.6-11.
1852 Terebratula ovata Sowerby; Davidson: 47, pl.4, figs. 6-13.
1874 Terebratula ovata Sowerby; Davidson: 32,pl.2,fig.14.

DESCRIPTION. Characteristically oval in ventral outline with a sulcate to paraplicate anterior commissure. The large circular foramen truncates the massive umbo. The suberect beak is bounded by sharp beak-ridges outlining a short triangular interarea. A shallow sulcus originates from about midway between umbo and anterior margin in the brachial valve and deepens and widens anteriorly. The pedicle valve is correspondingly carinate,sometimes producing a marked ridge or keel for about two thirds of the shell length. Consequently this valve is always more acutely convex than the brachial valve.

Shell ornament consists of step-like concentric growth-lines and short spinules. The spinules are not always evident because the preservation is not always conducive. However, if the shell is examined under

a hand lens it is seen that the short spinules are arranged along the leading or growing edge of the shell in pairs, unlike those of Arcuatothyris which are seen to be more indiscriminately arranged over a wider shell area. This phenomenon is best seen under the higher magnification offorded by the electron microscope and Pl.23,fig.4 shows the short,paired bases of the spinules on the surface of a specimen of O. ovata from the Warminster district. It would appear that this surface ornament is not as stable as suggested in such descriptions and illustrations as those of Davidson (1852), who illustrated a series of specimens (pl.4,figs.6-13) showing very marked ornamentation of spinules, but in fact is not always visible and may have, in some cases, been worn away. The holotype of this species shows no evidence of spinules on the shell surface.

Internal Characters. From a series of fifteen transverse serial sections taken through a specimen from Warminster it can be seen,Fig.12 , that a pedicle collar is not developed in the ventral umbo and that a low, poorly developed cardinal process appears in the early stages of the dorsal umbo. The long slender hinge-teeth also make an early appearance and are seen to be deeply incerted into sockets in the brachial valve. Acutely ventrally concave hinge plates become progressively U-shaped anteriorly. Highly developed inner and outer

socket-ridges result from the acutely developed hinge-plates. The crural processes are long and slender, curving gently towards one another. A high-arched transverse band of the brachial loop quickly develops its maximum plication.

Although O. ovata would appear to be confined to the British and French Lower Chalk, five specimens showing a similar ventral profile, strongly sulcate to paraplicate anterior commissure and typical spinose ornament have been found in the Pictet Collection in the Muséum d'Histoire Naturelle, Geneva from Perte du Rhône, Switzerland and are registered as CB 56-58, CB 8, 89. One of these is figured here, Pl. 7, figs.19-21.

HOLOTYPE. In the Sowerby Collection, British Museum (Natural History) B.M. B 49840, from the Lower Chalk, Chute Farm, Wiltshire.

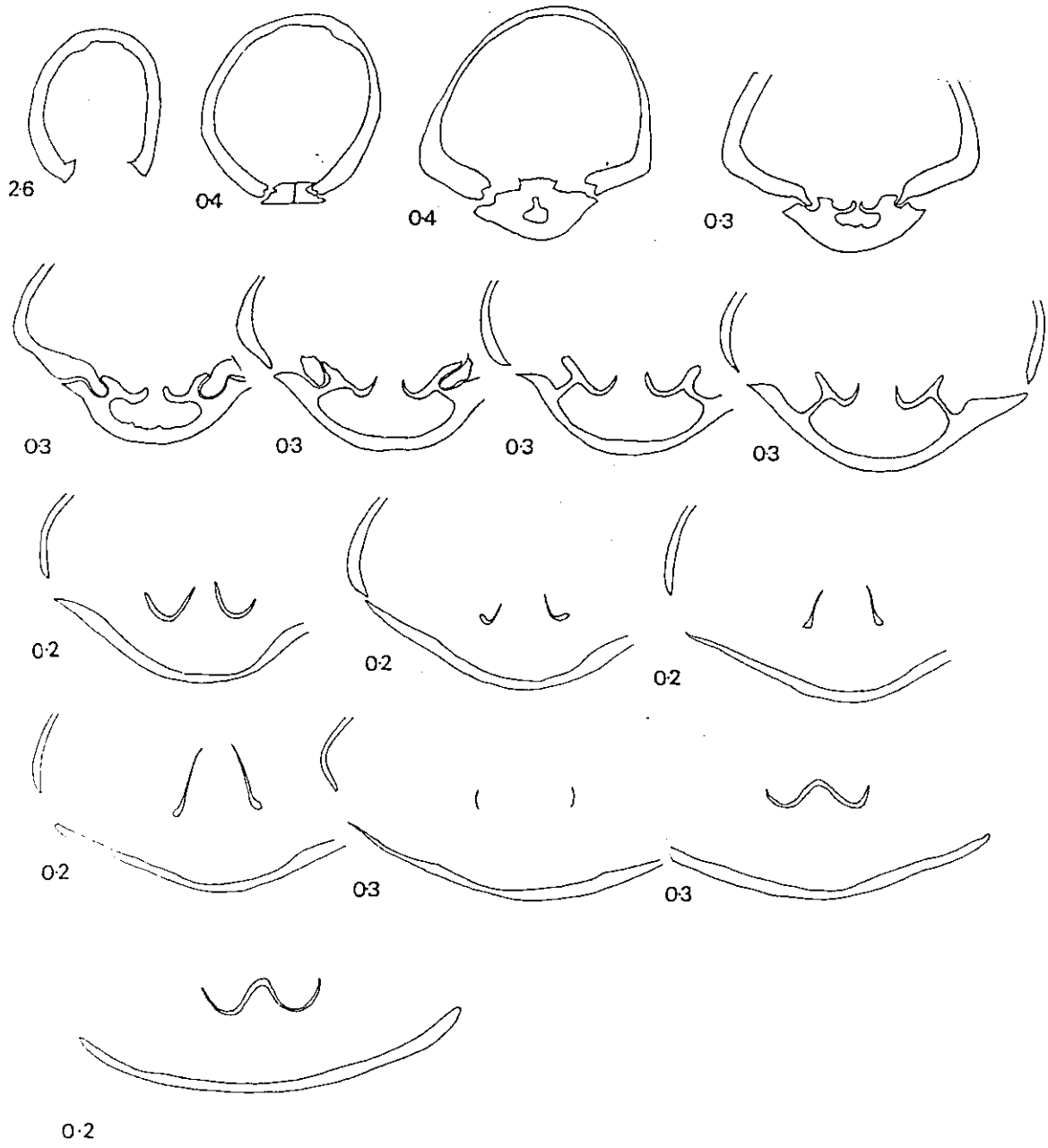
MATERIAL AND DIMENSIONS.

	LENGTH	WIDTH	THICKNESS
BM. B 492 Warminster.	24.6 mm	19.3 mm	13.9 mm
	25.0	17.2	14.6
	32.2	20.1	18.3
	28.5	18.6	16.0
	26.5	18.2	13.6
BM. BB 5534 South Wiltshire.	32.4	25.5	18.1
BM. B 6297 Vimoutiers (Orne), France.	33.8	24.4	18.1

REMARKS. Apart from the type locality at Chute Farm and the district around Warminster, Wiltshire, and the sanpits at Wilmington, Devon, the species does not appear to enjoy a very wide distribution in this country, although two specimens have been collected from Bed A of the Cenomanian Limestone at Chardstock, Devon B.M. B 1522, and a rare specimen has been found by Dr W.J.Kennedy from the Chalk Basement Bed, acutus Subzone of the rhotomagense Zone, Middle Cenomanian of Snowdon Hill, Chard, B.M. BB 82219. Other rarely occurring examples have been collected from the Lower Chalk, Basement Bed, Osmington, Dorset by Mr C.W.Wright, B.M. BB 82152 and a specimen from an unknown zone within the Cenomanian is in the J.F.Walker Collection, B.M. B 25279.

In France, Ovatathyris ovata occurs rarely in the coarse sandy beds and the glauconitc marls which crop out along the Normandy Coast from St. Jouin to Cap de la Heve where it has been quoted as the junior synonym "Terebratula" lacrymosa d'Orbigny. It is certainly not the species quoted under the name of T. ovata by Roemer (1841: 44).

TEXT-FIG. 12 . A series of transverse serial sections through a specimen of Ovatathyris ovata (J.Sowerby) from the Upper Greensand, Warminster, Wiltshire. B.M. 88764. X 4.


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Ovatathyris potternensis sp.nov.
Pl. 7, figs. 10-17. Text-fig. 13.

1847 Terebratula squamosa Mantell: Morris & Davidson: 254,pl.18, fig.8,a,b.
1852 Terebratula squamosa Davidson: 50,pl.5,figs.7-9.

DIAGNOSIS. Biconvex Ovatathyris ; pentagonal to oval in ventral profile. Umbo massive, slightly produced, beak suberect, beak-ridges distinct. Interarea extensive, symphytium well exposed; foramen large,circlar, mesothyridid. Biplicate to paraplicate. Rugose ornament.

DESCRIPTION. An additional ornament of short spinules, similar to those described for the type species, occurs on lateral aspects or flanks of well preserved specimens. This is best seen under a light microscope but is better illustrated in micrographs taken with the electron microscope. The results of this technique are shown here, Pl.23, figs. 1-4, from examples of O. potternensis compared with those from O. ovata.

Internal structure. Serial sections shown here, Fig.13 , compare favourably with those taken through a specimen of Ovatathyris ovata from Warminster, Wiltshire.

HOLOTYPE. Specimen figured here Pl.7,figs.10-12, in the collections of the British Museum (Natural History), B.M. BB 82149, from the Upper Greensand, Potterne, Wiltshire.

Dimensions of holotype. Length 24.3 mm, width 18.7 mm, thickness 16.0 mm.

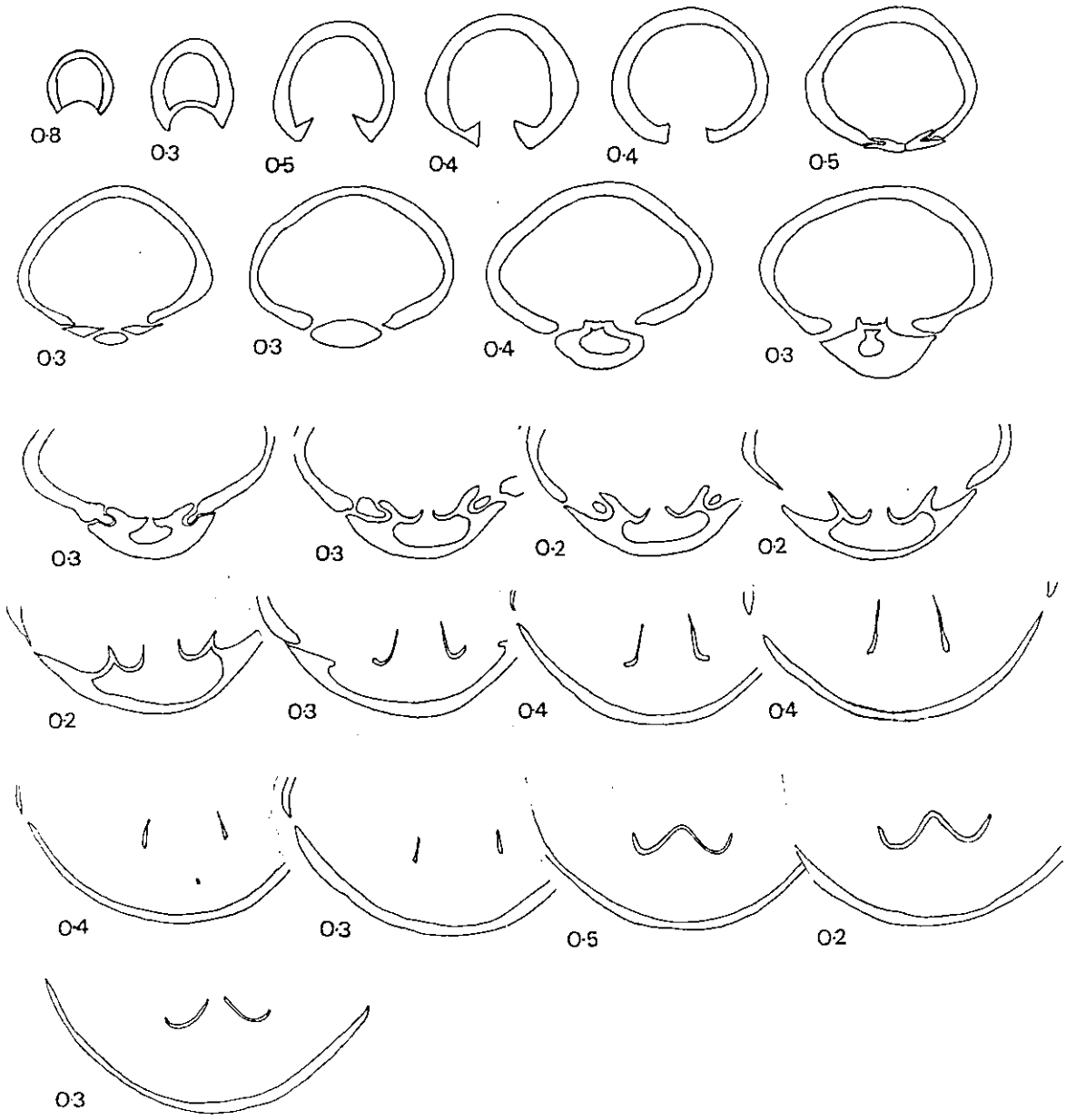
REMARKS. The rugose ornament of concentric growth-lines in this species led Davidson to believe that the specimens he was describing belonged to Mantell's Terebratula squamosa from the Chalk Marl of Hamsey. A close look at these growth-lines reveals that they are quite plain without the additional ornament seen on T. squamosa. The difference between the two shell surfaces can be seen in micrographs of the shell surfaces of the two species. Pl.23, figs. 1 & 2 are from a specimen of O. potternensis from Warminster and Pls.25 & 26, figs. 1-4 illustrate the full range of the ornament of Platythyris squamosa from the Lower Chalk of Folkestone.

O. potternensis can be distinguished from O. ovata by its consistantly acute biconvexity and its rugose shell ornament. It can be distinguished from other species of terebratulidae, such as Ornatothyris, largely in its internal characters which show acute ventrally concave hinge-plates and high arched transverse band of the brachial loop.

MATERIAL. Additional specimens from Potterne are from the Walker Collection, B.M. B 25261, B 25284, the Davidson Collection, B.M. B 8287-9, and the C.W. & E.V. Wright Collections B.M. BB 59839-45, and BB 82148.

It seems likely that the species is confined to the Upper Greensand.

TEXT-FIG. 13 . Ovatathyris potternensis sp. nov., a series of twenty-three transverse serial sections through a specimen from the Upper Greensand of Potterne, Wiltshire. B.M. B. 71430. X 4.


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Genus BOUBEITHYRIS Cox & Middlemiss, 1978

Type species. Terebratula boubei d'Archiac
Boubeithyris boubei (d'Archiac)
Pl.7, figs.4-6

1847 Terebratula boubei d'Archiac: 320, pl.19,fig.11.
1903 Terebratula boubei d'Archiac; Lamplugh & Walker: 252, pl.18,fig.5.
1978 Boubeithyris boubei (d'Archiac); Cox & Middlemiss, 419, pl.40, figs. 1-4, text-fig.4.

NEOTYPE. In the collections of the Institut Royal des Sciences Naturelles de Belgique in Brussels; registered number M.T.C. 10154, from the Tourtia of Tournai.

REMARKS. Cox & Middlemiss(1978) on recognizing the occurrence of this species in the Lower Albian of Leighton Buzzard, Bedfordshire, extend the geological range of the species to Lower Albian-Cenomanian. It should be noted that the ecological circumstances which prevailed at Leighton Buzzard during the Lower Albian were quite distinct from any which existed at that time in any other part of the United Kingdom, with the possible exception of the Melton Carstone, in Yorkshire. They were, in fact, very similar to the conditions which existed within part of the Tourtia from Tournai district in Belgium.

The genus Boubeithyris is represented in the British Cenomanian by B. diploplicata sp.nov., a species formerly referred to "Terebratula biplicata" sensu J.Sowerby (1815) and J.de C.Sowerby (1825).

Boubeithyris diploplicata sp. nov.
Pl. 7,figs.1-3,7-9, Pl.8,figs.4-24, Text-Fig.14.

1815 Terebratula biplicata J.Sowerby, 201,pl.90,figs.2-5.
1852 Terebratula biplicata Brocchi; Davidson,pl.4,figs.34-38,
1871 Terebratula biplicata Sow.;Quenstedt,pl.48,figs.61-62.
1867 Terebratula biplicata Sow.;Schloenbach,pl.21,figs.1-3.
1903 Terebratula biplicata Sow.; Jukes-Browne & Hill: 123, 129.
1968 Terebratula dutemplei d'Orbigny: Panow: 583,pl.CXl, figs. 1-3.

DIAGNOSIS. Elongate-oval to pentagonal to subquadrate in ventral profile. Beak short, suberect. Foramen large, circular,mesothyridid; attrite to marginate. Anterior commissure strongly biplicate to sulciplicate.

Cardial process well developed, hinge-plates thin, ventrally concave, tranverse band moderately highly arched.

DESCRIPTION. Although exhibiting a broad range of morphological variations, this species is distinguised by its very acute anterior plication and predominant biconvexity. Its beak features are marked by a large circular foramen with well defined beak-ridges. The umbo is short and massive and the interarea very poorly developed. Concentric growth-lines are marked at all stages of development and are particularly evident at the shell margins.

HOLOTYPE. In the general collection of the British Museum (Natural History), B.M. BB 82144, from the Lower Cenomanian, Glauconitic Marl, Warminster, Wilts.

Dimensions of holotype. Length 28.5 mm, width 21.5 mm and thickness 20.6 mm.

PARATYPES. B.M. B.95590-602, Warminster, BB 5578-89, Maiden Bradley, B.6221, Undercliff,Isle of Wight, BB 6900, Rocken End, Isle of Wight, B 35063 Cap de la Hève, near Le Hâvre, Normandy, B 85265, Auberville, Normandy, B 6124,Vimoutiers (Orne), France.

REMARKS. This species has been widely misquoted as Terebratula biplicata Sowerby, a taxon already preoccupied by a Jurassic species described by Brocchi (1814). Davidson (1852) followed Sowerby in naming the acutely biplicate species from beds of Lower Cenomanian age in the Warminster district under this definition. It was at one time thought that the species was confined to localities in Devon,Dorset and Wiltshire but, because of a better understanding of its extraordinary morphological variation in size and degree of convexity, it has been recognized in the more sandy facies of the Normandy Cenomanian beds. In Britain, the distribution has been extended to the Isle of Wight, where it occurs in the Glauconitic Marl and from the same horizon in basal Cenomanian at Cow Gap, Eastbourne. A splendid series of specimens showing the full range of variation from very large to small has been kindly lent by Mr Simon Hurt of Eastbourne, confirming the specimen

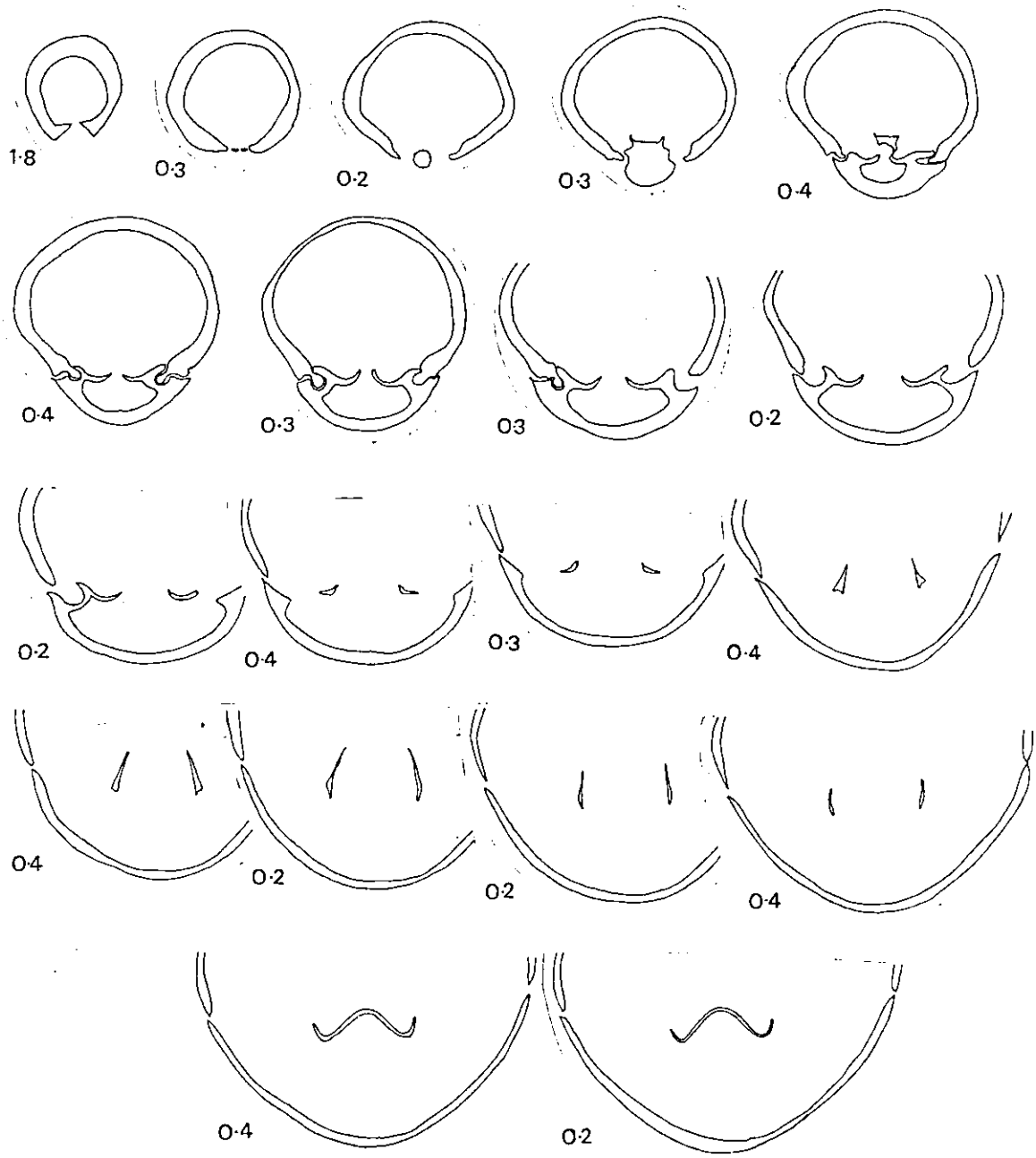
collected by Mr C.W.Wright and figured here, Pl.8, figs.13-15.

Other localities include Rye Hill Farm, and Deverill Hill, near Warminster and Chute Farm,Wiltshire. Series of specimens illustrating the full range of variation are in the collections of the Institute of Geological Sciences, London, registered as G.S.M. 109902-14, 109924-30, 110036-52 and 11015-35.

The specimens figured by Schloenbach (1867,pl.21, figs. 1-3) from the Unterer Planer of North Germany and the specimen figured by Panow (1968, pl.CXI,fig.1a-c) also belong to this species and are included in the ynonymy here. Panow's specimen was collected from the Cenomanian of the Krakow district of Poland and was part of a collection described in 1930 but was not published until 1969 after it had been revised by Drs Gertruda Biernat and Ewa Popiel-Barczyk.

All the specimens mentioned above are here assigned to the genus Boubeithyris on the strength of serial sections made from duplicate specimens of the British form. A series of transverse sections is shown here, Fig. 14 . It compares favourably with the series published by Cox & Middlemiss (1978:420) and of similar sections in the Ph.D., thesis by Dr Cox, submitted in 1967 to the University of London.

Fig. 14. Boubeithyris diploplicata sp. nov.
Nineteen serial sections through a specimen from the Lower Cenomanian, Le Havre, Normandy. B.M. B 82750


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Subfamily RECTITHYRIDINAE Muir-Wood, 1965

Genus RECTITHYRIS Sahni, 1929

Type species. Terebratula depressa Valenciennes in Lamarck, 1819

Rectithyris wrightorum sp.nov.
Pl.6, figs.10-12

Name for Messrs C.W. & E.V.Wright

DIAGNOSIS. Oval, biconvex Rectithyris. Umbo short, foramen large,circular; symphytium not exposed. Rectimarginate.

DESCRIPTION. The short,massive umbo is truncated by a large circular foramen which dominates the beak. There are no discernible beak-ridges and a very poorly defined interarea. Numerous faint concentric growth-lines are visible on the shell surface and become more evident towards the margins. The shell is inflated in the dorsal umbo but remains equi-convex in lateral profile.

HOLOTYPE. In the C.W. & E.V.Wright Collection, British Museum (Natural History), from the Lower Cenomanian, 'Grizzle' , White Hart Sandpit,Wilmington, South Devon, B.M. BB 82175.

Dimensions of holotype Length 45.3 mm, width 38.9 mm and thickness 18.9 mm.

PARATYPE. Collected by Dr W.J.Kennedy from the same locality and horizon, B.M. BB 82215. Dimensions of paratype. Length 45.3 mm, width 38.9 mm, thickness 18.9 mm.

REMARKS. This is an extremely rare species in the Lower Cenomanian of Wilmington but is probably the ecological equivalent of the original species described from the Essen Greensand. It differs from this species in having a short, massive umbo, whereas the type-species, like its equivalent (Terebratula nerviensis d'Archiac) in the Belgian Tourtia, is characterized by its slender, produced umbo and well exposed symphytium. Apart from this morphological difference, the two species have a similar oval outline in ventral profile and exhibit approximately the same degree of biconvexity.

In many ways, a closer morphological comparison can be made with the species described by J.F.Walker (1903) as Terebratula shenleyensis from the Lower Albian of Leighton Buzzard, Bedfrodshire which featured in a description of Rectithyris and varieties by Dr M.Cox, (1967,Ph.D.,Thesis). It differs from this species in its oval ventral outline and less acutely inflated brachial valve.

Internal structures. Because of lack of suitable material for transverse serial sections it is not possible to confirm, by this means, the reference of this species to the genus Rectithyris.

Genus TROPEOTHYRIS Smirnova, 1972

Type species. Tropeothyris kugusemi Smirnova

Tropeothyris vectis sp.nov.

Pl.9, figs.10-12. Text-fig.16.
Pl.8, figs.1-3, 4-15.

DIAGNOSIS. Pentagonal to broadly oval in ventral profile. Umbo short, massive; foramen large, circular. Beak suberect, beak-ridges mesothyridid. Biplication poorly developed.

DESCRIPTION. Although the shell is biconvex, the pedicle valve is more acutely developed than the brachial valve. A shallow sulcus develops at about the middle of the dorsal valve, deepening and broadening anteriorly. Some individuals tend to have their maximum width just anterior to the middle of the shell and this tends to increase the degree of biplication at the commissure. Faint carinae can be seen on the surface of the dorsal valve bordering the median sulcus. Faint concentric growth-lines cover both valves but can be seen to be interrupted by two well marked stages usually at about half and two-thirds of the shell length in mature individuals.

Internal structure. From the series of transverse serial sections shown in Fig.16, it is seen that a pedicle collar is developed in the ventral umbo and that there is a wide symphytium. A low flat cardinal process

develops early in the dorsal umbo. Short, ventrally concave hinge-plates elongate slightly and become virgate. Thickened crural bases give rise to long slender, inwardly curving crural processes, quickly diminishing. A low arched transverse band appears terminally.

HOLOTYPE. Specimen in the E.F.Owen Collection, British Museum (Natural History), B.M. BB 82185 from the Glauconitic Marl, Gore Cliff, Isle of Wight.

Dimensions of holotype. Length 30.2 mm, width 22.4 mm thickness 16.6 mm.

PARATYPES. B.M. B 6221 from Culver Cliff, I.o.Wight, B.M. B 24944 from the Glauconitic Marl of Folkestone Warren, Kent.

REMARKS. Specimens have been collected from beds of equivalent age at Eastbourne. It is possible that the species described as Terebratula carteri by Davidson (1852: 72, pl.7, fig.3) may also be referred to this genus but it differs from the species described here in its uniplicate anterior commissure and slightly more produced umbo. Another specimen which might belong with T. vectis was collected from Pit 19, Loudon Road, Louth, Lincolnshire and is figured here, Pl.9, figs.16-18. It is more regularly oval in ventral outline than the typical form and has a less acutely developed anterior plication. It is, perhaps, more likely to be

related to a species which occurs in the Lower Cenomanian of Annopol on the Vistula, Poland. A specimen collected from Poland is figured here Pl.9, figs. 7-9 for comparison. In addition, transverse serial sections have been made through a duplicate specimen from the Phosphate Mine, Julianka, Annopol, Poland and are given here, Fig. They can be compared to the series through a specimen of Tropeothyris vectis given here, Fig.16. and also to a series of serial sections through a specimen from Loudon Road Pit, Louth, Lincolnshire, Fig. 17. The series have much in common. More research into these interesting forms is necessary before any direct relationship can be seriously contemplated.

MATERIAL AND DIMENSIONS.

		LENGTH	WIDTH	THICK.
Glauc.Marl.Rocken End, I.o.Wight..C.W. & E.V. Wright, Collection.	BB 69001	22.6 mm	19.6 mm	14.9 mm
	BB 69004	26.3	21.1	14.5
	BB 69005	22.0	18.8	11.8
	BB 69006	24.6	17.8	13.0
	BB 69007	17.4	15.2	12.8
	BB 69009	25.3	19.5	13.8
" W.J.Kennedy Collection.	BB 82122	27.0	20.8	16.1
	BB 82123	24.2	22.0	13.1
	BB 82124	22.0	17.1	12.3
	BB 82125	21.4	18.1	9.6

MATERIAL AND DIMENSIONS	LENGTH	WIDTH	THICKNESS
Eastbourne, *mantelli* Z. W.J.Kennedy Coll.			
BB 82303	25.9 mm	21.9 mm	14.3 mm
BB 82304	27.3	21.4	16.1
BB 82111	31.2	21.4	15.9
BB 82112	33.8	26.8	16.4
BB 82113	31.7	25.1	15.0
BB 82114	29.0	22.8	13.6
BB 82115	24.1	19.5	9.7
Ventnor, I.o.W. Glauc. Marl, Stinton Coll.			
BB 9298	29.2	25.7	12.8
BB 9299	26.0	20.7	12.0
BB 9300	23.8	18.5	13.6
BB 9301	24.4	19.1	13.5

Several more specimens which are crushed or damaged are in the collections of the British Museum (Natural History).

Fig.15. Seventeen transverse serial sections through a specimen of an undescribed terebratulid from the Lower Cenomanian, Julianka, Annopol, Poland. This series is included for comparison with Fig. 16.

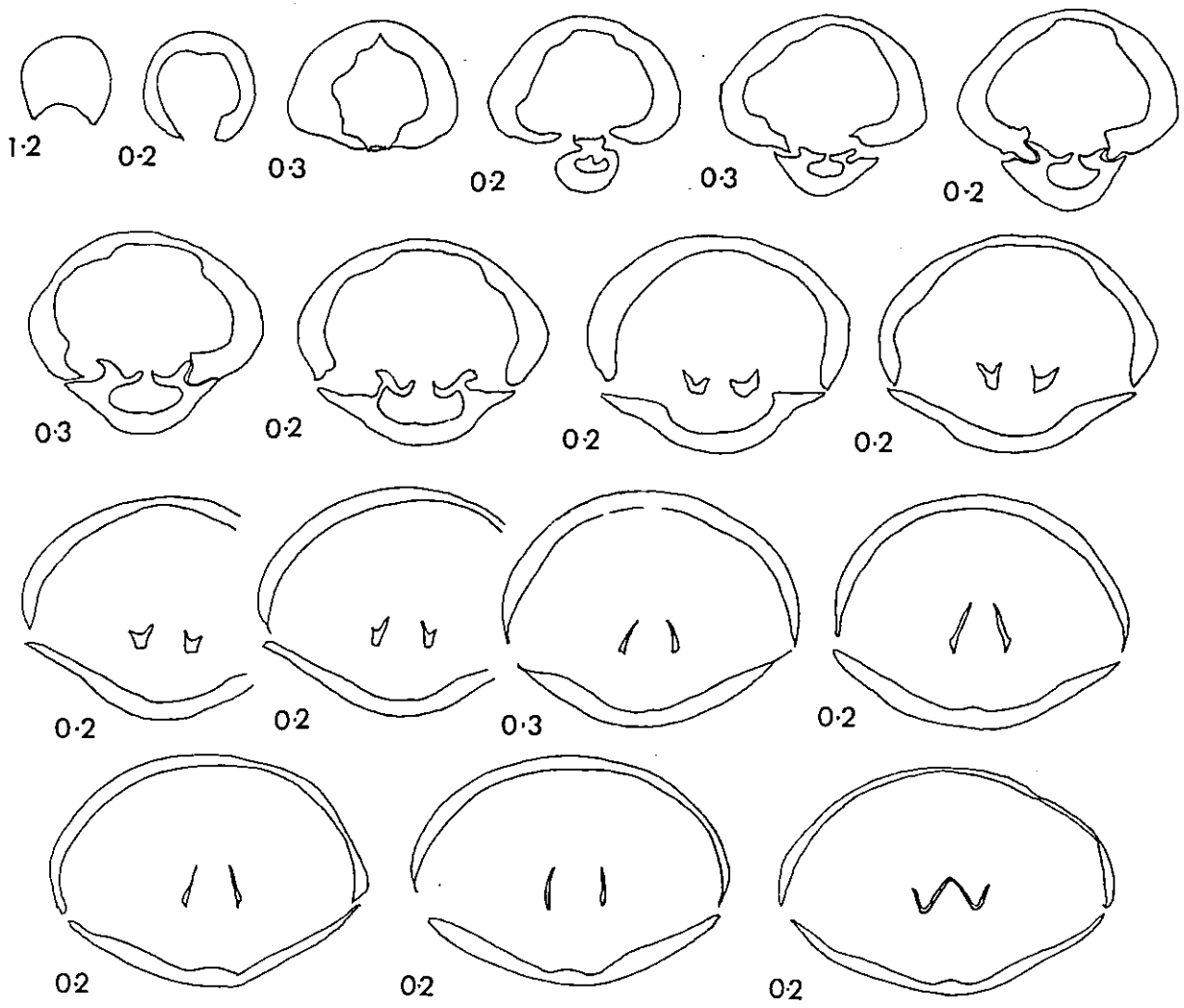

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Fig.16. Tropeothyris vectis sp. nov. A series of transverse serial sections through a specimen from the Glauconitic Marl, Rocken End, Isle of Wight.

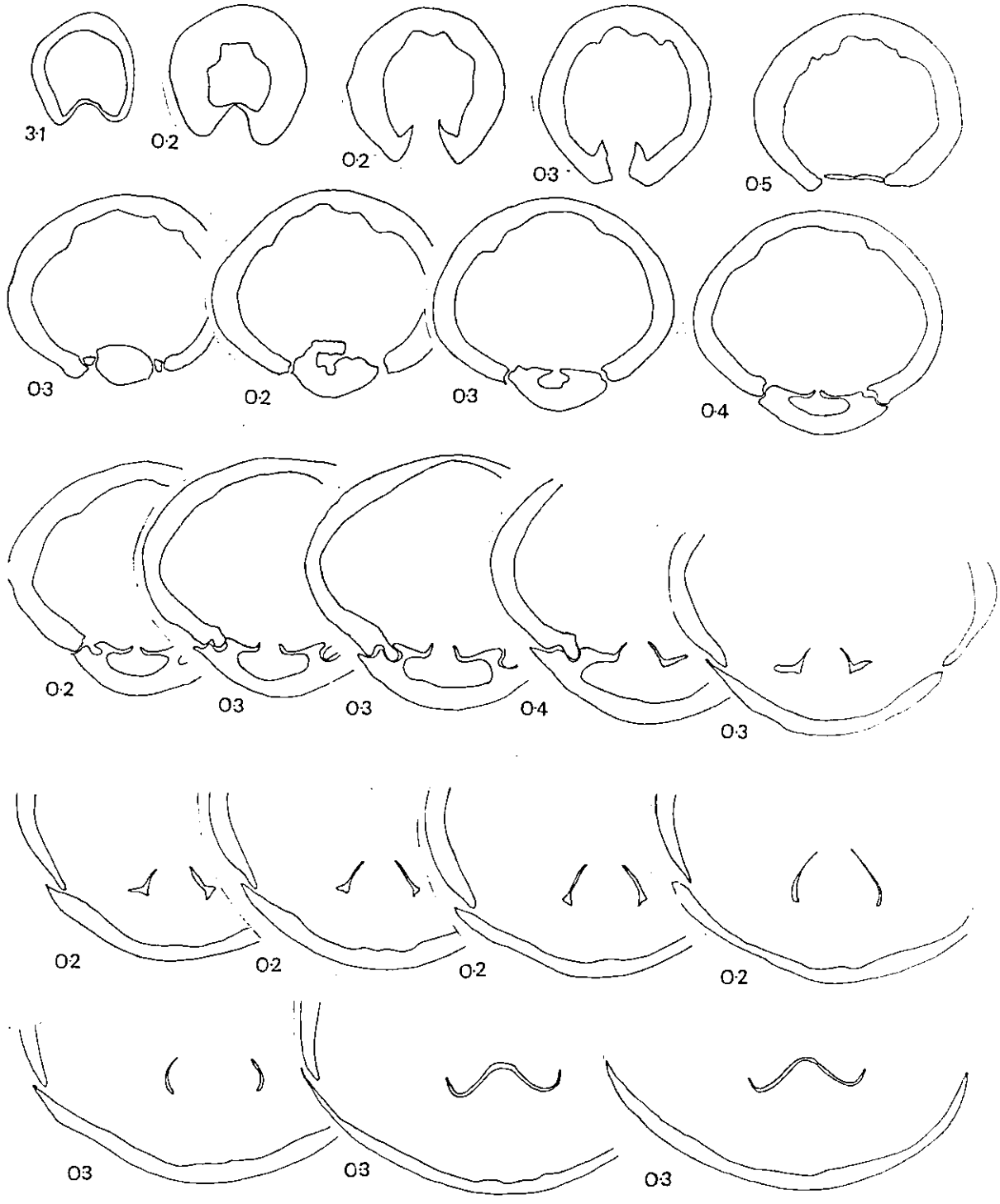
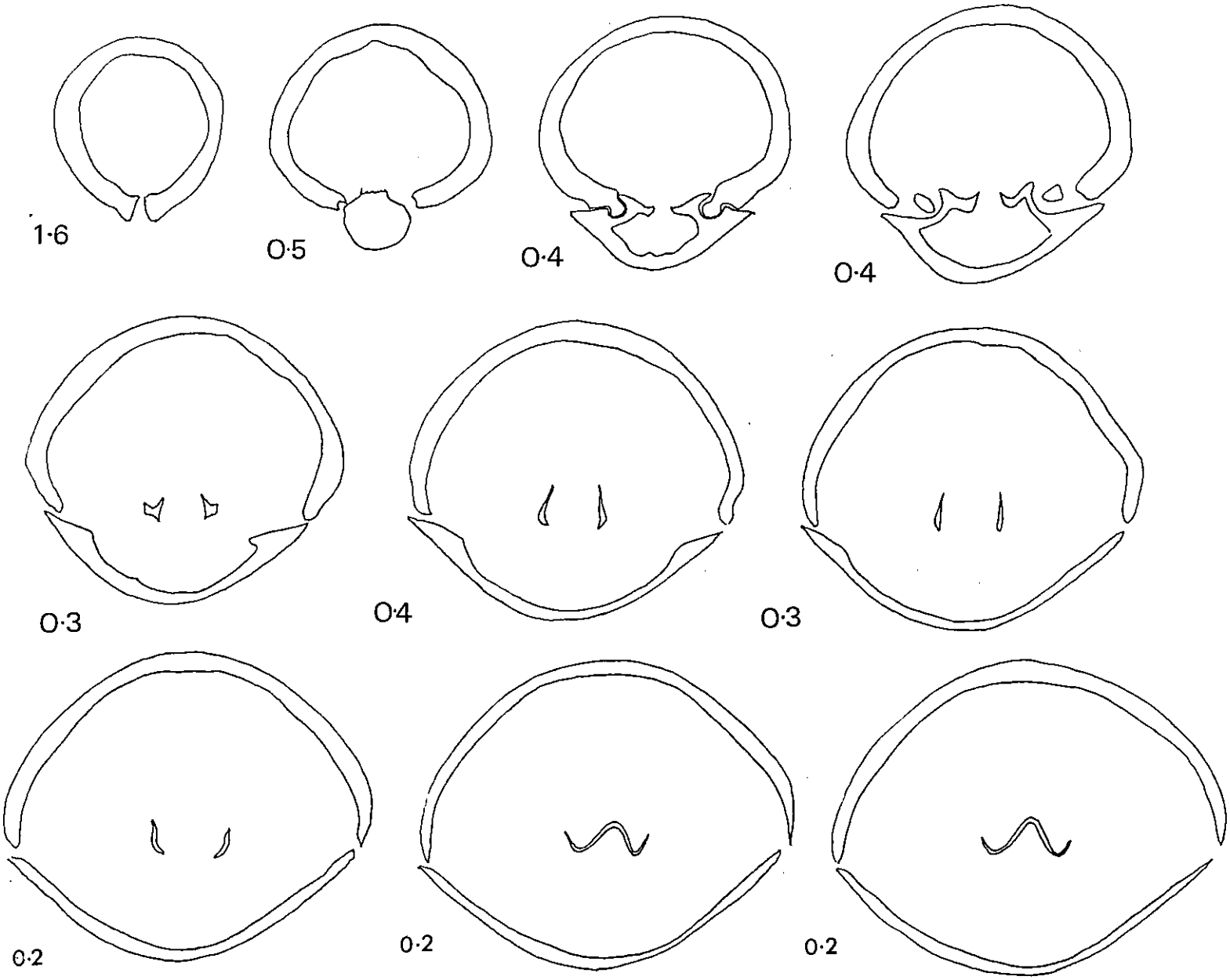

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Fig.17. A series of transverse serial sections through an undescribed species of terebratulidae from the Cenomanian, Loudon Road Pit, Louth, Lincolnshire. Included for comparison with Figs. 15 and 16.


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Genus MOUTONITHYRIS Middlemiss, 1976

Type species. Terebratula moutoniana d'Orbigny,1849

Moutonithyris dutempleana (d'Orbigny)
Pl. 10,figs.1-9, Pl.28, figs.23,24.
Text-figs. 18 .

1815 Terebratula biplicata J.Sowerby : 201, pl.90,fig.1 (non figs.2-5)
1823 Terebratula biplicata Sow.; J.de C.Sowerby : 53, pl.437.
1849 Terebratula Dutempliana d'Orbigny : 93, pl.511, figs. 1,2,3,6,7 (non figs.4 & 5)
1855 Terebratula biplicata Brocchi; Davidson: 55, pl.6, figs.1-30
1960 Terebratula dutempleana d'Orb.; Pauca & Patrulius: 88, pl.2, fig.10
1973 Terebratula dutempleana d'Orbigny; Middlemiss: 186, pl.33,fig.2, text-fig.9
1976 "Terebratula" dutempleana d'Orbigny; Gaspard,Pls.1-5.

LECTOTYPE. In the British Museum (Natural History),B.M. B 61531, from the Cambridge Greensand, Castle Hill, Cambridge and Figd. J.Sowerby 1815, pl.90,fig.1.

REMARKS. This species was reviewed and described by Middlemiss (1973) who applied Article 72 (d) of the International Commission for Zoological Nomenclature Code in order to establish the type specimen for the species. Up until this time the species had been very broadly used and had become confused with several interpretations of Brocchi's Jurassic species T. biplicata.

Even so, some confusion still arises over the exact stratigraphical horizon which should be accorded the lectotype, since the term Cambridge Greensand connotes a broad range from Upper Albian to Middle Cenomanian. The concept of the species M. dutempleana (d'Orbigny) taken from the lectotype is assumed here to indicate the commonly occurring terebratulid species which has its greater width of shell anterior to the middle distance between umbo and anterior margin and also exhibits a marked plication of the anterior commissure. This species is found as both derived and indigenous fossil within the Cambridge Greensand in the Cambridge area and as a common fossil in the Red Rock of Hunstanton Cliff in North Norfolk. The beds within this part of the Hunstanton section fall within the Middle to Upper Albian and have been divided into three distinct lithological units, A, B and C, with Bed C at the bottom resting on the Carstone. According to Dr H.G.Owen (pers. comm.) who has been working on ammonite species within this series, Bed C falls within the Anahoplites intermedius Subzone of the Middle Albian, Bed B within the upper part of the cristatum Subzone and Bed A has a lighter band representing the Hysteroceras varicosum Subzone at the base and a darker band within the ? Callihoplites auritus Subzone at the top. Both of these beds are of Upper Albian age.

The most commonly occurring morphological form in Beds A and B at Hunstanton and in the Cambridge Greensand is represented by two specimens figured here, Pl. 10, figs.1-3 from the Upper Albian of Hunstanton, and figs. 4-6 from the Cambridge Greensand. Variation within this species amounts to a more evenly oval ventral outline and less acutely biplicate anterior commissure. Two examples showing these features are figured also on Pl.10, figs.7-9 & 10-12, both from Cambridge.

Occurring with M. dutempleana in both Cambridge and Hunstanton is the the species originally described by J.de C. Sowerby (1825) as Terebratula obtusa . This species was included in Davidson's synonymy of M.dutempleana (then described as Terebratula biplicata) in his monograph of Cretaceous species (1852). The morphological difference between these two forms is considerable, T. obtusa maintaining a consistently pentangulate ventral outline, flatter or less inflated brachial umbo and uniplicate to incipiently biplicate anterior commissure. The nature of the concentric growth-lines appears to be of a more frequent occurrence which has suggested to some workers that it should be assigned to the genus Ornatothyris. The constant association of these two morphological forms extends beyond Britain and can be recognized in assemblages of

terebratulidae thought to be very closely related to Moutonithyris dutempleana collected from beds of Cenomanian age at Drap near Nice, Southern France. It is possible that this association might demonstrate sexual dimorphism, since the two forms are now known to be congeneric. Specimens selected from the Cambridge Greensand and compared to similar specimens from the Upper Albian beds of the Red Rock at Hunstanton have been serially sectioned and compared with serial sections of Moutonithyris dutempleana from Hunstanton and from the type locality at Cambridge. They compare favourably in each case. Examples of Moutonithyris obtusa are figured here, Pl.11, figs.7-9, from Cambridge Greensand and figs. 4-6 from Bed A Red Rock, Hunstanton which can be compared to Pl.12, figs.4-6 from Cambridge. Transverse serial sections for both species are given here, Fig . 18.

Although by no means common, M. dutempleana occurs in the Upper Gault , Price's Bed X, at Folkestone, Kent. Two examples are figured here, Pl.28, figs.23,24.

Frebold (1935) in describing a brachiopod fauna from the marine Upper Aptian of Koldewey Island, Northeast Greenland, included a specimen as Terebratula biplicata which he figured, pl.8, figs.1-3. The general form of the specimen figured is very close to the specimen described here as Moutonithyris dutempleana from the Cambridge Greensand and Red Rock of Hunstanton.

Associated with this species and figured also on pl.8, fig.4, is a crushed specimen with capillate ornament very similar to the species associated with Moutonityris species at Hunstanton as Capillithyris capillata (d'Archiac).

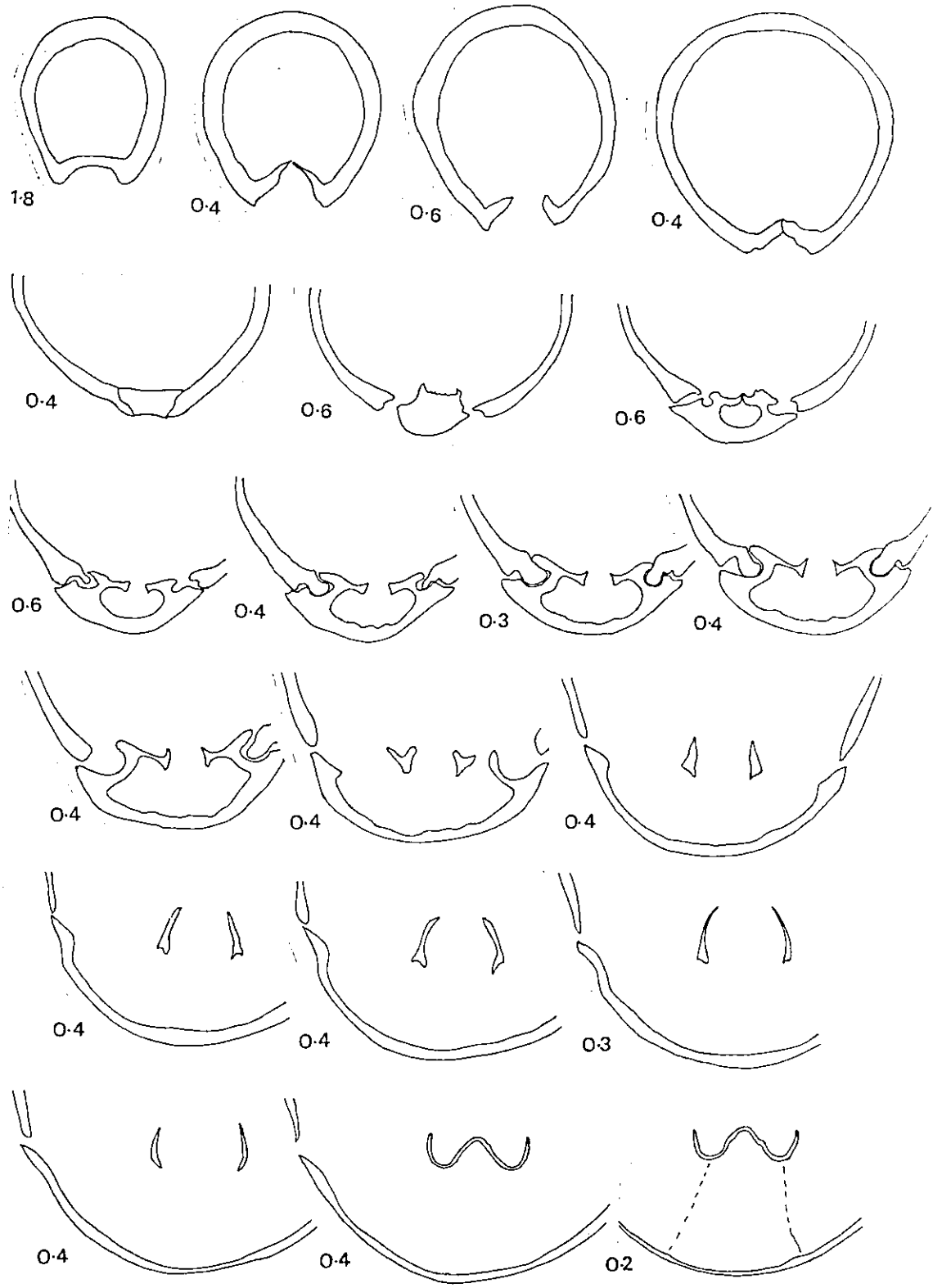
The following measurements have been recorded from specimens in the British Museum (Natural History) and registered as B.M. BB 82350-59. They occur in Beds A & B in the Red Rock, Hunstanton, Norfolk.

LENGTH	WIDTH	THICKNESS	REGD.No.
37.2 mm	30.8 mm	21.6 mm	BB 82350
34.0	27.9	20.2	BB 82351
34.5	25.0	19.1	BB 82352
30.8	25.1	19.9	BB 82353
31.1	25.5	19.0	BB 82354
34.0	26.3	19.1	BB 82355
31.1	25.5	18.9	BB 82356
30.2	23.6	18.0	BB 82357
27.9	23.4	17.1	BB 82358
29.3	23.4	17.2	BB 82359

These samples were taken at random from a colletion made by Mr H.Le Strange and show a remarkable consistency.

Fig. 18 . Moutonithyris dutempleana (d'Orbigny)

A series of twenty transverse serial sections through a specimen from Bed A, Red Rock, Hunstanton Cliff, Norfolk.


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MATERIAL. Numerous specimens of Moutonithyris dutempleana (d'Orbigny) are housed in the British Museum (Natural History), Institute of Geological Science, and the Sedgwick Museum, Cambridge. Specimens of M. obtusa also occur in the same institutions but are less numerous. Six specimens from the Upper Albian, Red Rock of South Cave, B.M. 68962-7 are in the collections of the British Museum (Natural History) and show a very close affinity to the type specimen from the Cambridge Greensand.

Moutonithyris anglia sp. nov.
Pl.6, figs.22-24. Text-figs.19,20.

DIAGNOSIS. Consistently oval in ventral outline. Maximum width half distance from umbo to anterior margin. Evenly biconvex. Uniplicate to incipiently biplicate. Umbo truncated by large circular foramen; beak suberect.

DESCRIPTION. Because this species is very close to M. dutempleana in morphological features, it is hardly surprising that the two have been confused for so long. Moutonithyris anglia, however, maintains a regular oval outline and a very marked even biconvexity. The anterior commissure is more often found as uniplicate to faintly biplicate in mature forms but never shows any of the advanced acute biplication of M. dutempleana at any stage. The umbo is massive and dominated by the large circular foramen with permesothyridid beak-ridges.

Unlike M.dutempleana, M.anglia has none of the labiate characters which are characteristic of the foramen and beak of the former species but the symphytium is never exposed.

Internal characters. From the series of transverse serial sections shown here in Figs. 19, 20 , it will be seen that all the species described here as belonging to the genus Moutonithyris have the same low, poorly developed cardinal process, short ventrally concave initial hinge-plates which lengthen , becoming almost horizontal and keeled before being deflected dorsally. The terminal ends of the hinge plates thicken,giving rise to V-shaped bases which develop anteriorly as the descending branches of the brachial loop. This quickly elongates ventrally with the development of inwardly curving crural processes, which in turn diminish.

The trasverse band is seen as a low-arched, comparatively broad W-shaped ribbon. This structure is quite commonly associated with a character named as a sub-loop skirt by Cox & Middlemiss (1978) and is probably as a result of consolidation of spicules within the mantle in the living specimen. Oddly, this character has been observed in specimens from Beds A and B and from specimens from the Cambridge Greensand but does not seem to occur in sectioned specimens from Bed C described here as M.anglia.

HOLOTYPE. A specimen in the collections of the British Museum (Natural History) collected by Mr H.Le Strange from Bed C of the Red Rock at Hunstanton cliff section. It is registered as B.M. BB 82262 and is figured here on Pl. 6, figs.22-24.

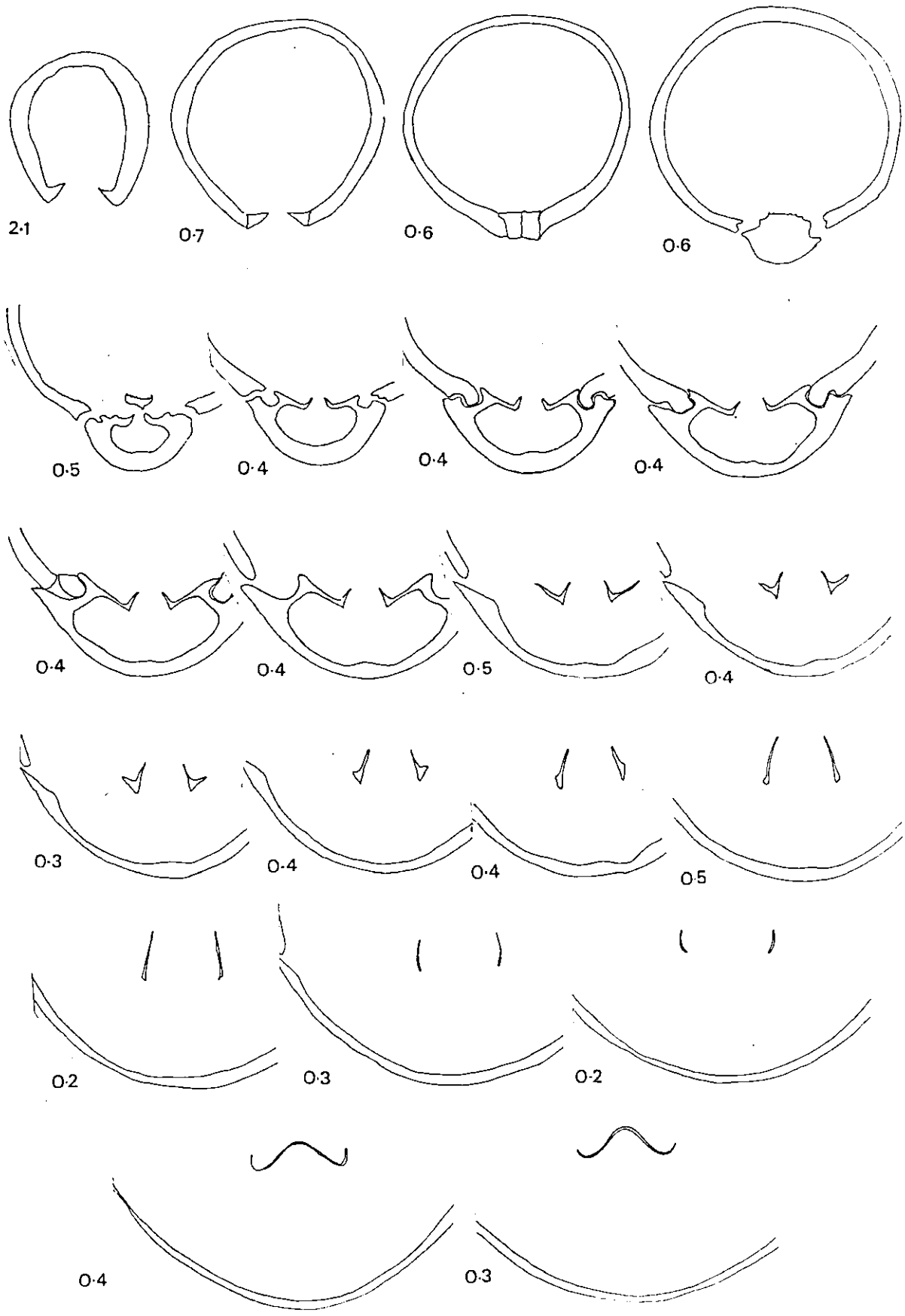
PARATYPES. Ten specimens from the type locality and horizon in British Museum (Natural History) B.M. BB 82263 - BB 82272.

The following records are the measurements made from the holotype and the ten paratypes mentioned here.

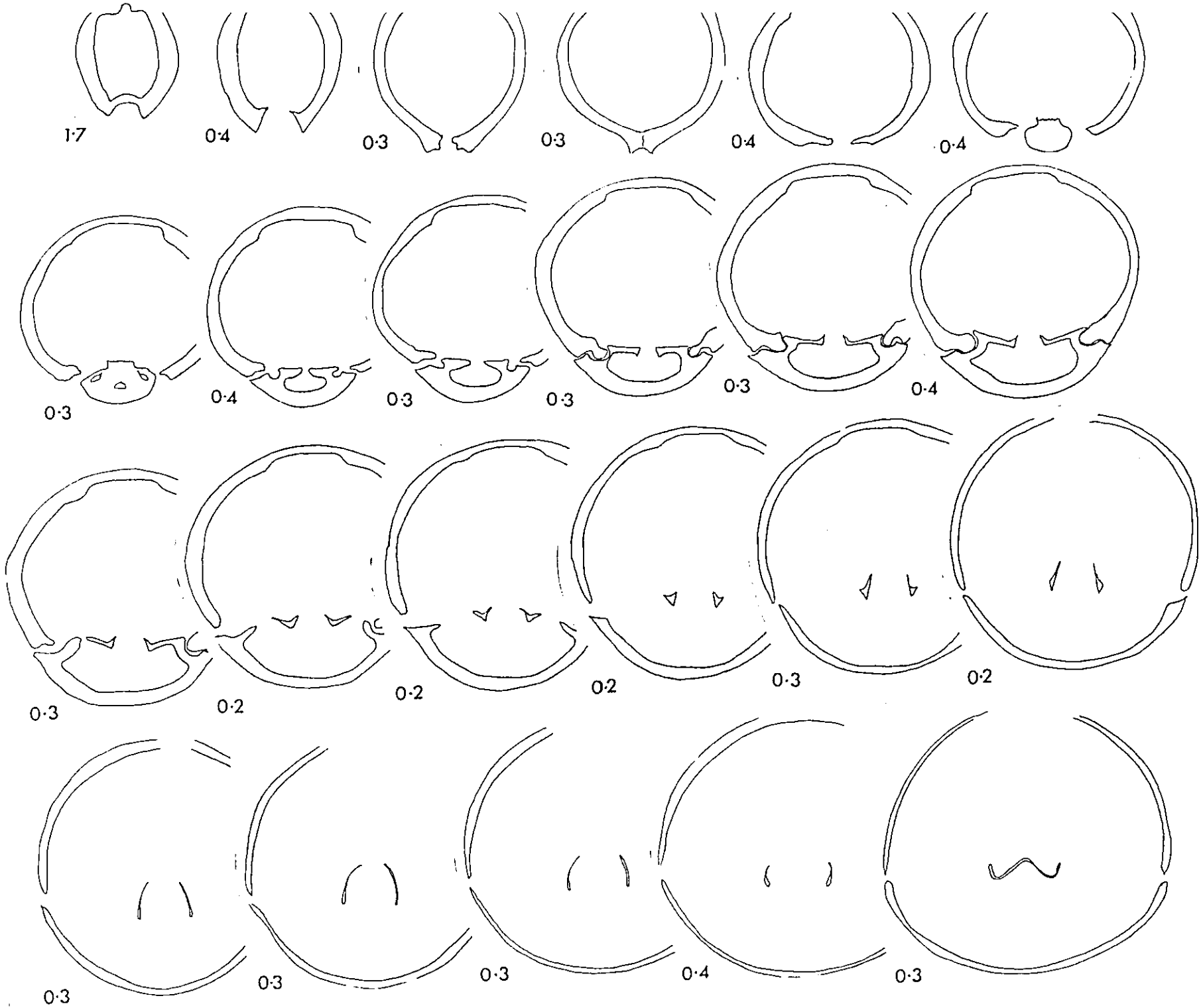
LENGTH	WIDTH	THICKNESS	REGD.No.
40.1 mm	30.2 mm	24.2	BB 82262
29.3	20.9	19.1	BB 82263
36.6	27.6	20.4	BB 82264
33.1	26.1	20.3	BB 82265
30.2	23.4	18.4	BB 82266
31.1	22.4	17.1	BB 82267
31.2	24.5	16.5	BB 82268
32.4	25.6	17.4	BB 82269
30.8	25.1	18.2	BB 82270
27.9	23.0	17.2	BB 82271
29.9	23.2	15.9	BB 82272

REMARKS. This species is the only Moutonithyris occurring in Bed C of the Red Rock. It can be distinguished from other species of Moutonithyris by its consistent

Fig.19 . Moutonithyris anglia sp. nov. A series of twenty-one transverse sections through a specimen from Bed C, Red Chalk, Hunstanton Cliff, Norfolk.


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TEXT-FIG. 20. A series of transverse serial sections through a specimen of *Moutonithyris anglia* sp. nov. from Bed C of the Red Rock, Hunstanton, Norfolk.


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Genus CONCINNITHYRIS Sahni 1929

TYPE SPECIES. Terebratula obesa J.de C.Sowerby 1823

EMENDED DIAGNOSIS. Elongate-oval to subcircular in ventral profile. Umbo massive, beak slightly incurved to erect, truncated; foramen small to large, circular, permesothyridid, rarely labiate; beak-ridges rounded, indistinct. Anterior commissure rectimarginate to uniplicate to biplicate.

Cardinal process low, flat, poorly developed. Hinge-plates fairly long, ventrally convex. Crural bases developing directly from anterior ends of hinge-plates. Crural processes high, tapering, inwardly curving. Transverse band developing from thin descending branches of brachial loop and forming low arch, sometimes with small depression or sulcus posteriorly.

Poorly defined pallial sinuses and muscle-marks are at times visible on internal moulds of decorticated specimens but are not considered to be of diagnostic importance.

RANGE. Albian to Cenomanian

REMARKS. The interpretation of this genus depends

very much upon the interpretation of the type species T. obesa J.de C.Sowerby. As the holotype is the only representative of this species in the Sowerby Collection and is from an unrecorded horizon at Norton Bavant, Wiltshire, it stands to reason that Dr M.R.Sahni (1929) must have based his description of the genus on this and other specimens from different localities which he identified as T. obesa. Although he states the range of the type species to be of Turonian age, he did, in fact, dissect a specimen from Eggardon Hill, Dorset, B.M. B 24914, which is probably the same species as Sowerby's type. This locality in Dorset has recently been revised and recorded by Kennedy (1970) as of jukesbrownei assemblage age, at the top of the Acanthoceras rhotomagense Zone of the Middle Cenomanian. Sahni's age determination of the species is probably based upon data recorded by d'Orbigny (1845) who cited specimens identical to the English form as from the 'Turonien Superieur' of Rouen, being in accordance with his views on the stratigraphy at the time. The species is found as a comparatively common fossil within the A. rhotomagense Zone in the Craie de Rouen. An example from the quarry at the Côte Ste. Catherine, Rouen, is figured here Pl.14, figs.4-6, with the holotype B.M. B 49832 for comparison.

Concinnithyris obesa (J. de C. Sowerby)
Pl.14, figs. 1-15. Text-fig. 21 .

1823 Terebratula obesa J.de C.Sowerby: 54,pl.438,fig.1.
1850 Terebratula obesa d'Orbigny: 105, pl.513, figs.1-3, (non fig.4).
1929 Concinnithyris obesa (J.de C.Sowerby); Sahni: 12, pl.1, figs.1-9, pl.8,figs.1,2.

HOLOTYPE. Specimen in Sowerby Collection, British Museum (Natural History), B.M. B 49832, from the Lower Chalk, Norton Bavant, Wiltshire.

DIMENSIONS. Length, 48.9 mm, width, 36.0 mm, thickness, 34.9 mm.

Sahni (1929: 12) gave an adequate description of the species as represented by the Sowerby type and accompanied this with two dissected specimens, (pl.8, figs.1,2) one of which,B.M.B 49884, he called a plesiotype from 'The Chalk' of Lewes,Sussex. This specimen from an unspecified horizon within the Chalk, in my opinion, shows very few of the characters concomitant with the species here described as Concinnithyris obesa (J.de C.Sowerby).

Sahni did not recognize the variability of the species he was describing and consequently regarded only the large, almost perfect specimens matching with the holotype, as representative of C. obesa. Thus the number of examples of this species as interpreted by Sahni is miserably few.

In fact, if a more thorough investigation is made of specimens collected from the Lower Chalk of Dorset, Wiltshire and the Isle of Wight, it will be seen that the range of variation includes specimens

which do not approach the holotype in their general dimensions, are sometimes steeper flanked and subparallel in ventral outline, may be anteriorly constricted and might also be less acutely biconvex. The ideal specimens which, in my view,adequately represent the full range of variation within the species are figured here, Pl.14, figs.1-15.

The ontogeny of the species C. obesa can, to some extent, be gauged from a number of specimens collected from a bed less than one meter above the phosphatic conglomerate comprising the Cenomanian Basement Beds at Snowdon Hill, Chard, Somerset, White Nothe, Ringstead and Durdle Cove, Dorset, Isle of Wight, and Charstock, Devon. Above the phosphatic beds, examples always appear non-phosphatized, highly calcareous and whitish in colour. A marked variant within these assemblages can be recognized from its flatter valves, large foramen, and more acute biplication of the anterior commissure.

Allthe above variants as well as the typical form have been recognized in collections from the Craie de Rouen, France, from where the species was collected by d'Orbigny (1847) and described as from his 'Etage Turonien'. Since the work of Kennedy & Hancock (1970), Juignet & Kennedy (1976) and others, it is now known that the Craie de Rouen is of Middle Cenomanian age.

The transverse serial sections shown here, Fig.21 , are from a specimen selected from a collection of variants from the Lower Chalk, one meter above the Cenomanian Basement Bed, White Nothe, Dorset. A resin cast of the specimen is in the collections of the British Museum (Natural History) B.M. BB 82332.

Davidson (1852: 53, pl.5, figs. 13-15) interpreted Sowerby's species as the biplicate terbratulid which occurs rarely in the Warminster Greensand. The two forms have little in common apart from their large proportions and it seems strange that Davidson should have made this decision, especially since Sowerby's original specimen of T. obesa was available to him. It was because of this misinterpretation that Rollier (1911 : 28) changed the name of the Warminster species to Terebratula davidsoni. This species occurs in the Tourtia of Tournai, Belgium and a specimen from that locality is figured here, Pl.11, figs.10-12. It has been confused with a species described by Parent (1893) as Terebratula sabinensis which is likely to be referrable to the genus Ornatothyris . It differs from C.davidsoni in its evenly oval ventral outline, suberect and truncated umbo, lack of pication of the anterior commissure. An example from Belgium is figured here, Pl.11, figs.1-3, B.M. BB 82188. It is 41.5 mm in length, 34.7 mm wide and 24.0 mm thick.

A series of transverse serial sections through a young specimen of Concinnithyris davidsoni is given here, Fig. 22 . It shows the comparatively short ventrally deflected hinge-plates, the long incurved crural processes and the low W-shaped transverse band of the brachial loop. This series can be compared to the series shown here for the type species, Fig. .

MATERIAL AND DIMENSIONS.

Concinnithyris obesa		LENGTH	WIDTH	THICKNESS
I.o.Wigth,B.M.	BB69017	28.9 mm	23.9 mm	19.3 mm
	BB 82080	44.8	33.3	34.9
Ringstead,B.M.	BB 69013	32.1	24.8	21.0
Osmington,	BB 45120	45.2	35.8	33.1
Durdle Cove	BB 69088	30.4	23.1	20.5
	BB 69085	30.7	26.0	19.6
Snowdon Hill,	BB 82364	40.6	34.9	26.1
	BB 82365	31.8	29.2	20.5
	BB 82366	29.4	23.9	18.7
Rouen,France	BB 82367	44.9	38.6	34.4

Fig.21. Tranverse serial sections through a specimen of Concinnithyris obesa (J. de C.Sowerby) from the Lower Chalk, White Nothe, Dorset. BB 82332

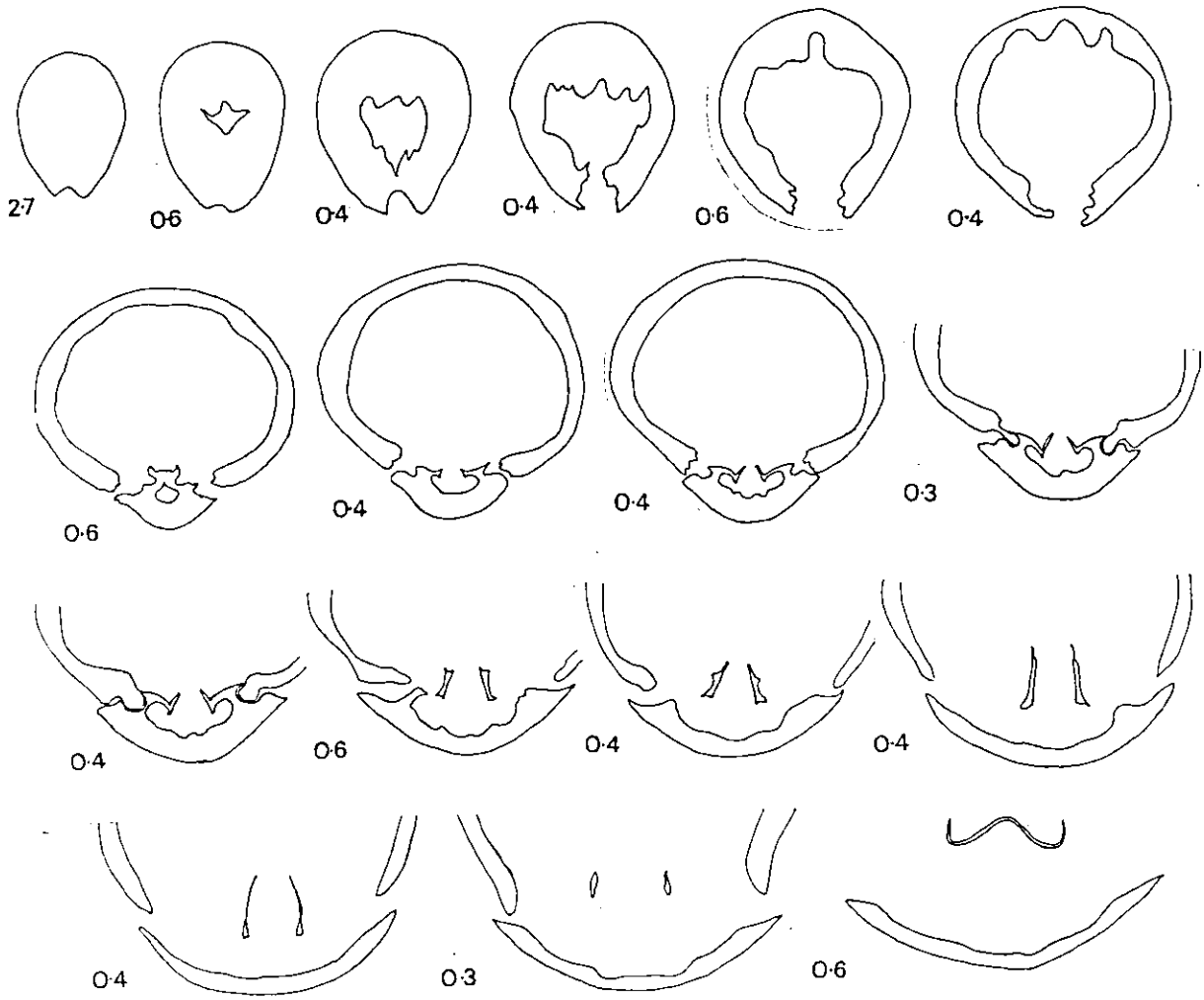
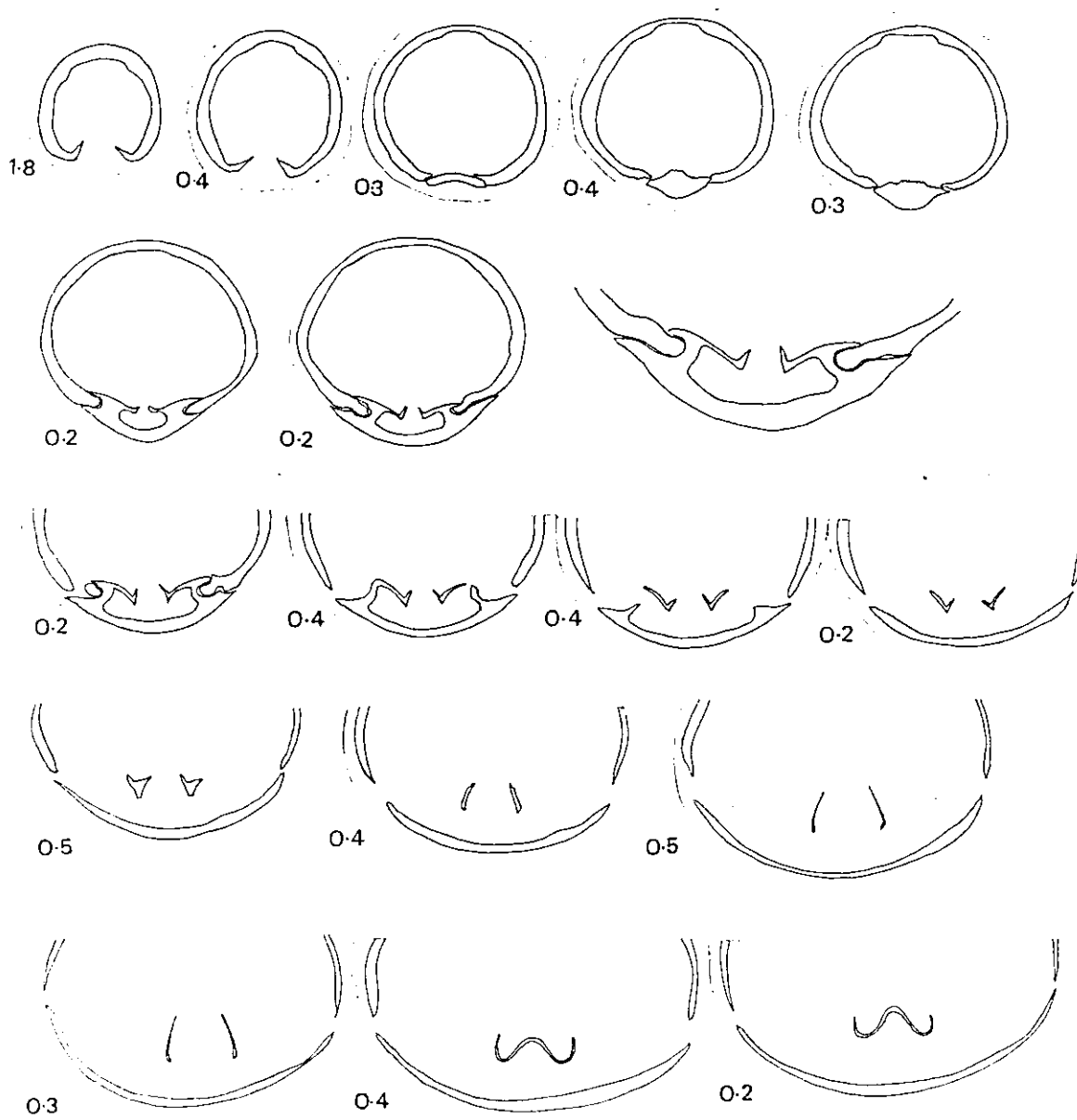

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Fig. 22. Concinnithyris davidsoni (Rollier) Eighteen serial sections through a specimen from the the Upper Greensand of Warminster, Wilts. B.5070.


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Concinnithyris subundata (J.Sowerby)

Pl.15,figs.4-16; Pl.16,figs.1-12.

Fig.23, 24.

1813 Terebratula subundata J.Sowerby: 47, pl.15, fig.7.
1929 Concinnithyris subundata (J.Sowerby); Sahni: 17, pl.1,figs.10-16, non fig.17; pl.8,figs.11,12.
1929 Concinnithyris burhamensis Sahni; 16, pl.2,figs.8-13; pl.8,figs.22,23.
1958 Concinnithyris subundata (J.Sowerby);Sahni: 4, pl.1,figs.1,2, non figs.3-7.

EMENDED DESCRIPTION. The suberect epithyridid beak is dominated by a circular foramen. Symphytium not exposed. The ventral profile of the shell varies from subpentagonal to subcircular to elongate-oval. In some individuals, the maximum width occurs anteriorly at a point just over half the length of the shell. The anterior plication varies from incipiently uniplicate to faintly biplicate. An even degree of biconvexity is maintained but diminishes in some variants. In some cases a shallow depression or sulcus may be developed medianly on the dorsal valve and this is usually bordered by faint carinae.

Internal Characters. Apart from the early stages in the development of the hinge-plates, which are slightly longer than those seen in transverse serial sections of the type-species, the characters are the same for the genus, Fig.21.

LECTOTYPE. The specimen figured by J.Sowerby 1813, pl.15, fig.7 and registered as part of the Sowerby Collection in the British Museum (Natural History), B.M. B 49827 and figured here,Pl.16, figs.1-3.

REMARKS. The original description of the species by Sowerby (1813: 47) was presumably based on one individual which was represented (pl.15, fig.7) by a robust, biconvex, elongate-oval specimen with a large circular foramen and, according to Sowerby, having a pinkish or flesh-coloured hew about it.

In the subsequent curation of this specimen, it appears to have been included with six other specimens which were attached to a wooden tablet as part of the Sowerby Collection and registered as B.M. B 49826-31. When Sahni (1929) included this species in his genus Concinnithyris he assumed that Sowerby's figure 7 on pl.15 was a composite of two specimens within the series of six and now registered as B.M. B 49826 & B 49827 and he may well have been right. However, he selected one of these specimens, B 49826, as holotype of the species, calling it a NEANIC HOLOTYPE but failed to quote the other specimen as paratype or paralectotype. In my opinion, if Sahni had considered the two specimens to have been used in a composite illustration of a species, then these two specimens are of equal rank, i.e. syntypes, and one should be chosen as lectotype in order to establish the species.

The specimen quoted as holotype of C. subundata is figured by Sahni (1929, pl.1, fig.17) but does not

in any way resemble the specimens subsequently figured under this name by Sahni himself, nor does it fit the illustration in Sowerby (1813, pl.15, fig. 7) in ventral profile or beak characters. Furthermore, it is clear, from the matrix attached to the specimen, that it originated from a higher horizon, probably the Chalk Rock, since the matrix contains numerous grains of glauconite. This view is shared by Mr Andrew Gale (pers. comm.). Sowerby specifically stated that his specimen had been collected from the 'Softish Chalk of Warminster', which suggests the Lower Chalk of that area.

If Sahni had selected the second of the two specimens he mentioned, B.M. B 49827, there would have been little argument since, ironically, this specimen fulfills most of the characters depicted in his descrition (: 17) and in most of the specimens figured by him under the name of Concinnithyris subundata on pl.1, figs. 10-16, pl.8, figs. 11,12. It is for this reason and for the sake of preserving a well established species within the Lower Chalk that I select here the specimen in the Sowerby Collection, registered as B.M. B 49827 as lectotype of the species Concinnithyris subundata (J.Sowerby). Although this specimen could hardly be described as 'flesh-coloured' it does have a faint reddish-mauve tinge to it.

MATERIAL, LOCALITY AND DIMENSIONS

Burham,Kent.	LENGTH	WIDTH	THICKNESS
BM. B 9449,	33.4 mm	26.1 mm	22.1 mm
B 9450	34.4	26.2	22.1
B 9455	32.8	29.1	18.2
B 9460	26.8	25.2	18.2
Folkestone,Kent.			
BM.B 22876	30.4	26.3	19.2
BB 5602	30.5	25.4	19.5
BB 5603	34.1	27.2	20.5
Oxted,Surrey.			
BM. B 58233	37.6	31.3	22.9
B 44820	30.1	27.1	18.2
B 44822	29.1	25.2	18.2
Chinor,Oxon.			
BM. B 47274	31.5	26.5	19.0
Guildford,Surrey.			
BM. B 10634	29.3	25.4	15.4
Culver,I.o.Wight.			
BM. BB 68996	39.4	33.8	22.0
BB 81153	35.7	29.0	20.3
Punfield,Dorset.			
BM. BB 69104	30.8	26.2	18.2
Evershot,Dorset			
BM. BB 82163	32.5	28.0	20.9
BB 82164	29.8	25.5	19.2
BB 82165	32.7	28.7	22.8
BB 82166	30.5	24.1	18.4
Burwell,Cambridge.			
BM. B 24968	32.1	26.7	16.8
	27.7	25.0	16.1
	26.7	24.5	16.9

MATERIAL, LOCALITY AND DIMENSIONS

Rouen, France	LENGTH	WIDTH	THICKNESS
BM. B 35074	26.0 mm	22.9 mm	16.6 mm
	26.3	23.1	15.6
BB 82167	28.6	25.3	18.0
St.Jouin, Normandy.			
BM. BB 82168	29.8	25.8	18.9
BB 82169	25.4	22.7	14.5

It has been noted that during the process of measurement of specimens from the Basement Beds in Dorset and Wiltshire and of those few specimens from French localities , there is a significant difference in the size of the foramen in specimens which show a maximum width just over half the distance from the umbo to anterior margin. These specimens often, but not always, tend towards less biplication or simply uniplication of the anterior commissure. As far as can be detected from the comparatively few specimens serially sectioned, this difference is not reflected in any change of internal structure. The species suggests a very good subject for further statistical analysis.

Fig. 23. Twenty-one transverse serial sections through a specimen of Concinnithyris subundata (J. Soweby) from the Lower Chalk, Southerham Gray Pit, near Lewes, Sussex.

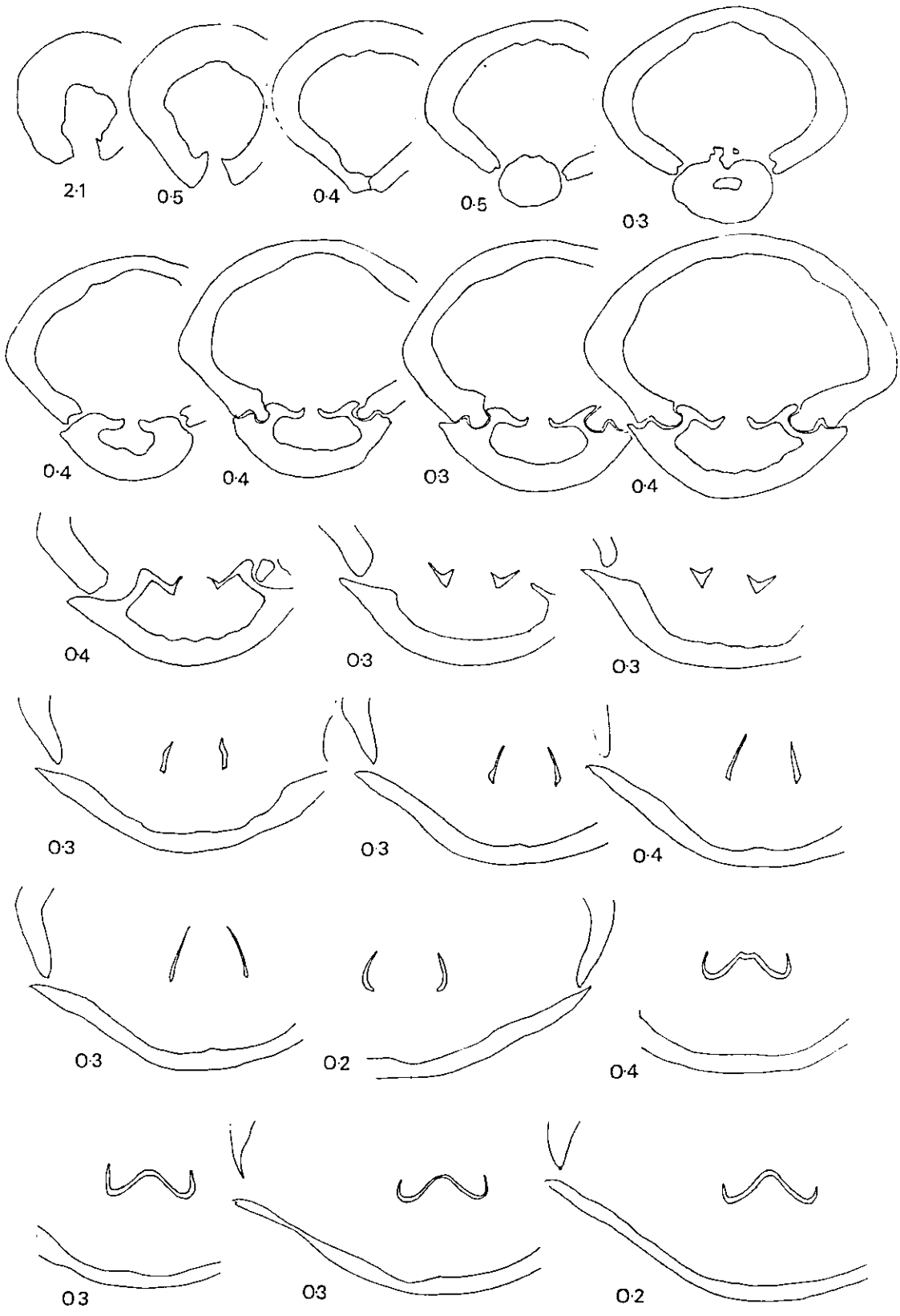

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0·2

Fig. 24. Concinnithyris subundata (burhamensis of Sahni) BM. BB 82330 from the Lower Chalk, Southerham Grey Pit, Sussex.

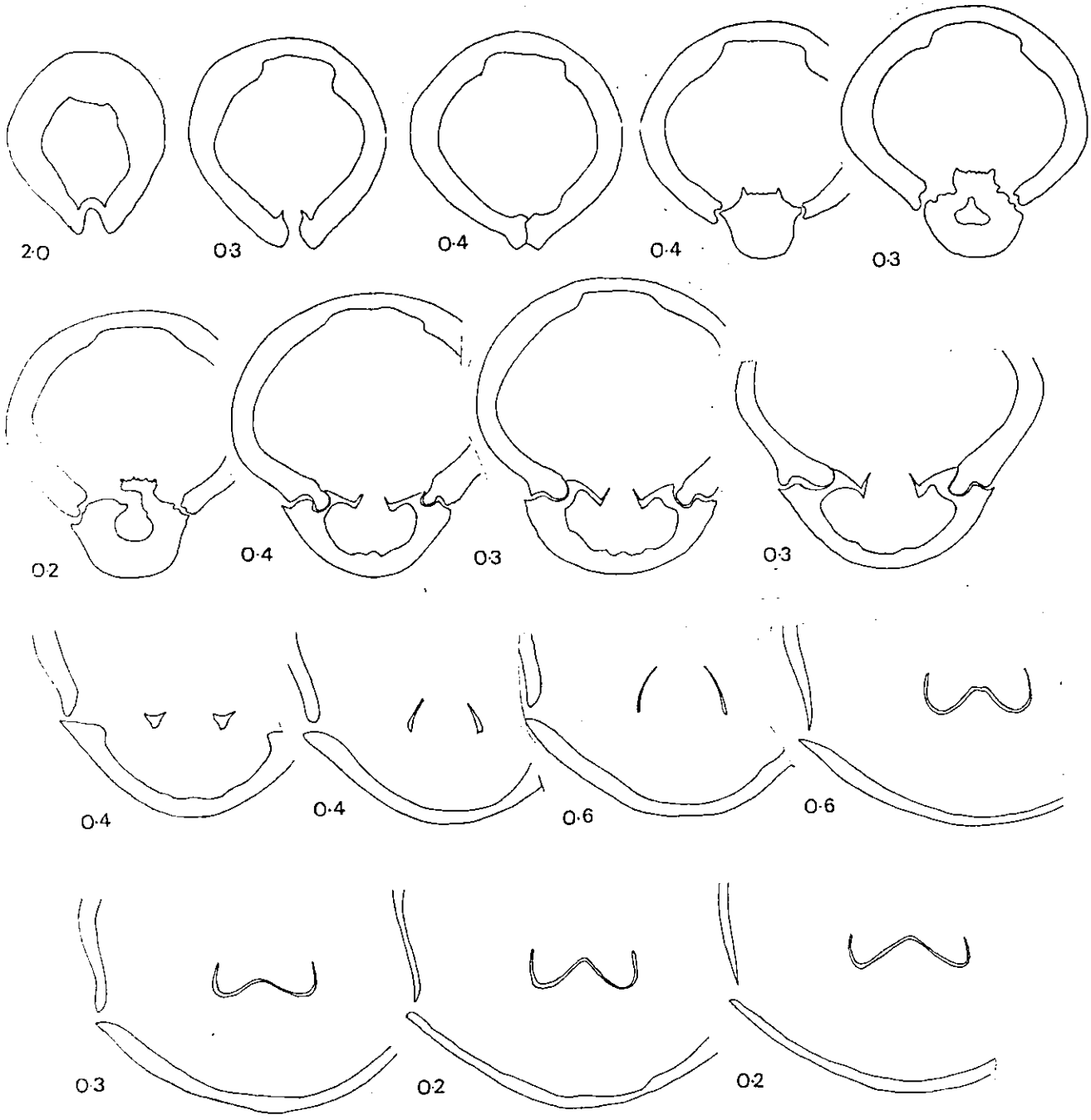
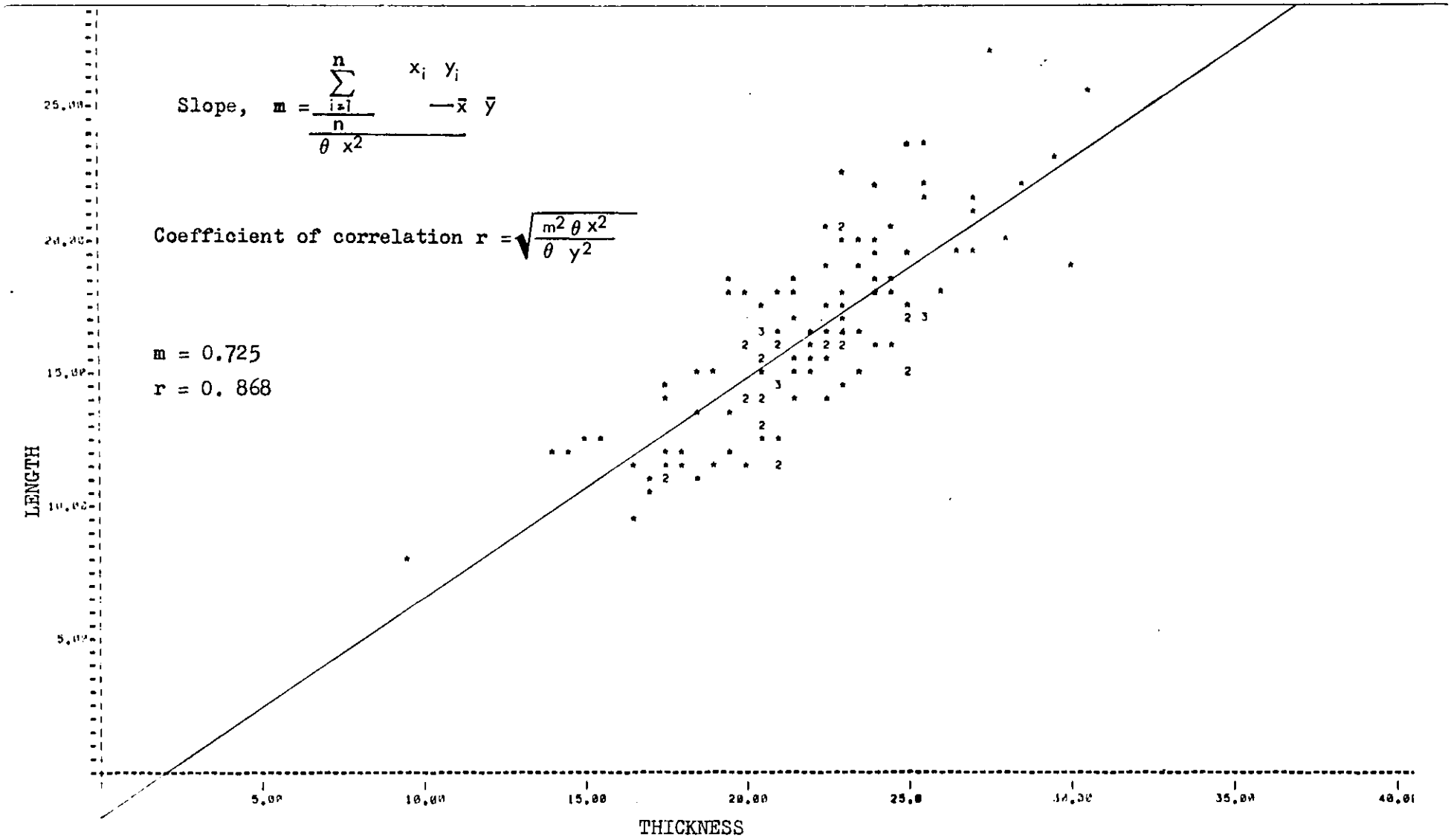

2·0
0·3
0·4
0·4
0·3
0·2
0·4
0·3
0·3
0·4
0·4
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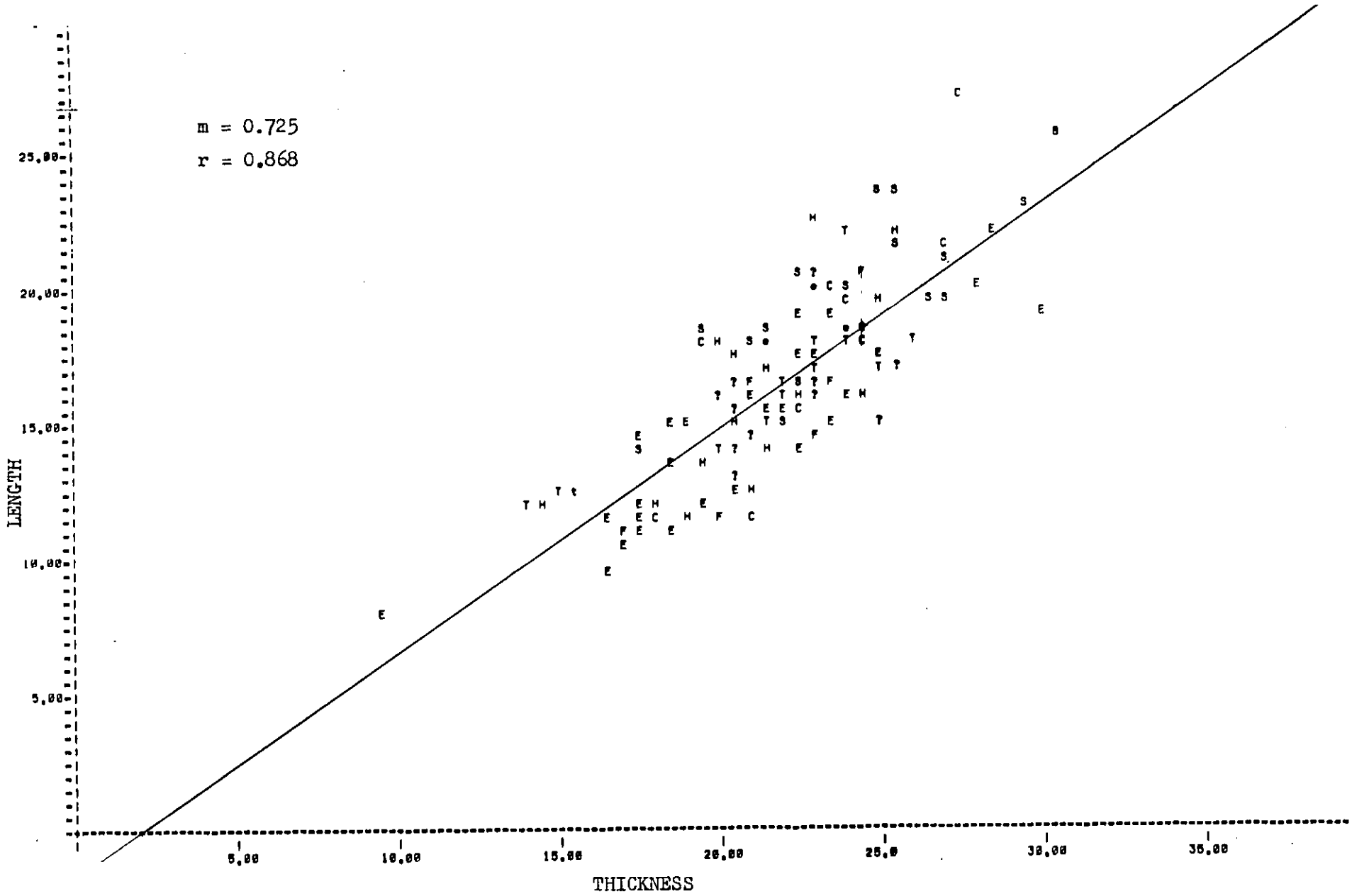
FIG. 25. Diagram illustrating length x thickness, length x width and width x thickness ratios within a random sample of Concinnithyris subundata (J.Sowerby)

Locality key. E = Evershott, Dorset
T = Toller Pocorum
F = Toller Fraterum
S = Snowdon Hill, Chard
H = Horn Hill,Dorset
C = Chilfrome

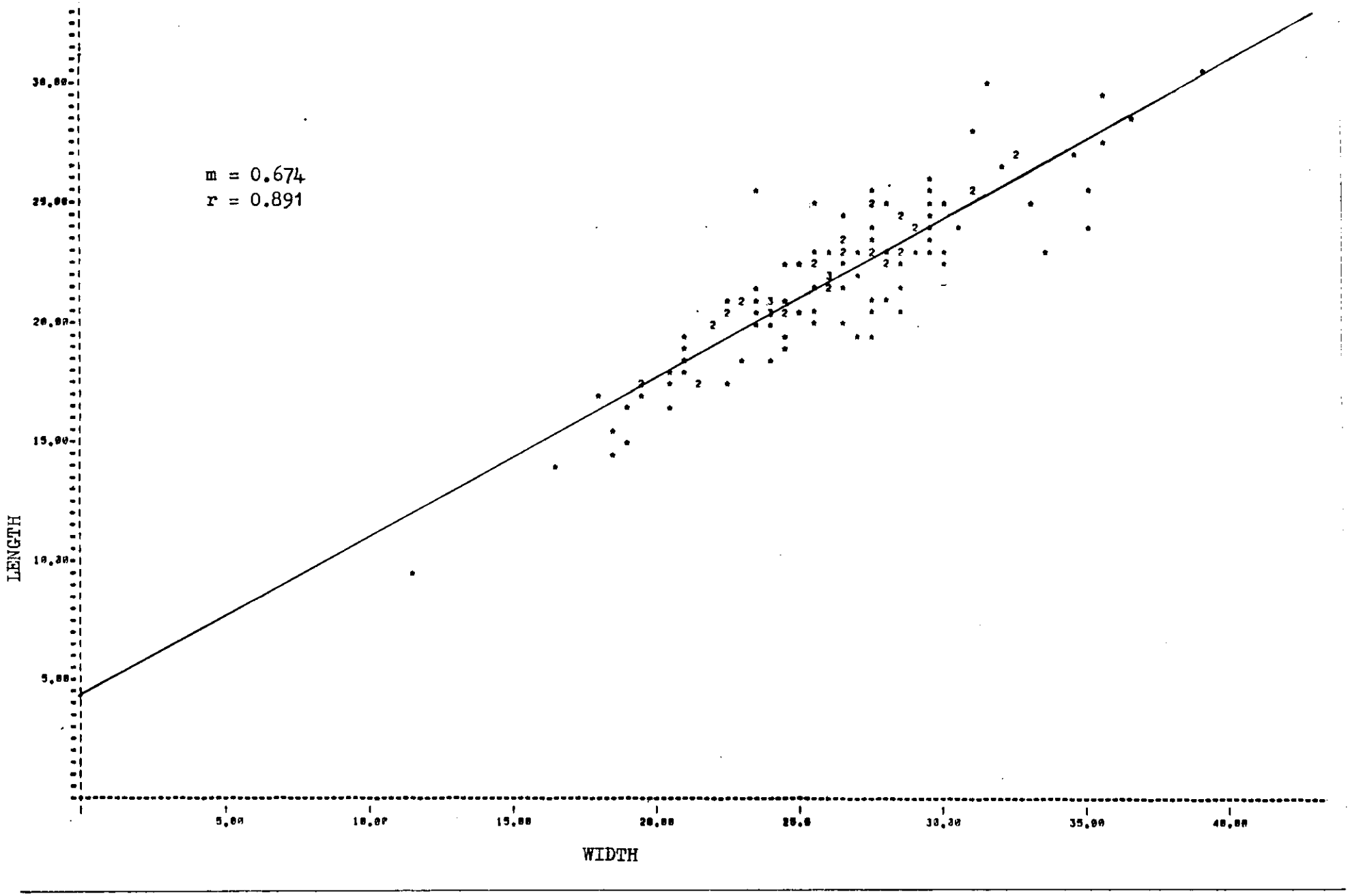
The numerals denote the number of specimens from each locality sampled.

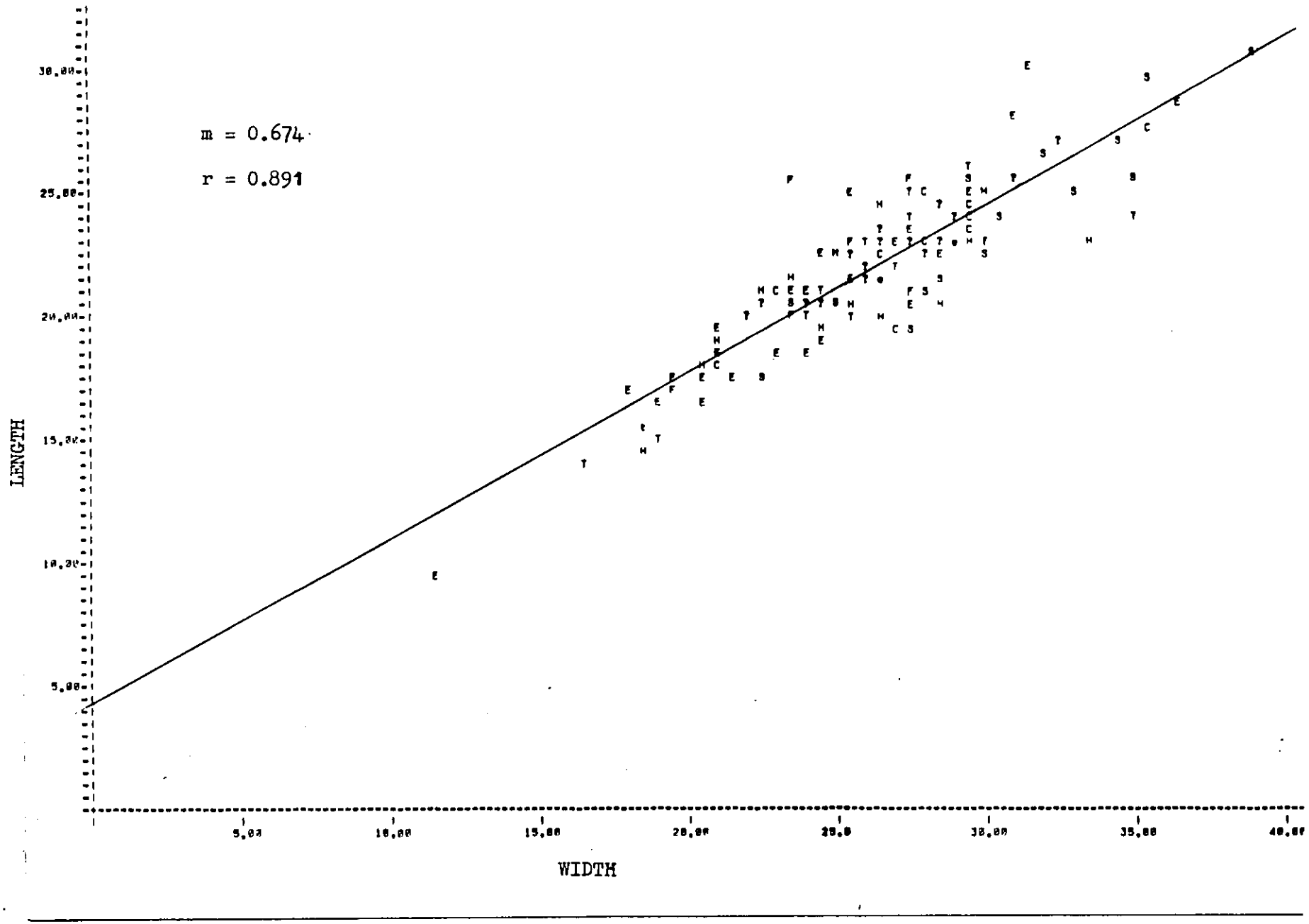
LENGTH X THICKNESS


Slope, $m = \frac{\sum_{i=1}^{n} x_i y_i}{\theta x^2} - \bar{x}\ \bar{y}$
Coefficient of correlation $r = \sqrt{\frac{m^2 \theta x^2}{\theta y^2}}$
m = 0.725
r = 0. 868
LENGTH
THICKNESS
5,00
10,00
15,00
20,00
25,00
30,00
35,00
40,00

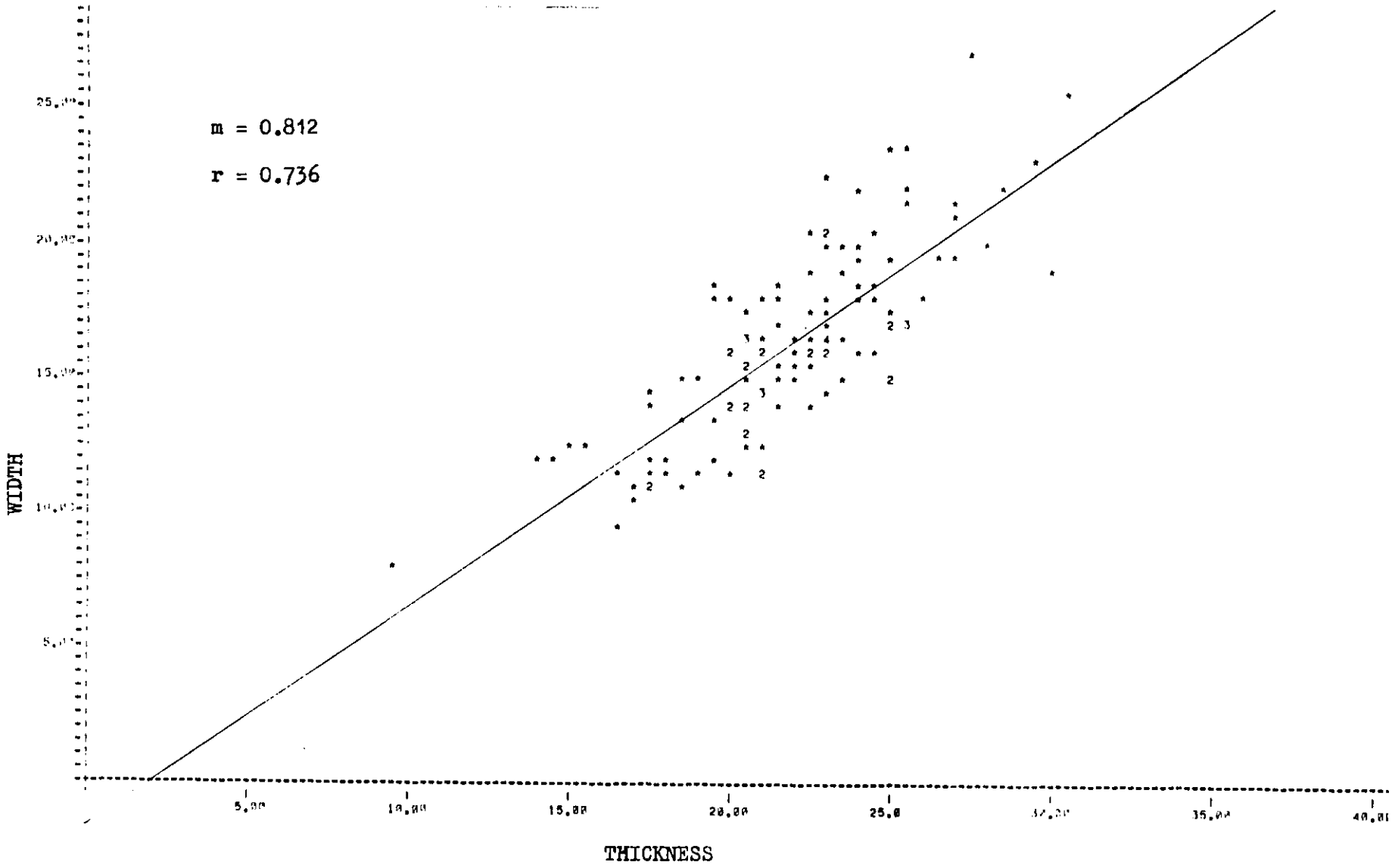

m = 0.725
r = 0.868
LENGTH
25,00
20,00
15,00
10,00
5,00
5,00
10,00
15,00
20,00
25,0
30,00
35,00
THICKNESS

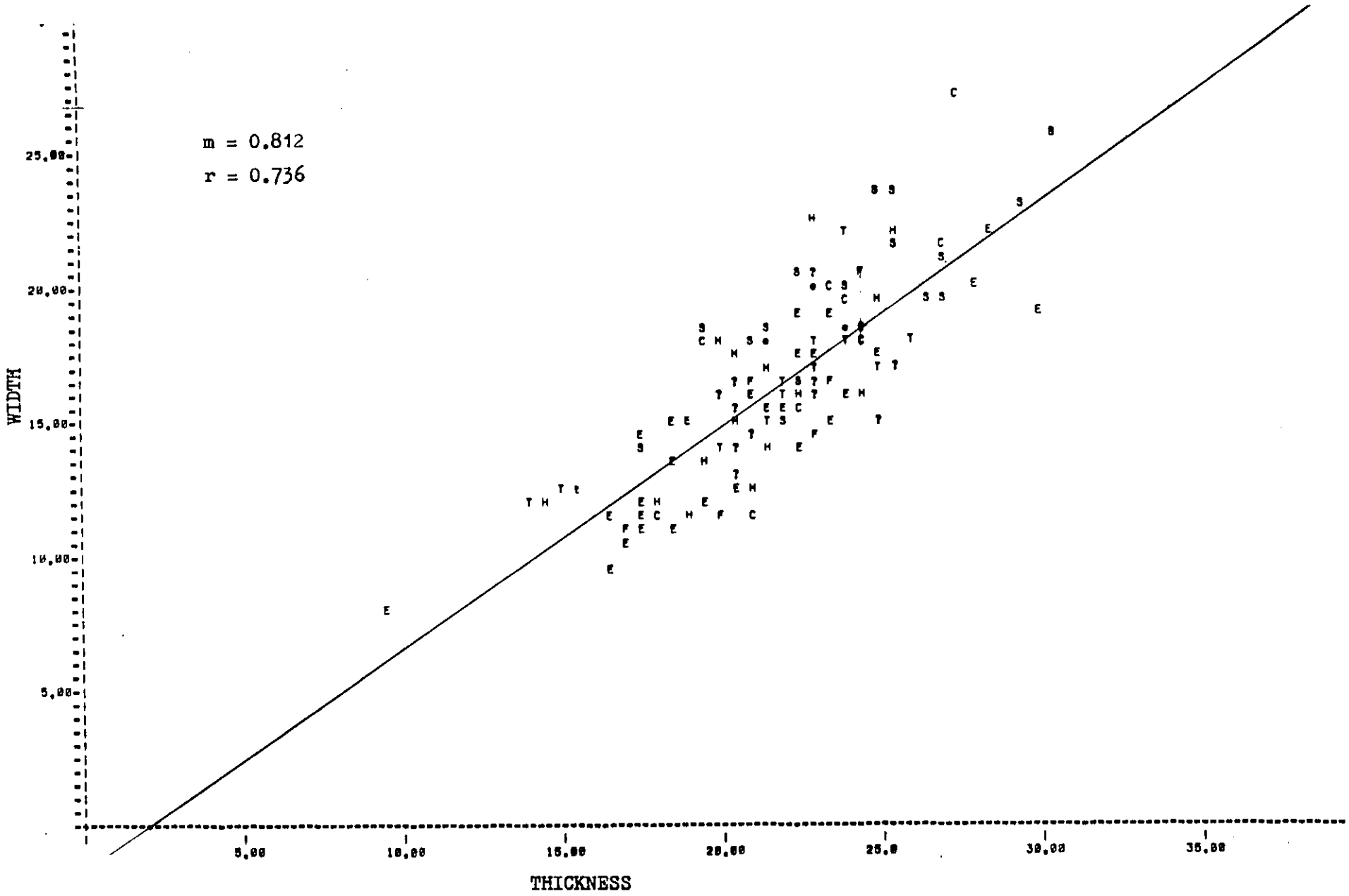
LENGTH X WIDTH


m = 0.674
r = 0.891
LENGTH
WIDTH


m = 0.674
r = 0.891
LENGTH
WIDTH
30.00
25.00
20.00
15.00
10.00
5.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00

WIDTH X THICKNESS


m = 0.812
r = 0.736
WIDTH
THICKNESS
5.00
10.00
15.00
20.00
25.0
35.00
40.00


m = 0.812
r = 0.736
WIDTH
25,00
20,00
15,00
10,00
5,00
5,00
10,00
15,00
20,00
25,0
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THICKNESS

Genus ORNATOTHYRIS Sahni, 1929

Type species. Terebratula sulcifera Morris

REMARKS. In his original description of the genus, Sahni (1929) gave the geological range as Cenomanian-Senonian. He distinguished two morphological groups within the nine species which he described, basing these distinctions on differences in rugose shell ornamentation. One group he termed as Totirugose included all the Cenomanian species which he said were completely rugose in both ventral and dorsal valves. In other words, the concentric growth-lines which start high in the umbonal region of each valve continue at more or less equal intervals towards the anterior margin.

His second group which included all the species from the Micraster coranguinum Zone of Greenhithe,Kent, were termed Partirugose, having rugose concentric ornament on only the anterior part of the shell.

All but one of the Totirugose species came from the Cambridge district. The sixth specimen was said to have come from an unknown locality but was described and figured with a specimen from Warminster, B.M. B49828, as a paratype. The genus has never since been recorded from this locality.

Although somewhat vague, the localities quoted by

Sahni from the Cambridge area are acceptable,but it is not known for certain from exactly what horizontal zone each of Sahni's holotypes originate. The Lower Chalk of the Cambridge district covers many of the zones within the Cenomanian, the lowest part being represented by the Cambridge Greensand, considered to be of N. carcitanense equivalent age, i.e. lowest Cenomanian (Carter & Hart 1977:75). The highest level ranges to the Plenus Marl.

It is likely that the type species O. sulcifera is a variable species and that the other taxa described by Sahni from the same area are merely variants within this species. The possible exceptions are O. pentagonalis and O. latissima which appear as consistant morphological forms within other assemblages. This is particularly so of O. pentagonalis which is found in the 'Paradoxica' Bed of the 'White Chalk' of Hunstanton Cliff, i.e. low in the succession. O. latissima, on the other hand, appears to be the dominant variant of an assemblage containingremanée Orbirhynchia multicostata and Monticlarella jefferiesi in pockets of green clay in the conglomeratic erosion surface below the Black Band at Elsham and Caistor in Lincolnshire and at Hillington and Heacham in Norfolk. This is high in the succession, taking it into the top part of Bed IX of Bower & Farmery (1910) in the Upper H. trecensis Zone.

Ornatothyris sulcifera (Morris)
Pl.13, figs.1-3, 7-9,10-12, Fig.26.

1847 Terebratula sulcifera Morris in Morris & Davidson:354, pl.18,fig.7

1855 Terebratula sulcifera Morris; Davidson: 64,pl.7, figs.17-20.

1929 Ornatothyris sulcifera (Morris); Sahni: 48, pl.7, figs.1-10, pl.10, figs.25-27.

HOLOTYPE. In the Davidson Collection, British Museum (Natural History) registered as B.M. 50822, from the Lower Chalk, near Cambridge.

REMARKS. Sahni figured four specimens,presumably from the same locality and horizon,to illustrate the species. I have selected a specimen said to have been collected from the subglobosus Zone of Cambridge by Mr.L.Barrett. The specimen is 36.2 mm long, 28.0 mm wide and 23.2 mm thick. It is part of the general collection in the B.M.(N.H.) and is registered as BB 6017 and figured here on Pl.13,fig.7-9.

The species appears to be confined to Eastern England and possibly some parts of southern France. The British forms are confined to thos e described by Sahni (1929). In Cassis, South France, a species which is probably synonymous with O. sulcifera occurs in the ironstained limestone deposits of that area. It is more circular in general outline with a large labiate foramen. The surface ornament is nevertheless the same as that found

on British Cenomanian species. A specimen collected from the Lower Cenomanian of Cassis, Southern France is figured here as Pl.13, fig.1-3. It is now part of the general collection in the British Museum (Nat. Hist.) registered as B.M. BB 82174. It is 30.4 mm long, 26.7 mm wide and 18.9 mm thick. It is a broader, more circular form in ventral outline than the type specimen and has more numerous concentric growth-lines which are more evenly spaced. The umbo is more massive than O. sulcifera or any other species within the genus. The circular foramen is perhaps slightly proportionately larger with a marked pedicle collar.

A British specimen collected by Mr.C.J.Wood, of the Institute of Geological Sciences,from the upper 1/3rd. of the subglobosus Zone of Grove Mill Pit, Cadge Lane, Hitchin, Hertfordshire, is similar in outline to the form from Cassis in ventral outline, convexity and type of concentric ornament. It differs from the French species in having a less massive umbo which is truncated bu a large circular umbo. The dimensions of this specimen are: length 25.0, width 22.3 and thickness 15.7mm.

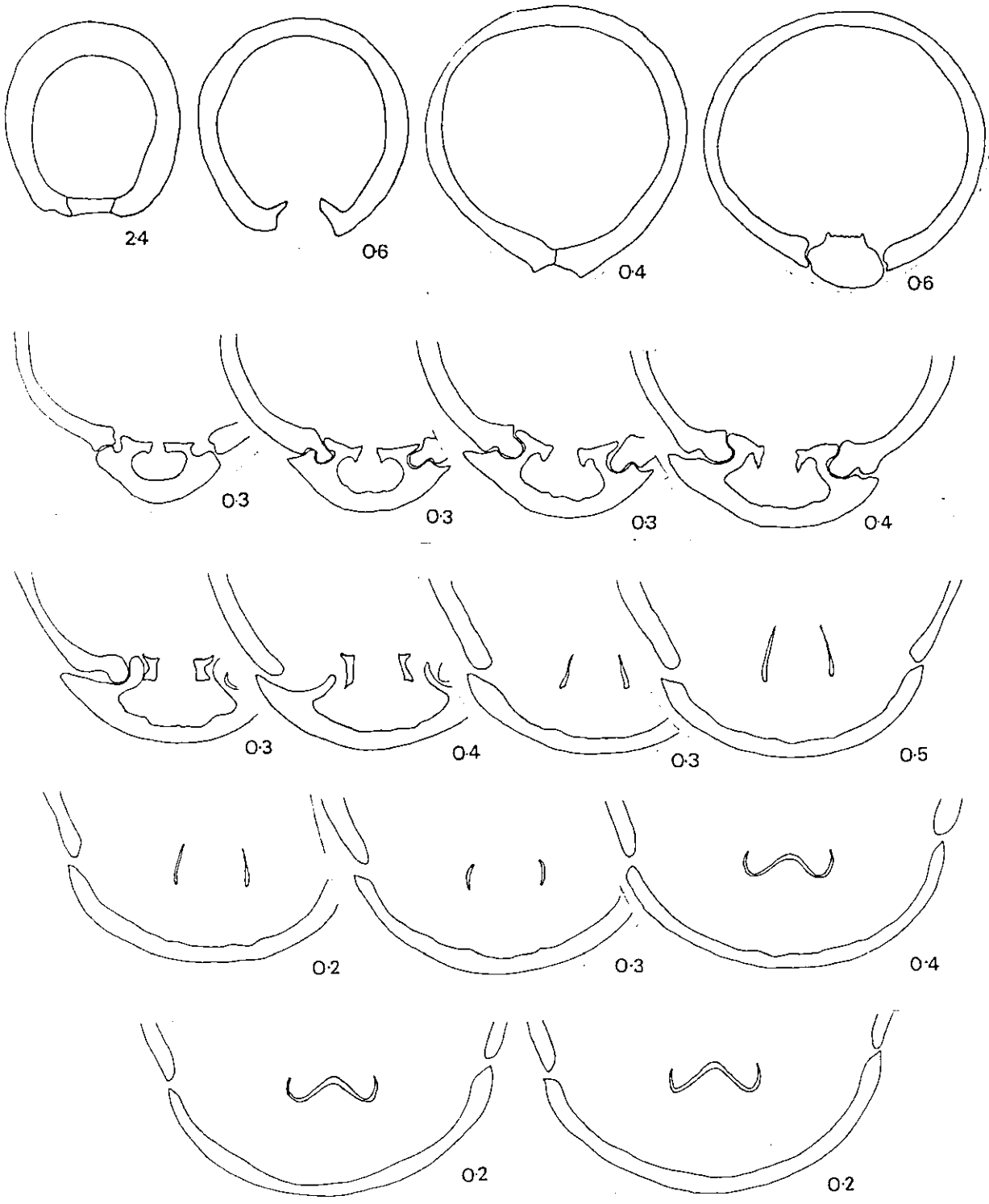
Internal Characters. A series of seventeen transverse sections through a duplicate speciemen from the Lower Chalk of Fulbourne, Cambridge is shown here, Fig. 26.

It shows a well developed pedicle collar guarding a large foramen in the ventral umbo. A low flat cardinal process is not further developed. Short, thickened horizontal hinge plates flatten proximally and curve gently towards the floor of the dorsal valve, developing short pendant plates which thicken anteriorly, giving way to long, slender, inwardly curving crural processes. The comparatively short brachial loop widens very slightly terminating in a broad, high-arched transverse band.

The hinge-plates develop fairly extensive inner and outer socket-ridges. The hinge-teeth fit into shallow, rounded sockets and become more massive.

Ornatothyris differs from Concinnithyris in external morphology by having a highly developed ornament of rugose concentric growth-lines. It differs in the internal characters in its less developed cardinal process, shorter and thicker hinge-plates, dorsally pendant and shorter brachial loop. It differs in this way from Moutonithyris but an obtuse species described as Terebratula obtusa by J.de C.Sowerby (1825) from the Cambridge Greensand and recorded by authors as Ornatothyris obtusa is here referred to the genus Moutonithyris.

FIG. 26. Seventeen transverse serial sections through a specimen of Ornatothyris sulcifera (Morris) from the Lower Chalk, Fulbourne, Cambridge.


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0·2

Family PYGOPIDAE Muir-Wood, 1965

Subfamily PLATYTHYRIDINAE Dieni & Middlemiss,1975

Genus PLATYTHYRIS Middlemiss 1959

Platythyris squamosa (Mantell)

Pl.25,figs.1-4, Pl.26, figs.1-4, Pl.28, figs. 14-16.

1822 Terebratula squamosa Mantell: 132.

1847 Terebratula squamosa Mantell; Davidson & Morris: 254, pl.fig.8, 8a, 8b.

1847 Terebratula disparilis d'Orbigny: pl.512,figs.14-16.

1852 Terebratula squamosa Mantell; Davidson: 50, pl.5, figs.5.5a, 6 & 11.

1874 Terebratula squamosa Mantell; Davidson: 33, pl.2, fig.5.

1978 Platythyris squamosa (Mantell); Middlemiss: 39, figs.11,12,16 (9).

HOLOTYPE. In the collections of the British Museum (Natural History) B.M. No. B 8292, Mantell Collection, from the Chalk Marl of Hamsey, near Lewes, Sussex. Middlemiss (1978) dealt with this species in his paper on the genus Platythyris and, consequently, no further description is necessary here.

REMARKS. There has been some confusion over this species and Arcuatothyris arcuata (Roemer) since both occur in the more highly calcareous beds in the southwestern provinces particularly in the phosphatic Basement Beds of Dorset, Wiltshire and beds of the B group on the coast of South Devon. This confusion is

made worse by the fact that the two forms also occur with a third species, regarded here as a distinct species, which is also somewhat homoeomorphic. This is the species described by Middlemiss (1978) as Platythyris squamosa disparilis (d'Orbigny) who considered this form to be a subspecies of Mantell's T. squamosa. It is also the species described by d'Orbigny as Terebratula disparilis (d'Orbigny,1847: pl.512,figs.16-18) as part of a series illustrating that species. Platythyris squamosa can be distinguished from Platythyris disparilis by its flatter valves, wider hinge-line and less massive umbo which is truncated by a large circular foramen. The ventral outline of this species is oval, with many individuals showing a more constricted anterior,allowing a tapering of that portion of the valves. Both species have a marked ornament of concentric growth-lines which are evenly spaced and show an unusual leading edge. This phenomenon is illustrated here, Pls.25 & 26, figs.1-4, and shows the cuspidation of the spaces between the longitudinal striae or capillae characteristic of the species. In the large species P. disparilis, this ornament tends to become more zig-zag towards the margins of the shell.

In this way, P. squamosa can be distinguished from Arcuatothyris arcuata , which it somewhat resembles in ventral outline. It can also be distinguished from this species by its lack of anterior sulcation of the brachial valve.

Family ? BOREIOTHYRIDAE Dagys, 1968

Genus ARCUATOTHYRIS Popiel-Barczyk, 1972

Arcuatothyris arcuata (Roemer)
Pl.24, figs.1-4.

1841 *Terebratula arcuata* Roemer: 44, pl.8, figs.18a-c.

1841 *Terebratula arcuata* Roemer; Schloenbach: 451,pl.21, fig.12.

1847 *Terebratula rugulosa* Morris: 153, pl.18, figs.5a-c.

1847 *Terebratula disparilis* d'Orbigny; 100, pl.512, figs. 12 & 13, *non* 16,17.

1857 *Terebratula rugulosa* Morris; Davidson: 49, pl.4, figs.14,14a.

1878 *Terebratula arcuata* Roemer; Deike: 15, figs.6a-d.

1969 *Terebratella arcuata* Roemer; Panow: 594,pl.110, fig.8,9.

1970 *Terebratula rugulosa* Morris; Kennedy

1974 *Arquatothyris arcuata* (Roemer);Katz: 268, pl.87, figs.18a-d, 20a-c.

1978 *Terebratula rugulosa* Morris; Owen

1978 *Terebratula rugulosa* Morris; Middlemiss, fig.16,3a-d.

HOLOTYPE. Although Roemer's original type specimen is missing with the rest of the Roemer figured specimens, it does seem likely from the drawing (Roemer 1841,pl.8,figs.18a-c) that the species indicated is a senior synonym of Morris's *T. rugulosa*. The absence of a holotype makes the question of a neotype desirable. This should be considered in the near future and should, if possible, come from the conglomeratic horizon known as the Essen Greensand.

The species is known in Britain from the description of the junior synonym Terebratula rugulosa Morris from the Glauconitic Marl of Chardstock, Devon. The holotype of that species was by Morris (1847) and the specimen is part of the Davidson Collection, British Museum (Natural History) B.M. B 6130. This specimen was also figured by Davidson (1852: pl.4, fig.14) and Middlemiss (1978,fig.15/2).

The species can be distinguished from Platythyris squamosa(Mantell) by its different ventral outline which is more rectangular than P. squamosa,with steeper flanks and a small depression or shallow sulcus anteriorly placed on the brachial valve. It differs from Ovatatathyris ovata in its general outline and lack of ventral carina poorly defined beak-ridges, smaller foramen and less marked brachial sulcus. It differs from both the named species in its characteristic shell ornament of spinules which are arranged indiscriminately over the surface of the valves. These are seen here in the electromicrographs, Pl.24, figs.1-4, showing the area between each growth-mark devoid of spinules. This area is thought to have been developed at a time of accelerated growth at the mantle edge of the specimen which did not allow the development of spinules. Small spinulation can just be seen on the surface of this intermediate area of growth. This ornament differs from that of Ovatathyris in its distribution over the surface of the shell. In A. arcuata the spinules are

seen on most surfaces of the shell and appear to be less organized or less discriminate in their distribution.

This species occurs with Platythyris squamosa and P. disparilis in the phosphatic chalky conglomerates of the Basement Beds of the Lower Chalk at Evershott, Eggardon Hill,Toller Porcorum,Toller Fratrum and Beaminster in Dorset and at Bovey Lane, Wilmington Sandpit and from the coastal sections at Humble Point and the Pinnacles where it occurs in Beds B and C of the Cenomanian.

MATERIAL.

Numerous specimens have been collected from the above localities and are in the Kennedy Collection at the British Museum (Natural History), in addition to which are the following. BB 76507 from the Glauconitic Marl, Chardstock, Devon, BB 82221-25 from the Lower Chalk Basement Bed, Snowdon Hill, Chard, Somerset, BB 82361 Horn Hill Qy., Beaminster, BB 82362-65, White Hart Pit, Wilminton, BB 82260 Hutchin's Pit, Wilmington, and B 6131 from the Craie de Rouen, Côte St.Catharine, Rouen, France.

Family TEREBRATELLIDAE King, 1850
Subfamily TRIGONOSEMINAE Elliott, 1965
Genus DERETA Elliott, 1959

Type species Terebratella pectita (J.Sowerby 1816)

Dereta pectita (J.Sowerby)
Pl.17,figs.10-15.

1816 Terebratula pectita J.Sowerby: 83, pl.138,fig.1
1819 Terebratula pectita Sow.; Lamarck:255
1822 Terebratella pectita (Sow.); Brongniart & Cuvier : pl.9,fig.3
1838 Terebratula pectita Sow.; von Buch : 168, pl.16,fig.12
1847 Terebratella pectita (Sow.); d'Orbigny : 120; pl.517, figs.16-20.
1852 Terebratella pectita (Sow.); Davidson : 26, pl.3, figs.29-33
1871 Terebratula pectita Sow.; Quenstedt : 267, pl.44, figs.104-5
1959 Dereta pectita (J.Sowerby); Elliott : 147.
1965 Dereta pectita (J.Sowerby); Elliott : H853,fig.736, 2a-c.
1977 Dereta pectita (J.Sowerby); Owen : 246, pl.1, figs. 8a-c

HOLOTYPE. The specimen from the Upper Greensand of Horningsham, Wiltshire in the Sowerby Collection, British Museum (Natural History), B.M. B 61622, figured by J.Sowerby (1816: pl.138,fig.1)

Dimensions of holotype. Length 19.9 mm, width 20.0 mm and thickness 14.0 mm

REMARKS. This species was reviewed, described and figured with additional data from transverse serial

sections by Owen (1977). In that description (: 248) mention was made of a variant from the Upper Albian, dispar Zone of Punfield Cove near Swanage, Dorset. This variant is further discussed and described here as Dereta pectita ballardensis subsp. nov.

Dereta pectita (J.Sowerby) can be distinguished from the subspecies D. pectita ballardensis subsp. nov. by its evenly subcircular ventral profile, equal biconvexity of valves, marked but regularly spaced growth-lines and comparatively fine costation. It has a more clearly defined triangular interarea and a slightly more extensive hinge-line.

Dereta pectita ballardensis subsp. nov.
Pl.17, figs. 16-18

DESCRIPTION. Subquadrate in ventral profile, this species is distinguised by its coarse costae and very prominent concentric growth-lines. The umbo is massive and the beak erect to slightly incurved. The symphyitium is not exposed. The beak-ridges are obscured by the heavy ornament. The interarea is short and poorly defined. The anterior commissure is rectimarginate to incipiently ligate, a faint sulcus in the ventral valve being opposed by a similarly faint sulcus in the anterior part of the dorsal valve.

HOLOTYPE. The specimen figured here ,Pl.17, figs.16-18.,

in the British Museum (Natural History) B.M. BB 82098, from the Upper Albian, dispar Zone of Ballard Point, near Punfield Cove, Swanage Bay, Dorset.

MATERIAL. Specimens in the British Museum (Natural History) from the Lower Cenomanian, Melcombe Bingham, B.M. B 25288, from Horningsham, B.M. B 61622, B 61623 and from the Warminster district B.M. BB 4199, B 25264. From the Upper Albian of Punfield Cove, Dorset, B.M. BB 82099-105 (George Bate Coll.)

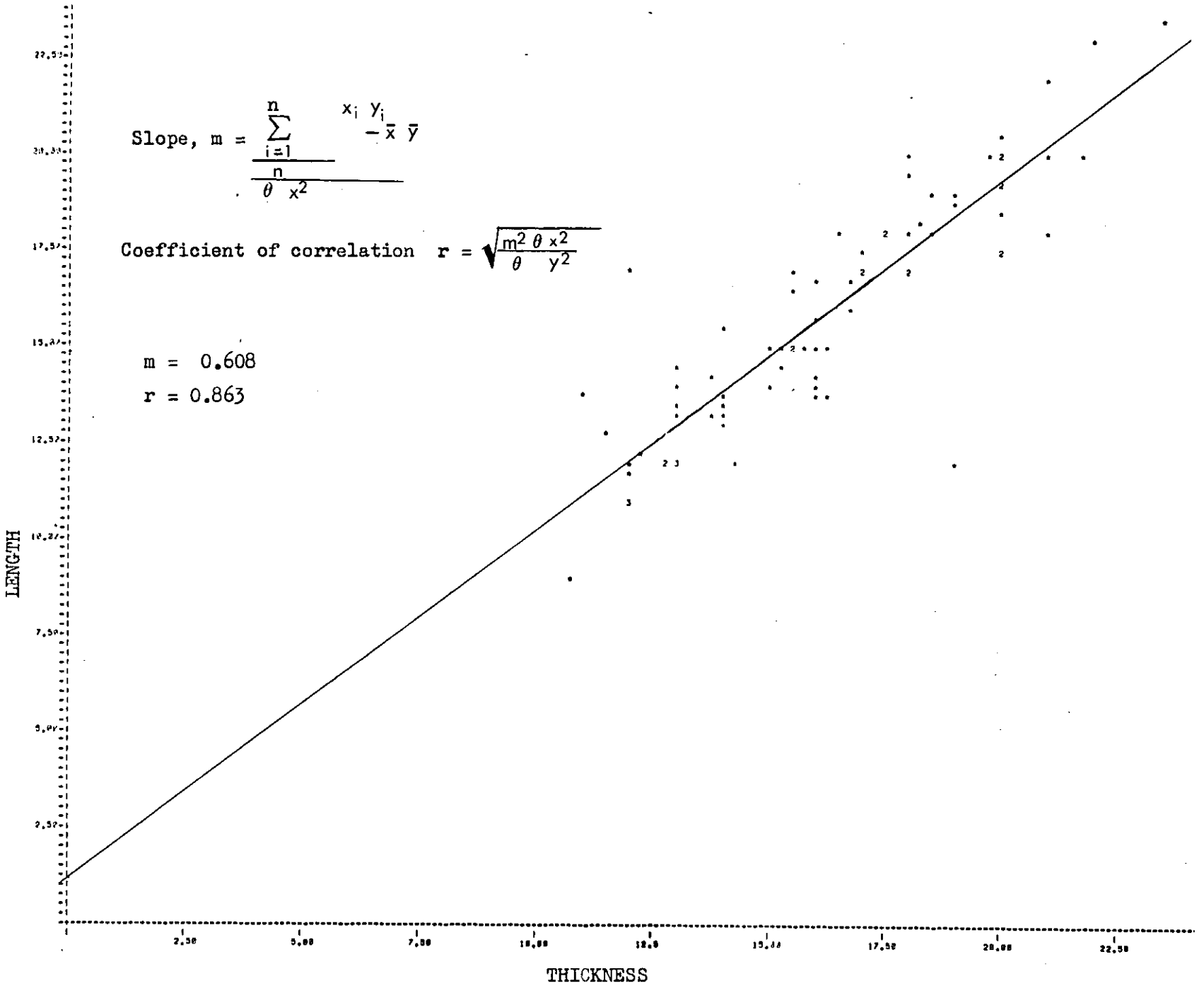
Specimens in the Sedgwick Museum, Cambridge from Punfield Cove, S.M. B 7304 and from Dunscombe, Devon, S.M. B 7291-93, from Pinhay Cliff, B 7502-8.

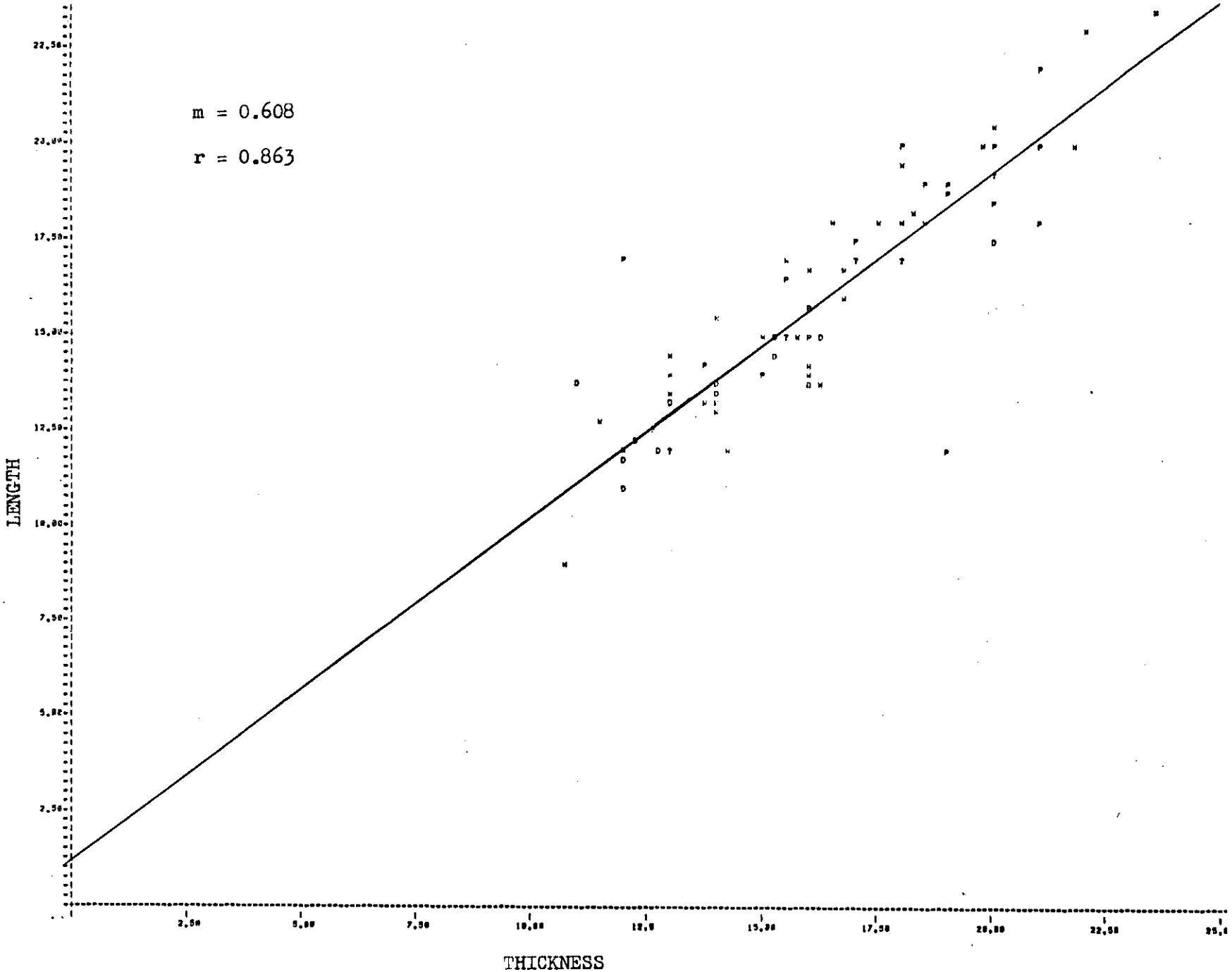
FIG. 27. Diagram illustrating length x thickness, length x width and width x thickness ratios within a random sample of Dereta pectita (J.Sowerby)

Locality key. W = Warminster, Wiltshire
D = Wilmington, Devon
P = France

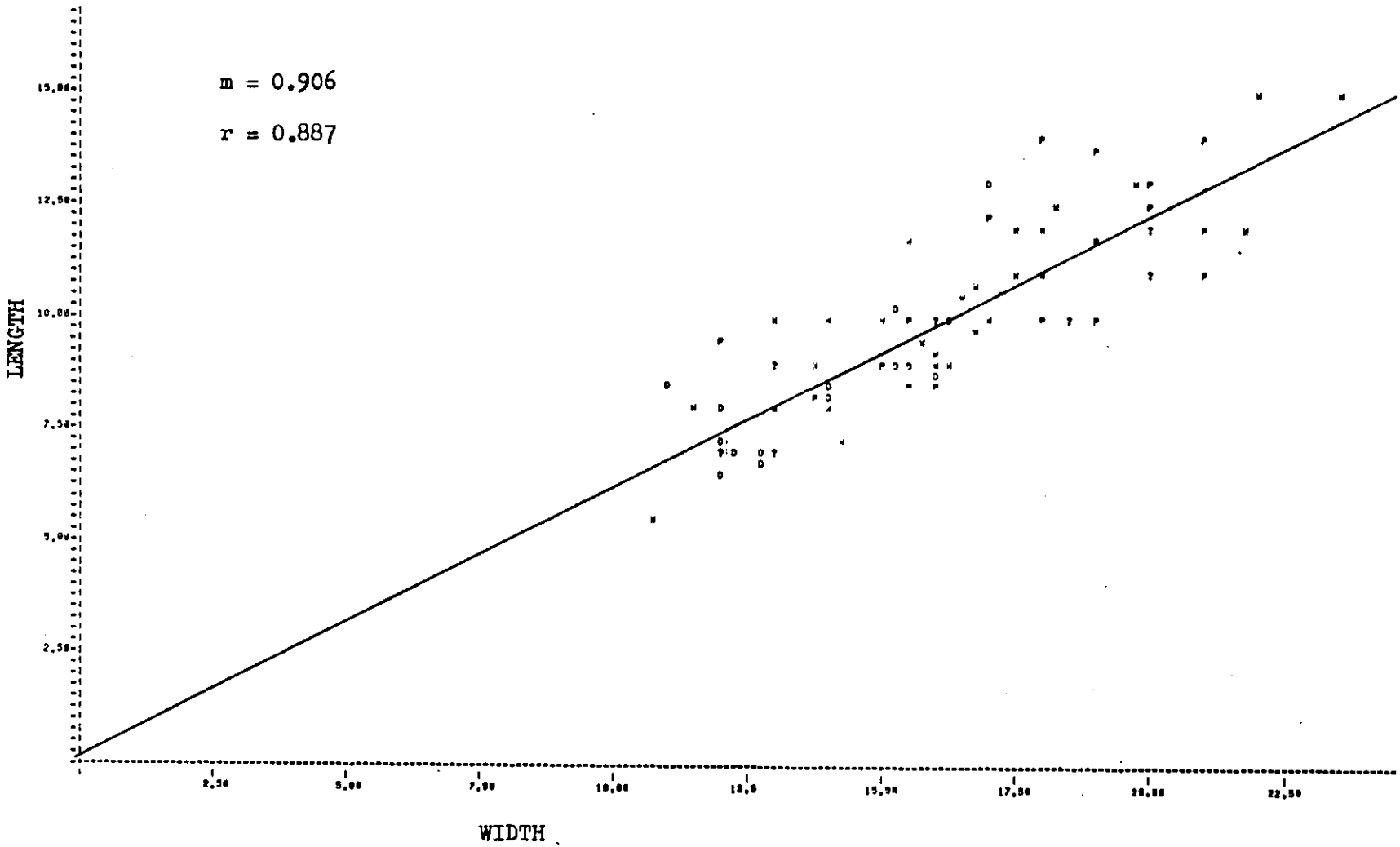
The numerals denote the number of specimens from each locality sampled.

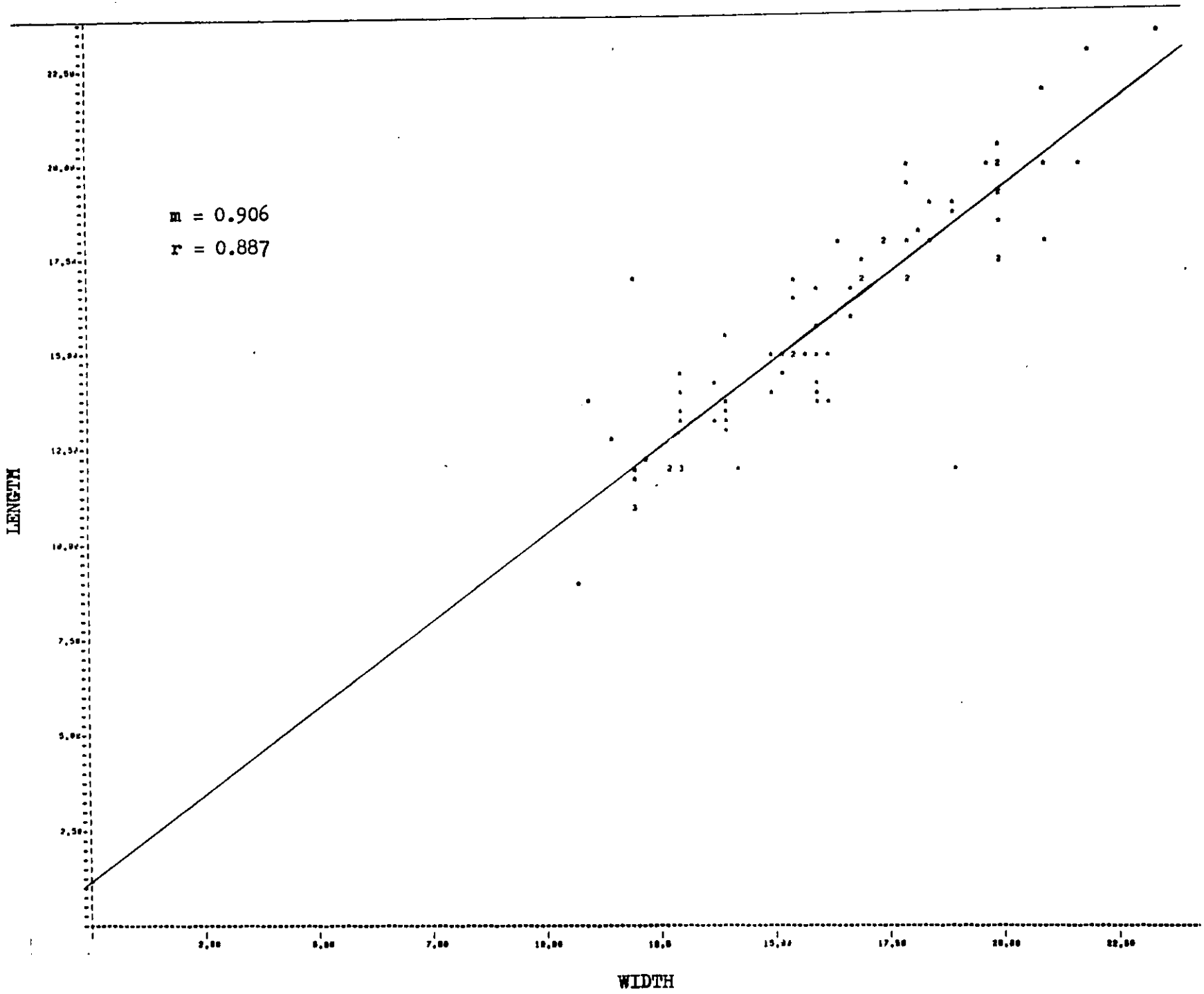
LENGTH X THICKNESS


Slope, $m = \frac{\sum_{i=1}^{n} x_i y_i - \bar{x}\,\bar{y}}{\theta\, x^2}$
Coefficient of correlation $r = \sqrt{\frac{m^2\, \theta\, x^2}{\theta\, y^2}}$
m = 0.608
r = 0.863
LENGTH
THICKNESS

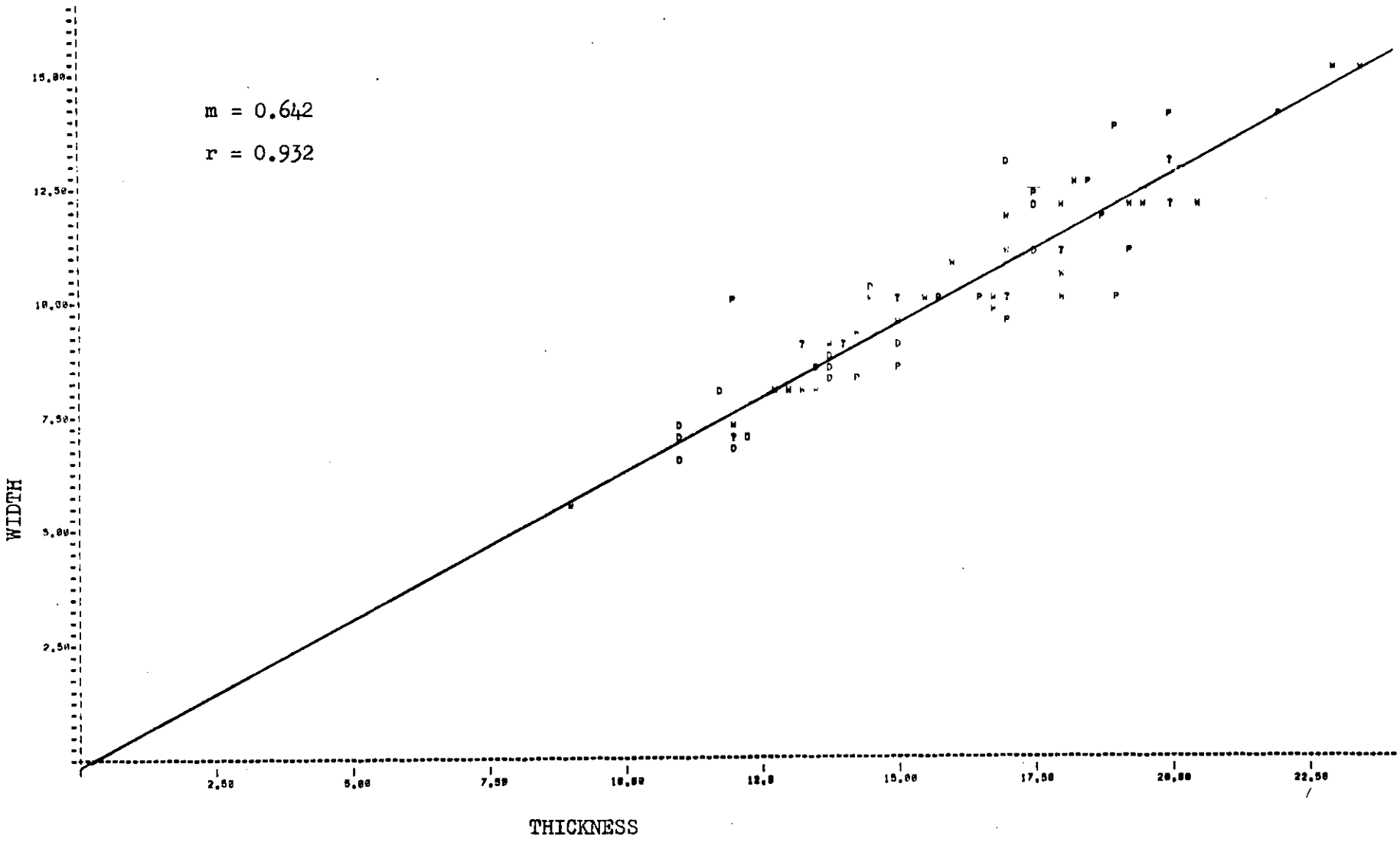

m = 0.608
r = 0.863
LENGTH
THICKNESS

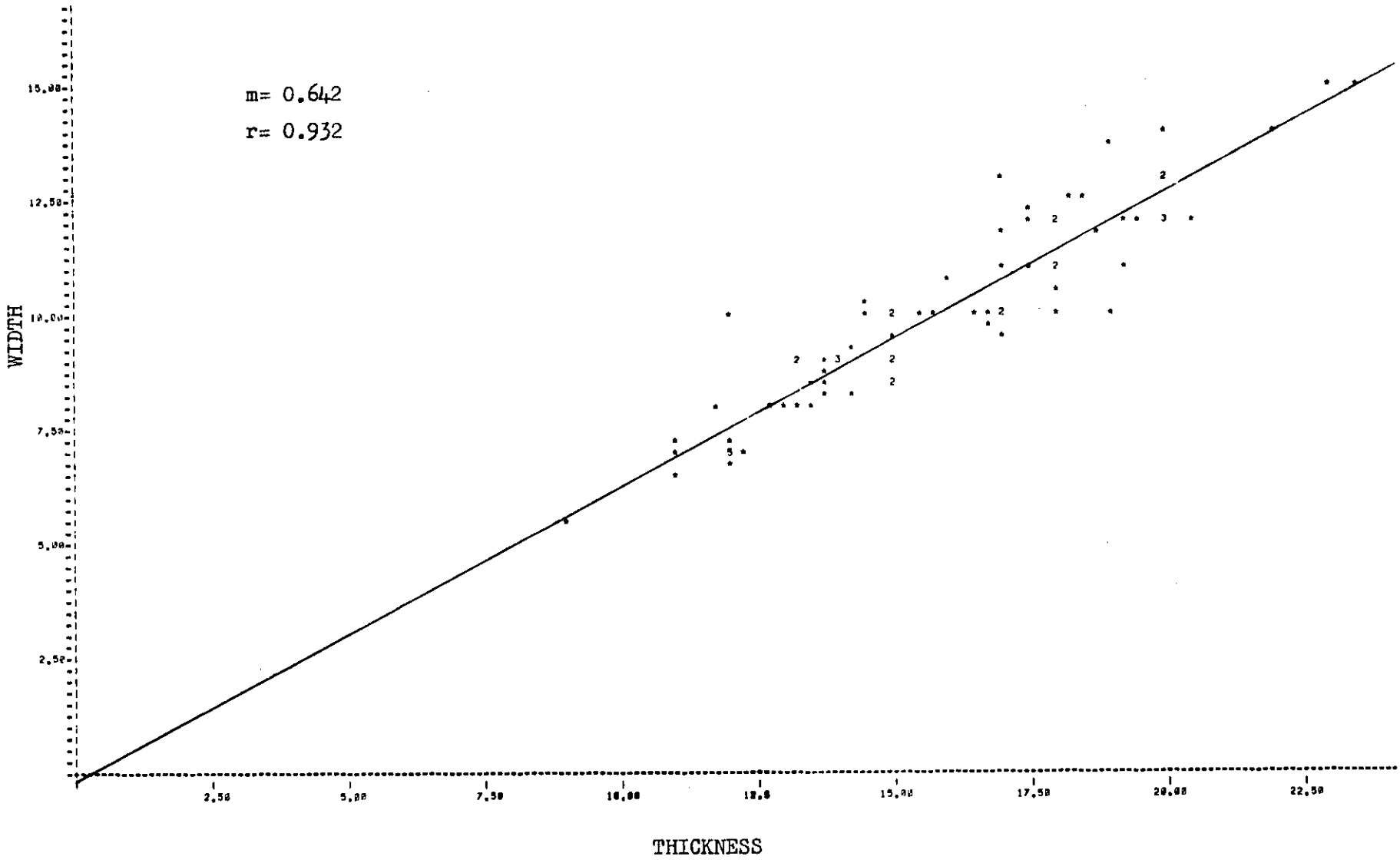
LENGTH X WIDTH


m = 0.906
r = 0.887
LENGTH
WIDTH


m = 0.906
r = 0.887
LENGTH
WIDTH

WIDTH X THICKNESS


m = 0.642
r = 0.932
WIDTH
THICKNESS


m= 0.642
r= 0.932
WIDTH
THICKNESS
2,50
5,00
7,50
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Dereta incerta (Davidson)
Pl.17, figs. 25-27.

1852 Trigonosemus incerta Davidson: 31, pl.4,fig.5,a-c.
1871 Terebratella incerta (Davidson); Quenstedt: 268, pl.44, fig.106.

EMENDED DESCRIPTION. Neat looking Dereta. Average dimensions; length 8.4 mm, width 8.0 mm. and 5.4 mm thick . Hinge-line straight, slightly extended. Interarea broad, triangular,symphytium well exposed. Foramen circular, comparatively large. 28 to 30 rounded costae with intercalations and marginal bifurcation. One to two well marked concentric growth-lines.

HOLOTYPE. In the Davidson Collection, British Museum (Natural History), B.M. BB 82145, from the Glauconitic Marl, Chardstock, Devon.

REMARKS. The only records are those of Davidson (1852) and Quenstedt (1871) but specimens have been found in Sussex by C.T.Gaster and in Dorset by W.J.Kennedy. Wiest recorded this species from Bed B. Devon, but this record was considered to be very doubtful in view of the lack of specimens. However, three specimens were collected from Bed B, White Cliff, Devon, and two from the same horizon at Little Beach, Beer Head,Devon by T.Grimsdale, B.53190, B.53191, B.53192 respectively. These specimens appear to be somewhat broader than the type specimen and may well be dwarf forms of D. pectita.

A specimen which is slightly larger than the type specimen with coarser costae was also collected from Downlands Beach, Devon by C.W. & E.V.Wright, B.M. BB 59325. A similar specimen was collected by the same collectors from the Glauconitic Marl of Compton Bay, Isle of Wight, B.M. BB 59317.

In the Meyer Collection in the Sedgwick Museum, Cambridge are five specimens , two from Dunscombe were collected from Meyer's Beds 10 - 12 S.M. B 7308, 7309 and three specimens from Bed 13 from White Nothe, Dorset, B 20677-9.

The species is assigned here to the genus Dereta entirely on consideration of its external morphology as nothing is known about the internal structures. Some of the specimens recorded here as belonging to this species may have to be revised at some future date and may well find themselves assigned to another taxon.

It appears that Dereta incerta preferred a different environment to that of D. pectita and records show that most of the identifiable specimens have been collected from a more highly calcareous or chalky lithology. This may account for the less restricted distribution as compared to that of D. pectita.

Genus ARENACIARCULA Elliott, 1959

Arenaciarcula beaumonti (d'Archiac)

Pl.17, figs.28-30

1847 Terebratula Beaumonti d'Archiac: 331; pl.21, figs. 12-14.

1867 Terebratula (?) Beaumonti d'Archiac; Schloenbach: 461, pl.22, figs.3-5.

1869 Trigonosemus kiprijanovi Hofman: 25, pl.5,figs.18-21.

1871 Terebratula orbicularis Sow.,Quenstedt: 293; pl.45, figs.63-69.

1874 Terebratella Beaumonti (d'Archiac); Zareczny: 177, pl.2, fig.3.

1916 Terebratella Beaumonti (d'Archiac); Ravn: 22; pl.4, fig.8.

1969 Terebratella beaumonti (d'Archiac); Panow: 593; pl.112, fig.5.

1972 Oblongarcula beaumonti (d'Archiac); Popiel-Barczyk: 127, pl.1, figs.1-5, pl.4, fig.3.

1977 Arenaciarcula beaumonti (d'Archiac); Owen: 236, pl.2, figs.7a-c.

This species was reviewed recently (Owen,1977) and the geographical distribution was given as Britain, Tournai,Belgium, Poland, Germany, Denmark and the U.S.S.R. To this list can now be added a further locality, that of southern France.The specimen figured here, Pl.17, figs.7-9, is considered to be a variant of the species. It is larger than the any of the specimens collected from Belgium or Britain but closely resembles the specimen figured by Panow (1969) from the Krakow district of Poland. It is part of a collection of Cenomanian brachiopods from the Nice district.

Family CANCELLOTHYRIDIDAE Thomson, 1926

Subfamily CANCELLOTHYRIDINAE Thomson, 1926

Genus TEREBRATULINA d'Orbigny, 1847

Terebratulina etheridgei nom. nov.
Pl.5, fig.17, Pl.27,fig.5,6.

nom. nov. pro Terebratulina triangularis Etheridge,1881 : 148, pl.13, fig.15; non Terebratulina triangularis Tate, 1880 : 160, pl.8, fig.7.

REMARKS. It is a pity that the original name given to this species is no longer valid since it has become entrenched in literature as typifying the Cambridge Greensand in the Cambridge area and in other districts. The species Terebratulina triangularis , however, had already been described by R.Tate from the Lower Tertiary of South Australia by the time Etheridge's description appeared in the Memoir of the Geological Survey for 1880.

The species can be distinguished from other Terebratulina species by its consistently triangular ventral profile. This is due very largely to the slightly more extended hinge-line which adds greatly to the posterior width of the shell and increases the interarea. It can be further distinguished from T.imbricata sp. nov. in having few concentric growth lines, in fact very often only one in noted in the anterior half of the shell. The radiating costae, while exhibiting the same degree of bifurcation and intercalation

as seen in the other two species described here as T. imbricata sp. nov. and T. nodulosa, appear flatter or more rounded than in the species mentioned above.

HOLOTYPE. Etheridge selected a specimen from the Jukes-Browne Collection to illustrate his species from the Cambridge Greensand. The specimen is in the collections of the IGS no. 3156.

MATERIAL. Numerous specimens from the J.F.Walker Collection and many other sources in the British Museum (Natural History), Institute of Geological Sciences and the Sedgwick Museum, Cambridge.

Terebratulina nodulosa Etheridge
Pl.5, fig.16, Pl.27, figs.1-4

1881 Terebratulina nodulosa Etheridge: 148, fig.13
1903 Terebratulina nodulosa Etheridge: Jukes-Browne & Hill: 204, 215, 224.

EMENDED DESCRIPTION. Circular to oval in ventral profile with strong radiating costae averaging 14-18 and with nodular constitution. Short umbo truncated by large circular foramen. Average size about 9.5 mm in length, 8.6 mm wide and 2.4 mm thick.

NEOTYPE. From the Totternhoe Stone, Burwell Rock, Burwell, Cambridgeshire in the IGS collection No.117521 and figured here Pl. 27, figs.2-4.

REMARKS. Etheridge (1881) described two species of

Terebratulina from the Cambridge area. One of these, T. triangularis (now T.etheridgei) has already been discussed here. The other species, T. nodulosa was described from the Totternhoe Stone of Cherry Hinton. Unfortunately, due to some curatorial error, the type specimen which should have been represented in the illustration by Etheridge (fig.13) was lost. The specimen subsequently thought to have been the holotype was found to be a specimen of T. triangularis from the Cambridge Greensand. Thus, a neotype was selected from a reliable collection and is figured here.

The ornament of nodular costae which distinguishes T. nodulosa from T. triangularis and T.imbricata has been noted on specimens of Terebratulina collected from the Upper Albian at Hunstanton and from the Lower Chalk, of Folkestone and Dover. Eight specimens from the Lower Chalk, Bed V, of Lydden Spout, Folkestone, B.M. B 25004, are in the British Museum (Natural History). A specimen in the collections of the IGS no. Hr.9030 has been collected from the top of the O.mantelliana Band of Kennedy = Tottenhoe Stone Horizon, from the Dover Pier borehole, at a depth of 202 ft.

In addition to the above records of occurrence, Terebratulina nodulosa appears in the faunal list given by Jukes-Browne & Hill (1903:40) from Bed 4 (Bed V of Price) in the Lower Chalk at Folkestone.

Terebratulina imbricata sp. nov.
Pl.22, figs. 1-4

Terebratulina ornata (Roemer); auctt.
Terebratulina nodulosa Etheridge; auctt.

DIAGNOSIS. Oval to subcircular in ventral profile. Umbo short, foramen small, circular. Ornament of 12 - 14 coarse bifurcating costae. Concentric growth lines imbricate. Average length 6.7 mm, width 5.8 mm, thickness 2.2 mm. Rectimarginate.

DESCRIPTION. This small Terebratulina is characterized by its ornament of well marked radiating costae which are given to frequent marginal bifurcation and intercalation. The concentric growth-lines which cross the main costae are lamellose and produce a surface ornament of overlapping plates which are said to be imbricate. Additional ornament is seen as faint papillae which are rounded and smooth and lie between the main costae and on the slopes of the intercostal surfaces, Pl. 22, figs.2-4. In common with many species of Terebratulina, the costae are also seen to have a degree of nodulose development. This is particularly apparent in the early stages of growth and remains evident at and around the umbonal regions. No folding or sulcation of the valves occurs at any stage of growth, the anterior commissure remaining rectimarginate.

HOLOTYPE. A specimen in the collection of C.W. & E.V. Wright from the Lower Pink Band (Bower & Farmery Bed V

equivalent), Lower Chalk, Rifle Butts Pit, Market Weighton, Yorkshire, in the British Museum (Natural History) B.M. BB 82196.

PARATYPES. Three other specimens from the same collection, B.M. BB 82197-9 and five specimens from the same horizon at Clapham's Limeworks, near Louth, Lincolnshire in the collections of the IGS Nos. 99058-62.

Specimens have also been collected by Mr K.Evans from the Lower Pink Band at Hubbard's Vale, near Louth.

REMARKS. As Bower & Farmery's collection was destroyed by enemy action during World War II, it is not certain as to whether or not this was the species to which they were referring when they indicated (Bower & Farmery 1910) the abundance of "Terebratulina ornata" in the Lower Pink Band. This situation is not improved by the fact that specimens identified as Terebratulina nodulosa originally described by Etheridge (1881) from the Totternhoe Stone of Cherry Hinton and Burwell, Cambridge, have been collected from beds above the Totternhoe Stone. Jukes-Browne & Hill(1903: 224) record this species from the Totternhoe Stone and beds above this horizon from Lincolnshire. As T. nodulosa is the species which seems most likely to have been the one referred by Bower & Farmery to Roemer's T. ornata because of the similarity in nodulose shell ornament, it is probable that T. imbricata sp. nov. is quite a distinct species which may prove stratigraphically important.

Genus TEREBRATULINA d'Orbigny 1847

Terebratulina protostriatula sp.nov.

Pl.5,figs.1-3,4-6,13-15; Pl.20,figs.1,2.

Terebratulina striatula (Mantell),auctt.

1826 Terebratula striatula J.de C.Sowerby: 69,pl.536, figs.3,4.

1852 Terebrtatulina striata sensu Wahlemberg; Davidson: pl.2,figs.25,27,28.

DIAGNOSIS. Elongate-oval,uniplicate, evenly biconvex Terebratulina . Symphytium well exposed, foramen large, circular. Ornament of rounded bifurcating striae.

DESCRIPTION. Frequent concentric growth-lines interrupt the longitudinal striae. In young forms and some well preserved adult forms the ornament is seen to be nodulose in the umbonal region of each valve. The umbo, though slightly produced, is more massive or less constricted than species from the Middle and Upper Chalk.

Morphological variation within this species amounts to very slight anterior sulcation of the ventral valve and more spatulate general outline. The shell ornament varies from comparatively coarse to fine rounded striae.

HOLOTYPE. A specimen selected from the Mantell Collection in the British Museum (Natural History), from the Chalk Marl of Hamsey, B.M. B 6038.

PARATYPE. B.M. BB 82261 from the Lower Cenomanian of Wilmington, Devon.

REMARKS. This is obviously the species which Mantell (1822) had in mind when he described a specimen from Hamsey in Sussex, stating that it represented a species from the Chalk Marl of that locality. Unfortunately he figured (pl.25,figs.7,8,12) a specimen which, from the adhering matrix and general morphological features, originated from the Upper Chalk. As no other specimens were involved at the time of description,Mantell's specimen must be regarded as the holotype of the species Terebratulina striatula. This specimen is now part of the Mantell Collection in the British Museum (Natural History) and is registered as B.M. B 457. The dimensions of this specimen are: length, 21.4 mm, width, 17.4 mm and thickness, 9.3 mm. It differs morphologically from any specimen that I have examined from the Lower Chalk in its general outline and greater size. It has a marked median sulcus in the ventral valve which extends from the umbonal region and becomes slightly deeper and wider anteriorly. The surface ornament of fine striae is of a nature found on specimens of Terebratulina collected from the Micraster cortestudinarium Zone of the Coniacian from downland areas and other chalk exposures in both southeast and southwestern England. Photomicrographs of the shell surface taken under the electron-microscope for both T. striatula

and T. protostriatula sp.nov., Pl.20,figs.1,2, show quite clearly that the Upper Chalk species has longitudinal striae which are tranversely quadrate in scetion, while those of the Lower Chalk species are rounded.

As Mantell's specimen originated from the Upper Chalk of Hamsey, the name Terebratulina striatula cannot be applied to a species of Terebratulina from the Lower Chalk. It is pehaps fortunate that a species of Terebratulina which is represented in the Coniacian of various localities in England, is often quoted erroneously as T. striata Wahlemberg, a species which was originally described from the Upper Maastrichtian of Sweden. The original description is brief (Wahlemberg,1819:61) and there is is no illustration available. Specimens in the British Museum (Natural History) obtained on exchange from Sweden are very large, 40 - 50 mm in length, and quite distinct from any species of that genus from the British Upper Chalk. Mantell's species, therefore, should in future be quoted as from the Upper Chalk.

Davidson (1852) used the taxa Terebratulina striatula in the broader interpretation given by Sowerby (1829: 69),which included both Cretaceous and Tertiary forms, and applied it to a specimen collected from the London Clay of Sheppey. This was later

included in the synonymy of Terebratulina wardenensis by G.F.Elliott (1939).

However, Davidson was somewhat perplexed by the name striatula being used as a definite specific name for a Cretaceous species of Terebratulina as he regarded many of the species within the Mesozoic and Tertiary deposits as belonging to the same species, T. striata Wahlemberg. This is probably because he had great dificulty in differentiating the very closely morphologically similar forms.

It may have been unwise or even reckless to have created another taxon for a Cretaceous species of Terebratulina when the German specific name T.auriculata erected by Roemer (1841) for a species from the Hilsconglomerat of the Essen district in North Germany was available. The drawing given in Roemer's description, pl.7, fig.9, shows a small, very flat uniplicate specimen with a slightly extended hinge line and a large circular foramen. The concentric growth-lines were not very marked and the striae appeared somewhat coarser than any of the British Cenomanian specimens that I have examined. Roemer' s name had not been used for a specimen of Terebratulina since d'Orbigny (1847) used it in his classic work on the Cretaceous; furthermore, the exact horizon within the Hilsconglomerat of Essen is not known and the beds within this stage are known to range from Neocomian to Cenomanian in age.

On these grounds I consider it justifiable in erecting the specific taxon protostriatula in preference to Roemer's name, auriculata for the species formerly known under the invalid name of Terebratulina striatula Mantell for a species of Terebratulina commonly found in the Lower Chalk of Britain and the European continent.

MATERIAL. Numerous specimens from the Lower Chalk of Britain and the Continent are contained in the collections of the British Museum (Natural History) and the Institute of Geological Science. The following have been selected as good examples to represent the species here described.

12 specimens from the Chalk Marl, Dover, Kent. B.M. B 29707.

1 specimen from the Lower Chalk, Eastbourne, Sussex . B.M. B 4804

1 specimen from Bluebell Hill, Burham, Kent. B.M.B.9458

2 specimens from Peter's Quarry, Burham, Kent. B.M. B 44805-6

2 specimens from the Glauconitic Marl of Warminster, Wiltshire. B.M. B 54862-3

5 specimens from the Glauconitic Marl, St.Lawrence, Isle of Wight. B.M. B 75.

1 specimen from the Lower Chalk of Newington's Chalk Pit, S.E.of Glynde railway station B.M. BB 862.

4 specimens from the Lower Chalk of Balcombe Pit, Glynde, Sussex. B.M.BB 43940-3

5 specimens from the lodge to Newtimber Place, Newtimber Church, Sussex. B.M. BB 43965-69

I specimen from the limeworks at Chinor, Oxfordshire. B.M. B 47302

5 specimens from the Upper Greensand of Deverill Hill, Dorset. B.M. B 7003

1 specimen from the Upper Greensand, Ventnor, Isle of Wight. B.M. B 10676.

6 specimens from the Chalk Marl, Hamsey, Sussex. B.M. BB 6038-43

3 specimens from the chalk above the Basement Bed, Punfield Cove, Swanage. B.M. BB 76500-2

15 typical specimens from the Grey Chalk, Bed V (Price), Lydden Spout, Folkestone, Kent.B.M B 25003

2 small individuals from the Cambridge Greensand. B.M. B 7002

8 typical forms from the Lower Chalk, Le Hâvre, France. B.M. B 35181

2 typical examples from Cap Blanc Nez, France. B.M. B 700

3 specimens from Glauconitic Marl, Rocken End, Isle of Wight. B.M. BB 76451-53

3 perfect examples from Cran d'Éscalles, Cap Blanc Nez, Boulonnais, France. B.M. BB82364-66

1 specimen from Bed 6 of Jukes-Browne (Lower Chalk), from a cutting in railway between Dover and Folkestone. B.M. BB 82363

PART IV CHAPTER 6

CONCLUSIONS

6.1 ADAPTATION

6.2 ECOLOGICAL CHANGE AND DISTRIBUTION

The distribution of brachiopod species of Boreal and Tethyan origin has been the subject of much discussion since Ager (1971), Middlemiss (1973) and Owen (1973) demonstrated the ubiquitous nature of some forms considered to have been confined to special ecological provinces. The Lower Chalk provides a very good stage from which to demonstrate the existence of faunal groups thought to have originated from within these two major realms. It must be understood, however, that what is happening here may not be an isolated example of the admixture of such groups but merely another example at a different point in geological time.

The adaptability of brachiopods to any change in the environment makes the job of delimiting exact ecosystems within a mixed community very difficult. It is fortunate, therefore, that the universal transgressive Cenomanian sea provided relatively stable conditions, with little change in depth, that the facies reflecting these conditions can be limited to very few. Ager (1965: 145) stresses the point that this stage within the Mesozoic probably provides the best example of a steady shallow water or littoral environment which, he points out, is characteristically a high energy environment.

Within the general area of high energy seen to exist within the Cenomanian broadly, are deposits which suggest conditions of relatively deeper water or quieter conditions. These areas support their own peculiar fauna. It is here that we see a situation somewhat analogous to Ager's 'Alpine' group but having a closer genetic link with the overall fauna than the isolated 'Alpine Group' species would suggest in relationship to contemporaneous proximal faunas.

In 1978, I pointed out, in a general review of brachiopod species within the Cenomanian of northwestern and central Europe, that each ecological group within its own particular lithological unit appears to contain a fauna with a characteristic or dominant group associated with some long ranging and obviously more adaptable forms which tend to fall into two groups. One characterized by rhynchonellids and costate terebratellids and the other by terebratulids and smooth terebratellids. This study has reinforced my views on this observation and I believe that these groups can be traced across Europe, into North Germany and southern France. In doing so on a somewhat superficial scale, I have taken into consideration differences in lithologies and major differences in geographical location. It is surprising how very

consistent the various groups appear to be in their specific constitution over a relatively wide area. For instance, in southeastern France, at Drap, near Nice, a collection of brachiopods has been made from highly glauconitic sandy limestone and from more argillaceous deposits nearby. The species within the glauconitic beds consists of large biplicate terebratulidae similar in general form to the Moutonithyris dutempleana (d'Orbigny) described from similarly highly glauconitic deposits in Britain and northern France, while the fauna in the more argillaceous deposits is of smooth terebratulidae and small rhynchonellidae. An assemblage not unlike the one which characterizes the more marly beds within the Central Weald.

In Britain a pattern is evident. In the south, particularly in the coarse sandy facies of the more western outcrops at Wilmington and Warminster, there appears to be a fauna which shows some characters of the one and some of the other main lithological assemblages. This sort of assemblage is considered to be a marginal faunal assemblage. Genera, such as Orbirhynchia, Grasirhynchia and Terebratulina are found within groups of acutely plicate terebratulidae, such as Boubeithyris diploplicata and coarsely costate Cyclothyridinae occur together with terebratellidae of the Dereta and Terebrirostra variety. Within this

assemblage there exists also some special species which are seen in the more chalky facies in association with smooth acutely biconvex terebratulidae such as Concinnithyris obesa. This reference is to the small highly ornate species Arcuatothyris arcuata (Roemer) and Platythyris squamosa (Mantell) which appear to be highly adaptable and can be found in the more chalky facies of the Lower Chalk Basemant Beds in Wiltshire and Dorset and the Craie de Rouen in France. Arcuatothyris arcuata also occurs in the glauconitic limestones in North Germany and on the Normandy coast. Platythyris squamosa occurs with a closely related species, P. disparilis in the Chalk Basement Beds and, once again, in the Craie de Rouen. P. squamosa is a fairly common fossil in the Chalk Marl and more marly facies of Kent and Sussex. It does not appear, however, in similar facies, such as the Cambridge Greensand or Marls associated with the eastern province. Both species have been collected with P. disparilis from the sandy facies of South Devon from the coastal sections, Bed C, at Humble Point and The Pinnacles.

Grasirhynchia grasiana which transcends the differences in the deposits and appears to adapt to both coarse sandy glauconitic limestones as well as more finely marly deposits of the Middle Cenomanian of the Weald and elsewhere, is also found in the marls of the Boulonnais, France and in the marly beds of Brochterbeck, North Germany where it occurs as a rare fossil.

Summarising; I consider that there is a vast area representative of the Cenomanian transgressive sea which extends from eastern Europe across Poland, Czechoslovakia, North Germany Belgium, France and Britain within which certain well marked areas demonstrate the limits of each special environment. It is possible, through a study of the brachiopod faunas, to relate each of these areas and evaluate the species according to their optimum depth and energy requirements.

It is possible to draw a broad comparison, for instance between the faunal composition of assemblages from the Essen, North Germany, Arnager Greensand of Bornholm, Denmark, the Tourtia of Belgium and the Cenomanian Sands of Wilmington, South Devon. Each of these areas appears to me to indicate a marginal facies with elements of both marly bed faunas and harder, coarse sandy bed faunal elements.

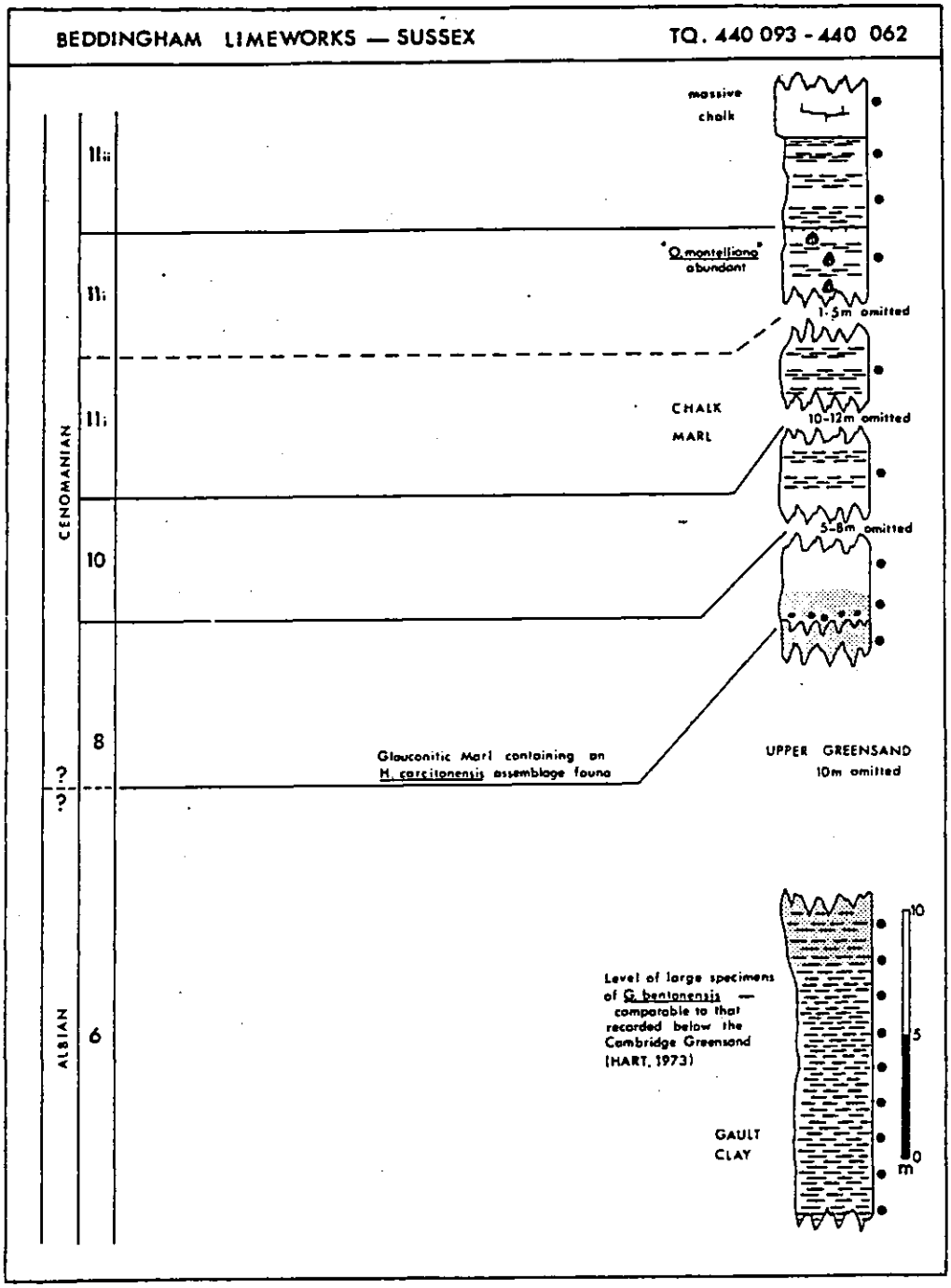
The more compact marly chalks and marls which occur within the compass of this same area seem to support a fauna requiring a softer substrate and perhaps deeper water. This is reflected in the composition of the assemblage which is composed of smooth shelled terebratuloids and finer costate rhynchonellidae. The absence of any costate terebratellid specimens is also significant of quieter and deeper conditions.

TEXT-FIGS. 28 - 42

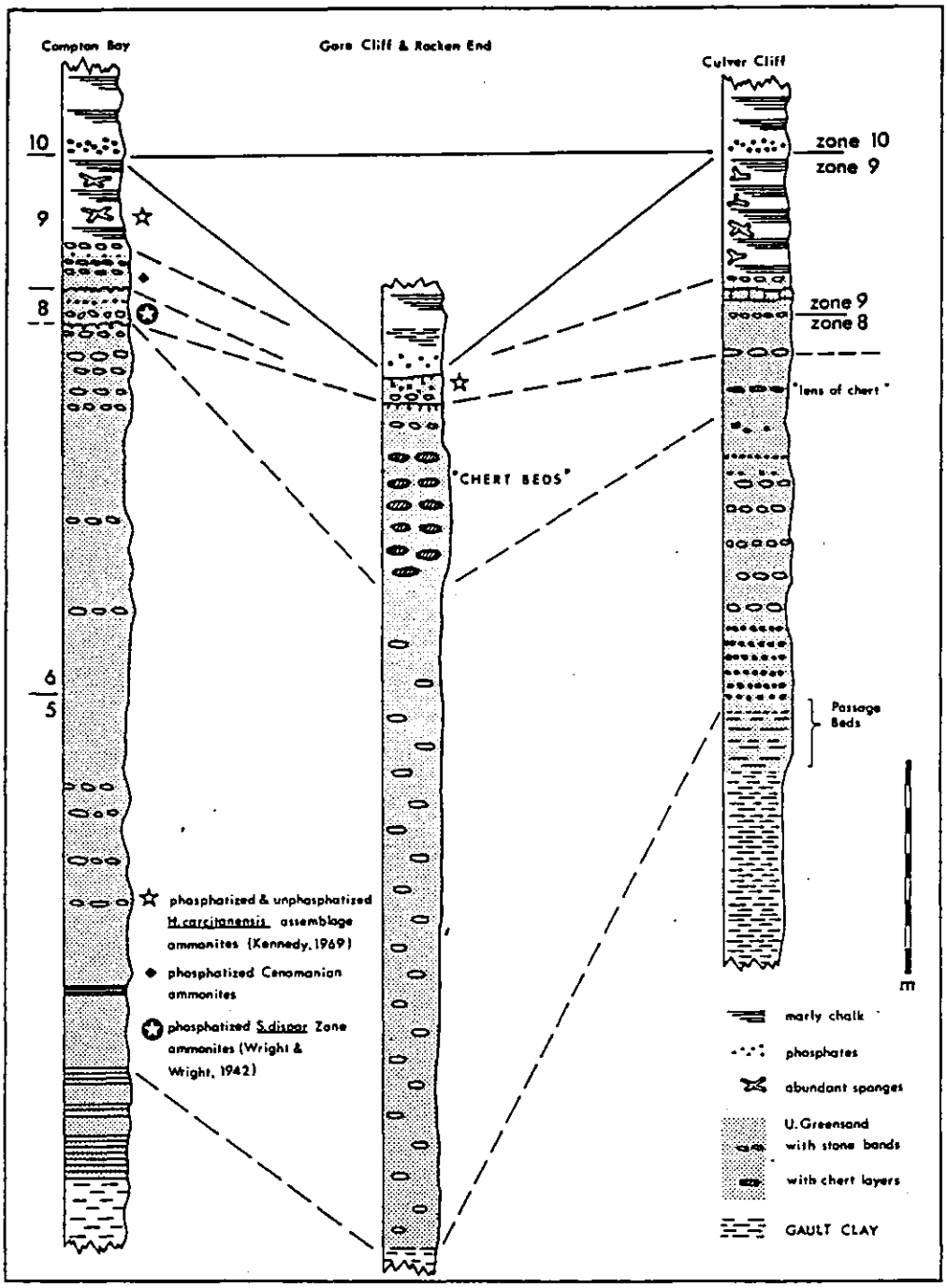
G E O L O G I C A L S E C T I O N S

The vertical sections shown here have been adapted from Carter & Hart (1977) and, with minor amendations, have been used to illustrate the facies existing throughout the research area studied during the course of the present work. All of the British sections have been visited and collections of brachiopods made from the fossiliferous horizons. Some, but not all, of the French localities were visited during the tenure of the present research and collections of brachiopods made from some classic sections.

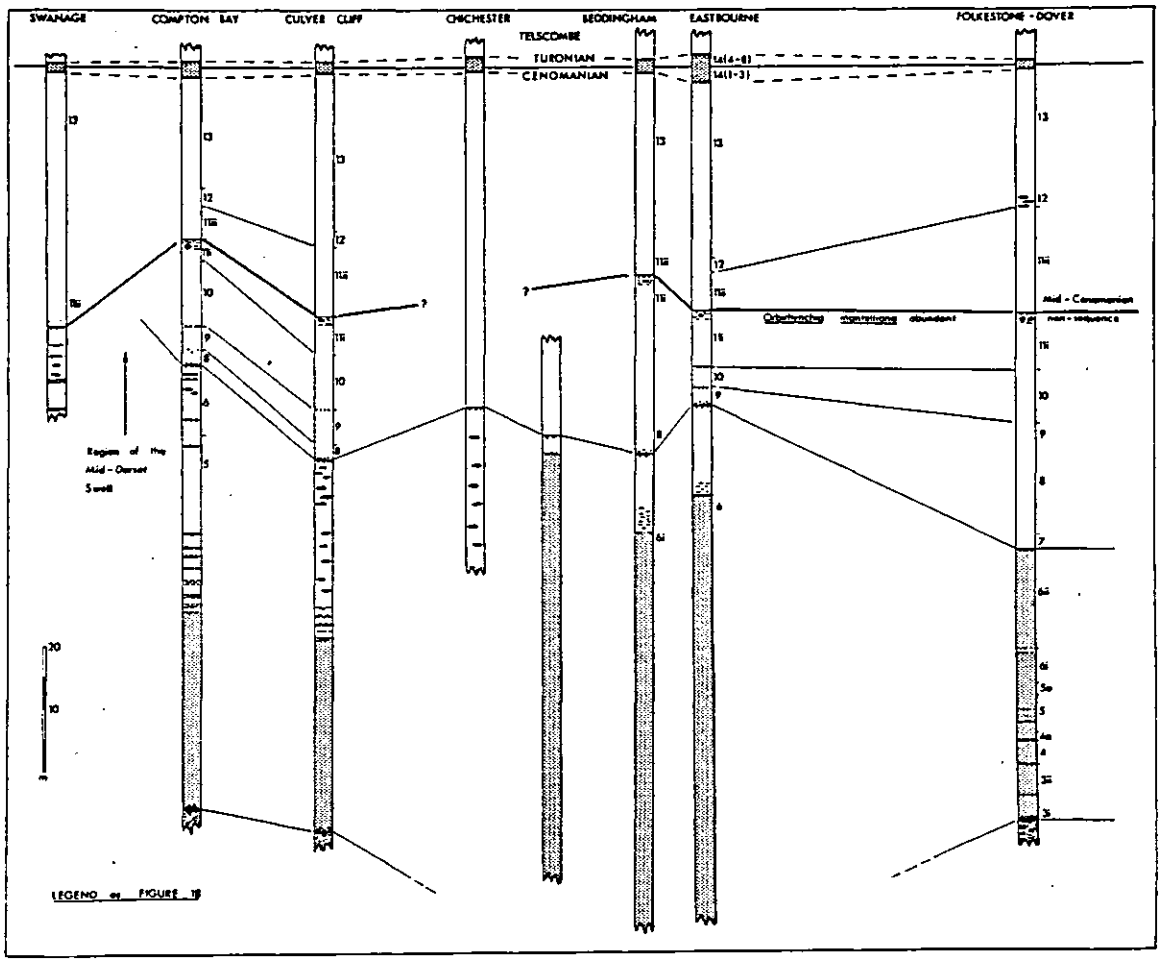
TEXT-FIG. 28. Partial section through the Chalk Marl and Glauconitic Marl at Beddingham Limeworks, Asham, Sussex.


BEDDINGHAM LIMEWORKS — SUSSEX
TQ. 440 093 - 440 062
massive chalk
"O. montelliana" abundant
1·5m omitted
CHALK MARL
10-12m omitted
5-8m omitted
UPPER GREENSAND
10m omitted
Glauconitic Marl containing an H. carcitonensis assemblage fauna
Level of large specimens of O. bentonensis — comparable to that recorded below the Cambridge Greensand (HART, 1973)
GAULT CLAY
CENOMANIAN
ALBIAN
11ii
11i
11i
10
8
?
?
6
10
5
0
m

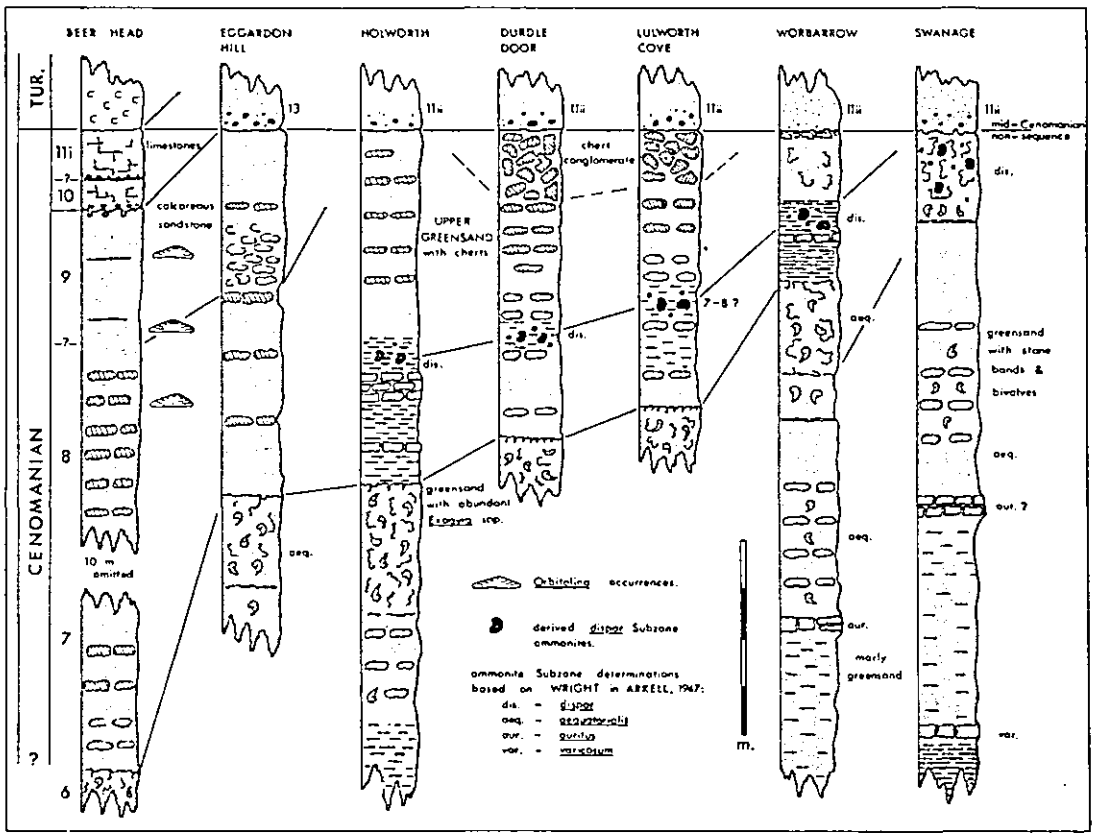
TEXT-FIG. 29. Correlation of the Upper Greensand and Cenomanian beds exposed at Compton Bay, Gore Cliff and Culver Cliff, Isle of Wight.


Compton Bay
Gore Cliff & Racken End
Culver Cliff
10
9
8
6
5
zone 10
zone 9
zone 9
zone 8
"lens of chert"
"CHERT BEDS"
Passage Beds
phosphatized & unphosphatized H. carcitanensis assemblage ammonites (Kennedy, 1969)
phosphatized Cenomanian ammonites
phosphatized S. dixoni Zone ammonites (Wright & Wright, 1942)
m
marly chalk
phosphates
abundant sponges
U. Greensand
with stone bands
with chert layers
GAULT CLAY

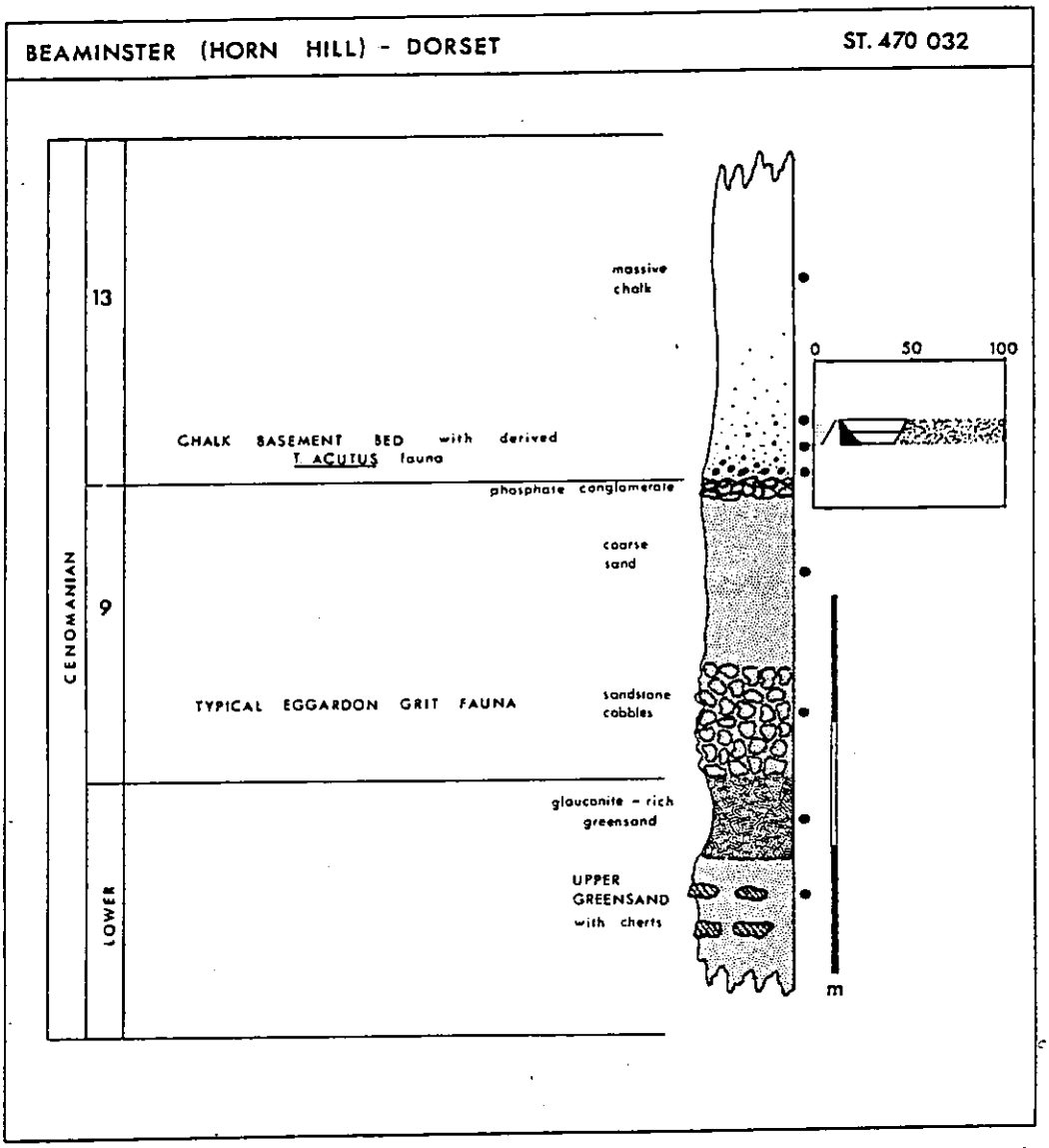
TEXT-FIG. 30. General correlation of Upper Greensand and Cenomanian from Swanage to Folkestone, Kent, tracing the Orbirhynchia Band across the Weald.


SWANAGE
COMPTON BAY
CULVER CLIFF
CHICHESTER
BEDDINGHAM
EASTBOURNE
FOLKESTONE - DOVER
TELSCOMBE
TURONIAN
CENOMANIAN
Region of the Mid - Dorset Swell
mid - Cenomanian
non - sequence
20
10
LEGEND as FIGURE 18

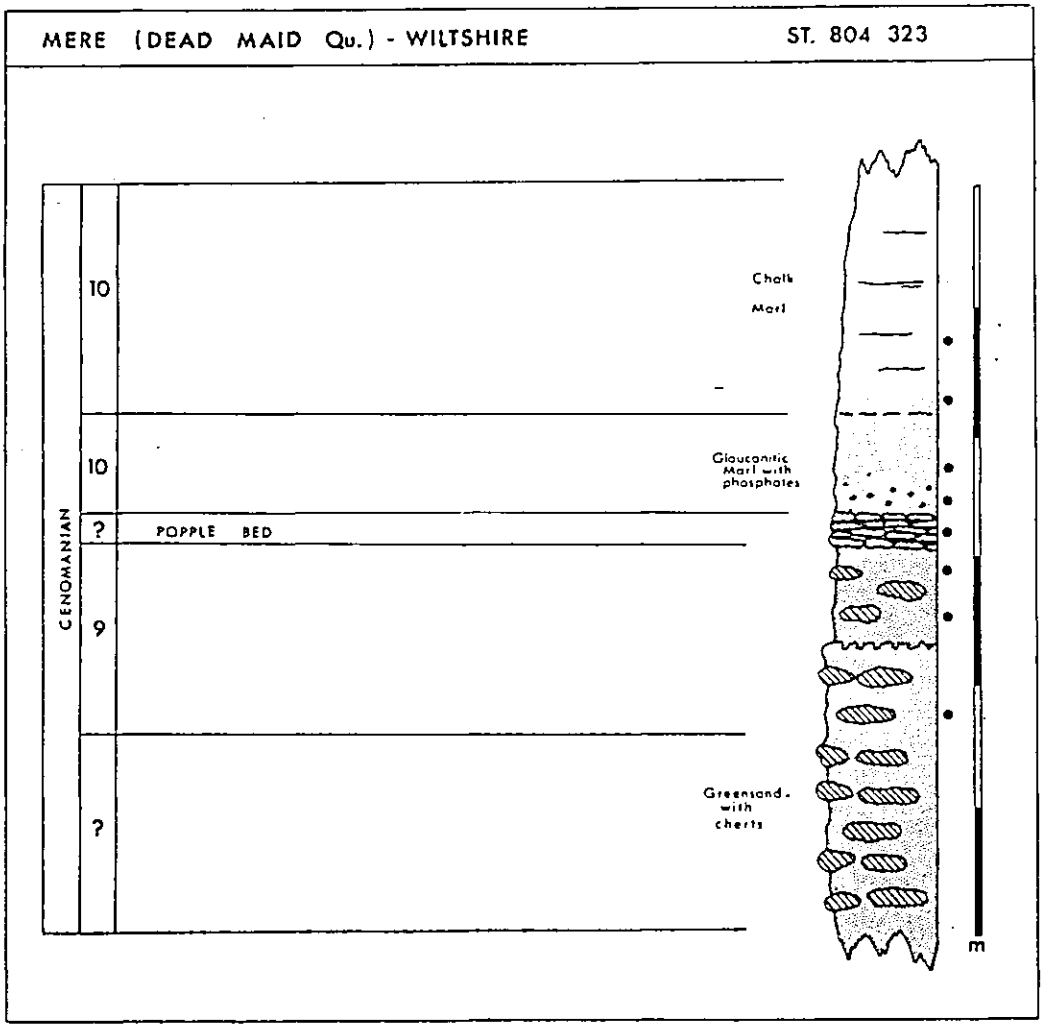
TEXT-FIG. 31. General correlation of Cenomanian beds within the southwestern province.


BEER HEAD
EGGARDON HILL
HOLWORTH
DURDLE DOOR
LULWORTH COVE
WORBARROW
SWANAGE
TUR.
CENOMANIAN
limestones
calcareous sandstone
10 m omitted
UPPER GREENSAND with cherts
greensand with abundant Exogyra sp.
chert conglomerate
7-8 ?
greensand with stone bands & bivalves
marly greensand
mid-Cenomanian non-sequence
Orbitolina occurrences.
derived dispar Subzone ammonites.
ammonite Subzone determinations based on WRIGHT in ARKELL, 1947:
dis. - dispar
aeq. - aequicostatus
cur. - curvata
var. - varicosum
m.

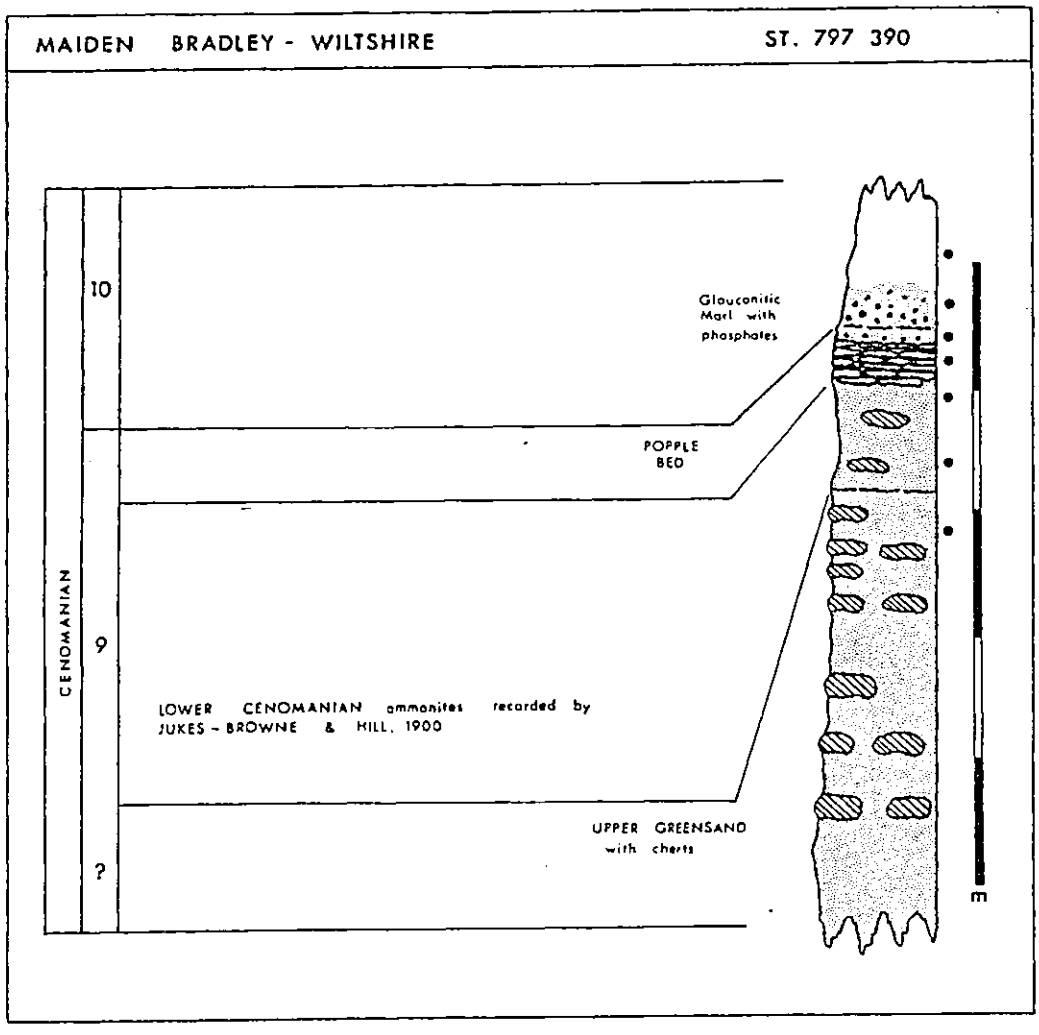
TEXT-FIG. 32. Section at Horn Hill, Beaminster, Dorset. The Chlak Basement Bed is seen here with a Turrilites acutus assemblage just above the phosphatic conglomerate. The Eggardon Grit is visible in this pit with the characteristic sandstone pebbles.


BEAMINSTER (HORN HILL) - DORSET
ST. 470 032
CENOMANIAN
13
9
LOWER
massive chalk
CHALK BASEMENT BED with derived T. ACUTUS fauna
phosphate conglomerate
coarse sand
TYPICAL EGGARDON GRIT FAUNA
sandstone cobbles
glauconite - rich greensand
UPPER GREENSAND with cherts
0
50
100
m

TEXT-FIG. 33. Section through the Chalk Marl and Glauconitic Marl at Dead Maid Quarry, Mere, Wiltshire, which is separated from the cherty Upper Greensand by the Popple Bed.

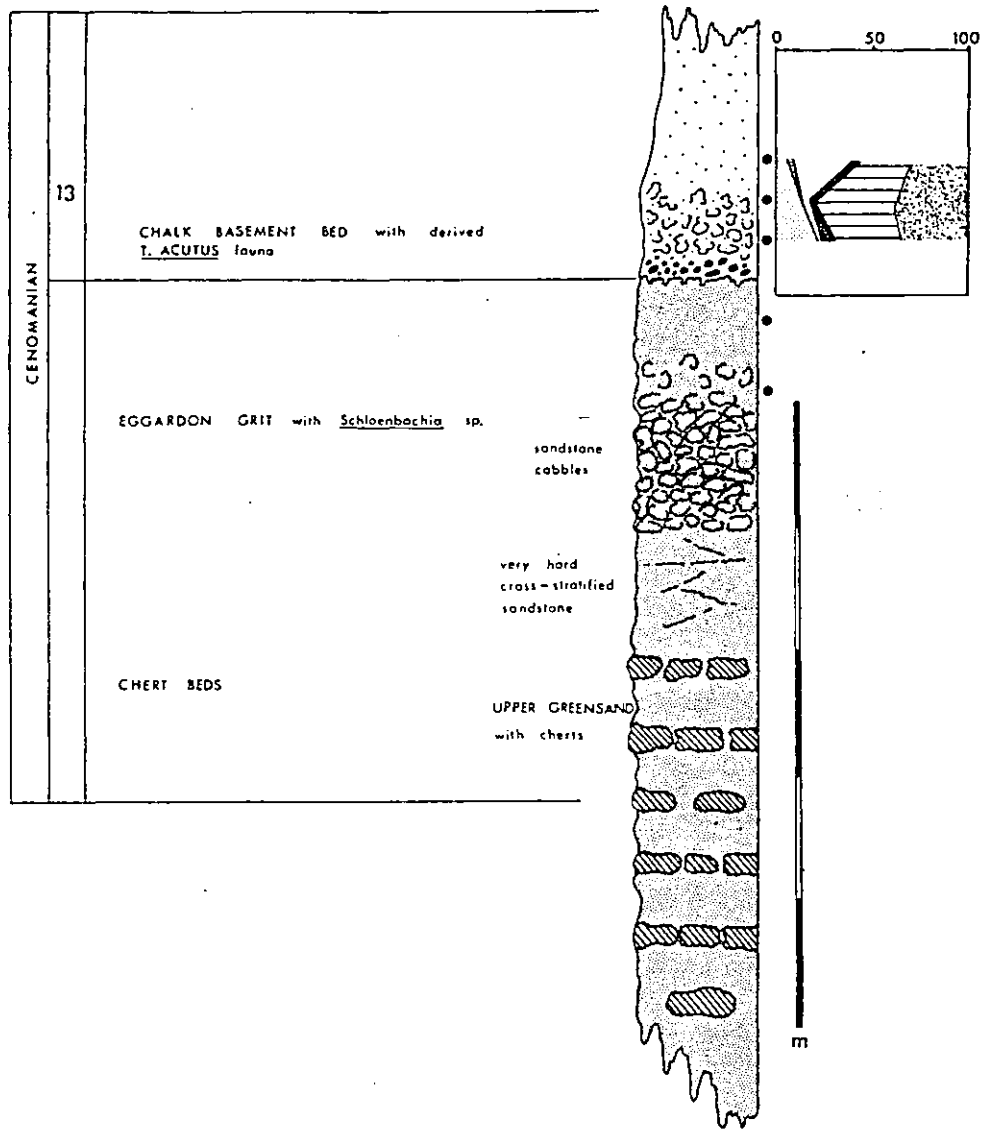

MERE (DEAD MAID Qu.) - WILTSHIRE
ST. 804 323
CENOMANIAN
10
10
?
9
?
POPPLE BED
Chalk
Marl
Glauconitic Marl with phosphates
Greensand with cherts
m

TEXT-FIG. 34. Section at Maiden Bradley, Wiltshire, showing the Glauconitic Marl and Lower Cenomanian sandy limestone separated by the celebrated Popple Bed containing brachiopods.

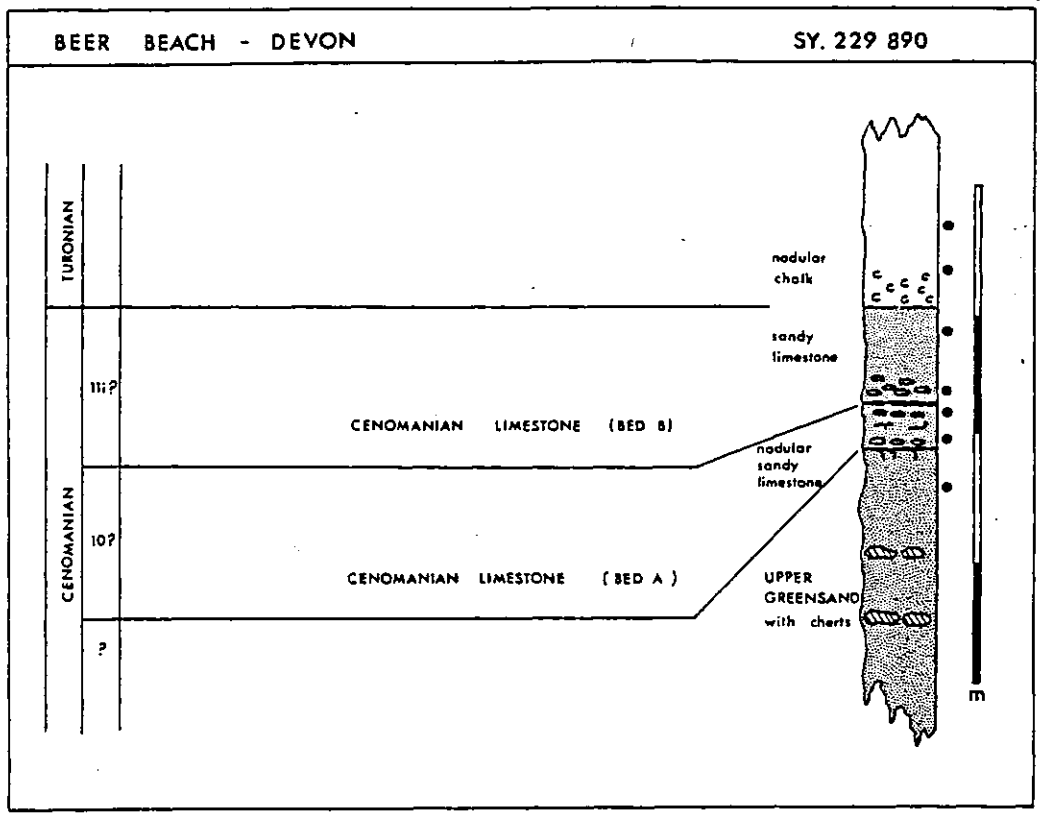

MAIDEN BRADLEY - WILTSHIRE
ST. 797 390
CENOMANIAN
10
9
?
Glauconitic Marl with phosphates
POPPLE BED
LOWER CENOMANIAN ammonites recorded by JUKES - BROWNE & HILL, 1900
UPPER GREENSAND with cherts
m

TEXT-FIG. 35. Snowdon Hill Quarry, Chard, Somerset. The vertical section shown here gives the position of the Chalk Basement Bed from which have been collected numerous specimens of Concinnithyris subundata. All the fossils in this bed are phosphatized.
Just above this bed, in the more chalky facies, several well preserved calcareous Concinnithyris obesa have been found.

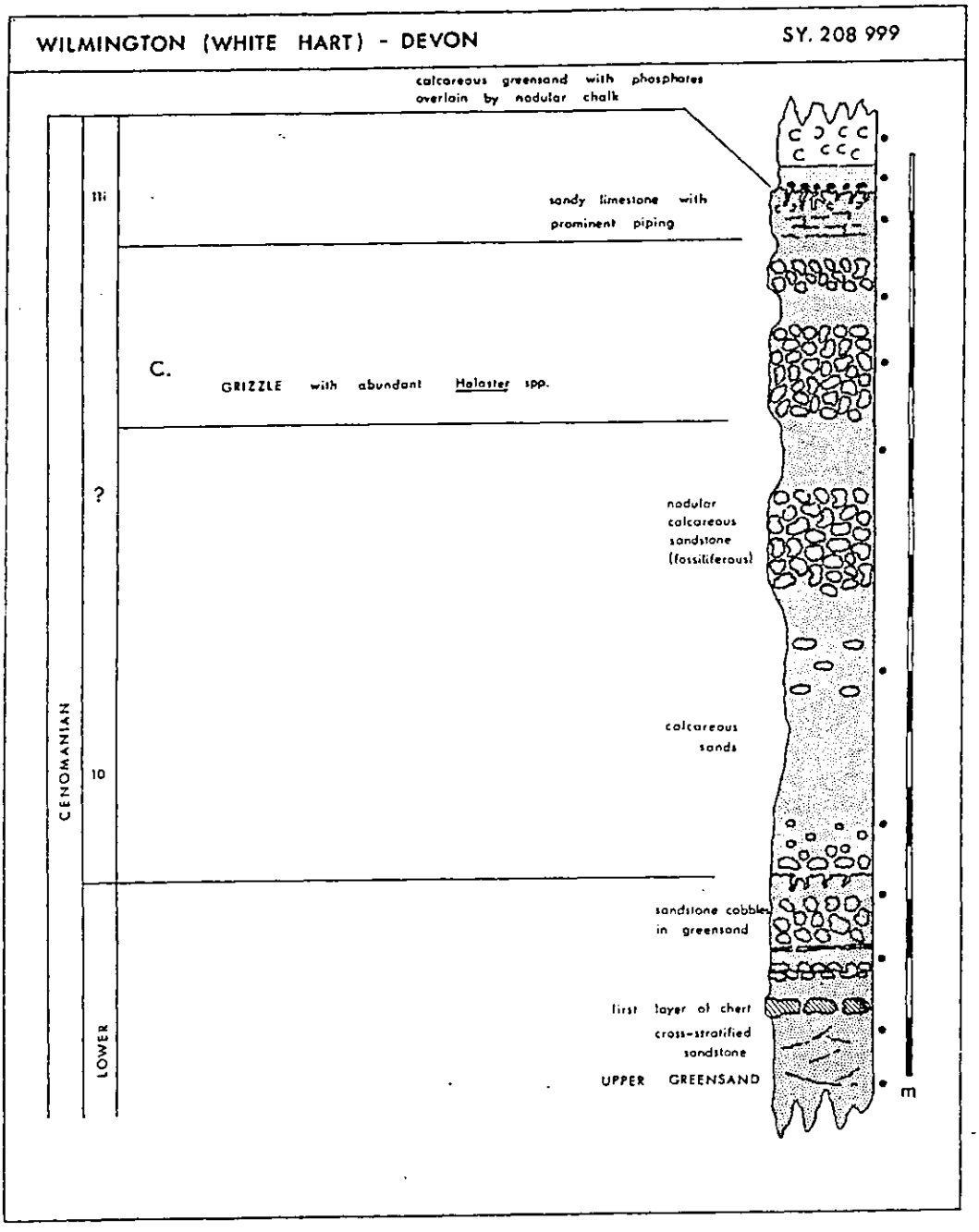
CHARD (SNOWDON HILL) - SOMERSET ST. 313 089



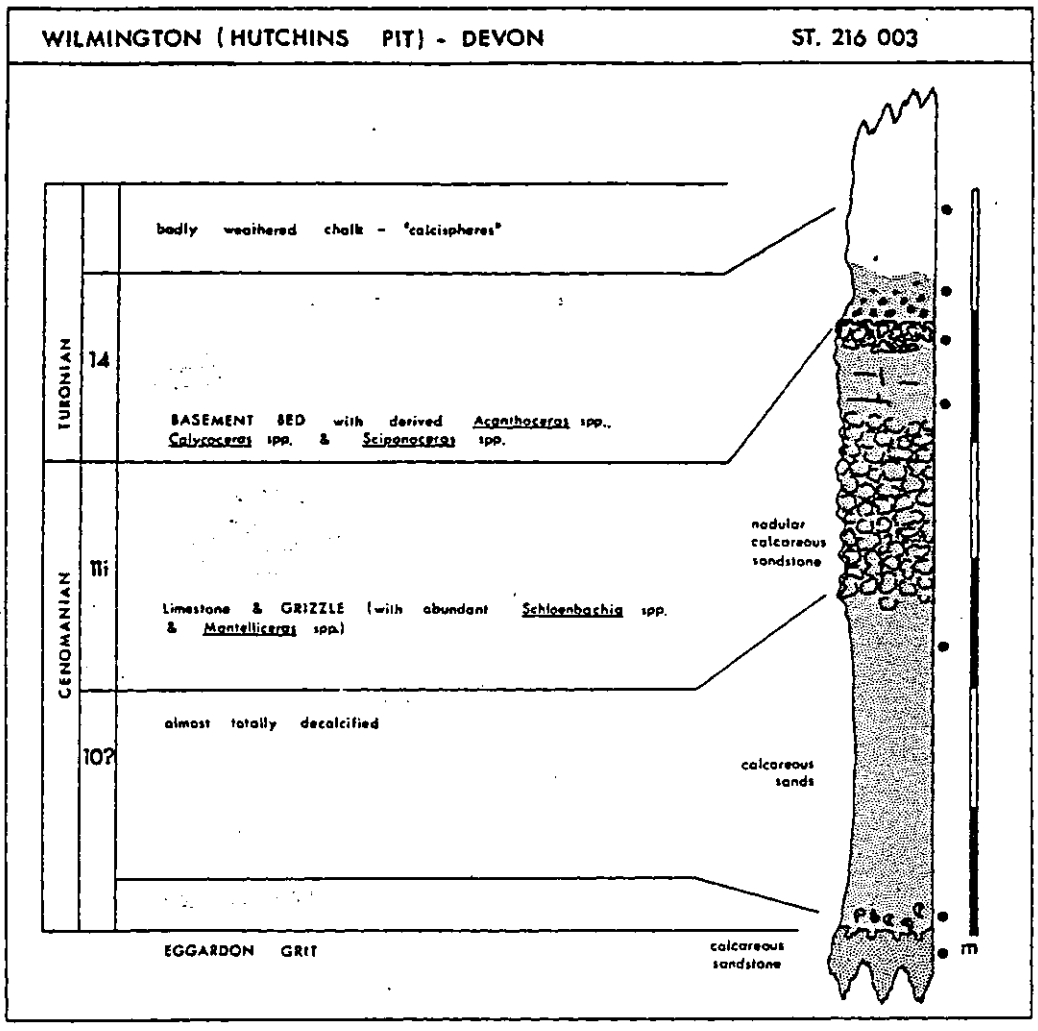
TEXT-FIG. 36. Vertical section at Little Beach, Beer, Devon illustrating the Cenomanian Limestone Beds A and B in relation to the Upper Greensand with cherts at the base.


BEER BEACH - DEVON
SY. 229 890
TURONIAN
CENOMANIAN
11i?
10?
?
nodular chalk
sandy limestone
CENOMANIAN LIMESTONE (BED B)
nodular sandy limestone
CENOMANIAN LIMESTONE (BED A)
UPPER GREENSAND with cherts
m

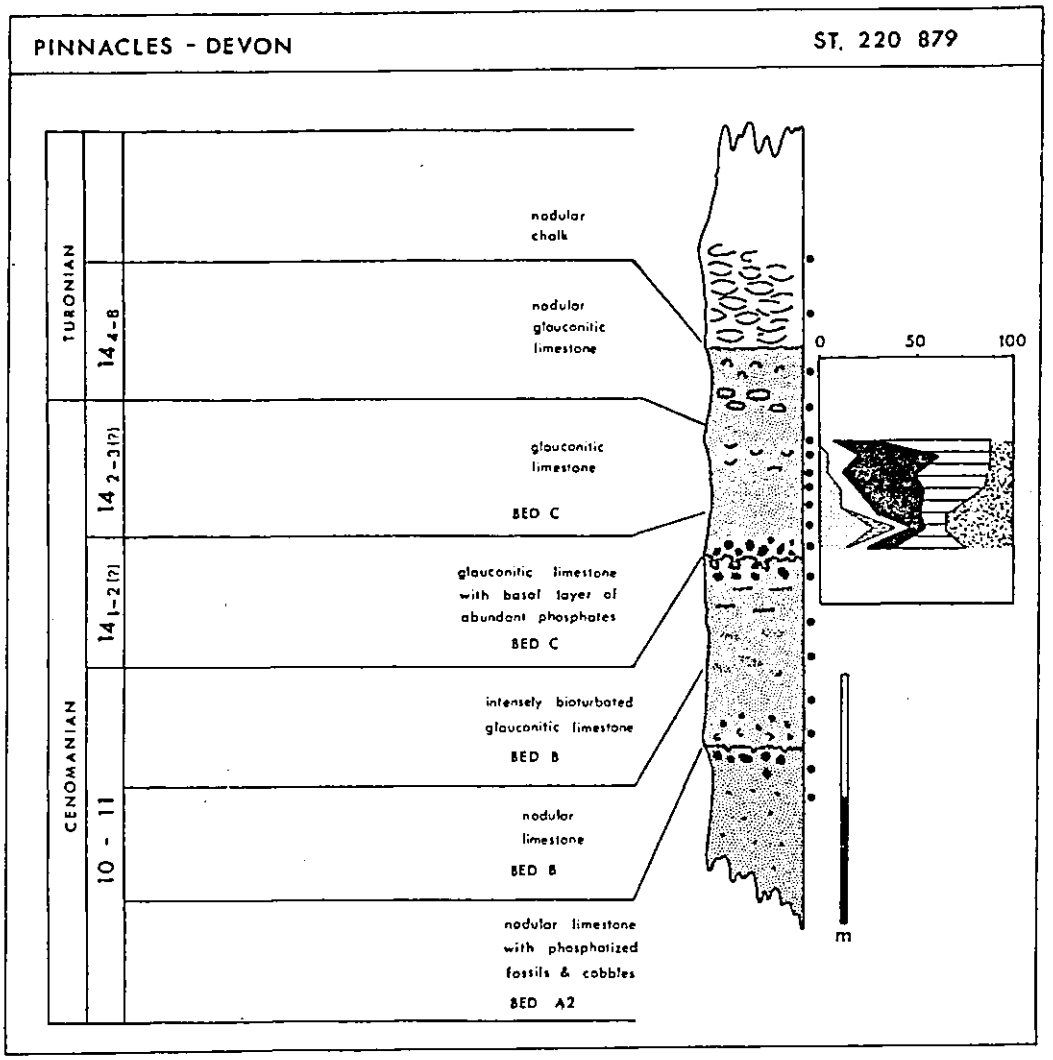
TEXT-FIG. 37. Section at White Hart Pit, Wilmington, Devon, showing the extent of the calcareous sands and the Grizzel above.


WILMINGTON (WHITE HART) - DEVON
SY. 208 999
calcareous greensand with phosphates overlain by nodular chalk
sandy limestone with prominent piping
C.
GRIZZLE with abundant Holaster spp.
nodular calcareous sandstone (fossiliferous)
calcareous sands
sandstone cobbles in greensand
first layer of chert
cross-stratified sandstone
UPPER GREENSAND
CENOMANIAN
LOWER
11i
?
10
m

TEXT-FIG. 38. The section at Hutchin's Pit is almost overgrown but this diagram illustrates the full extent of the section when available. It includes the Basement Bed of the Turonian with derived Acanthoceras spp. and the Grizzel of Mantelliceras mantelli age.

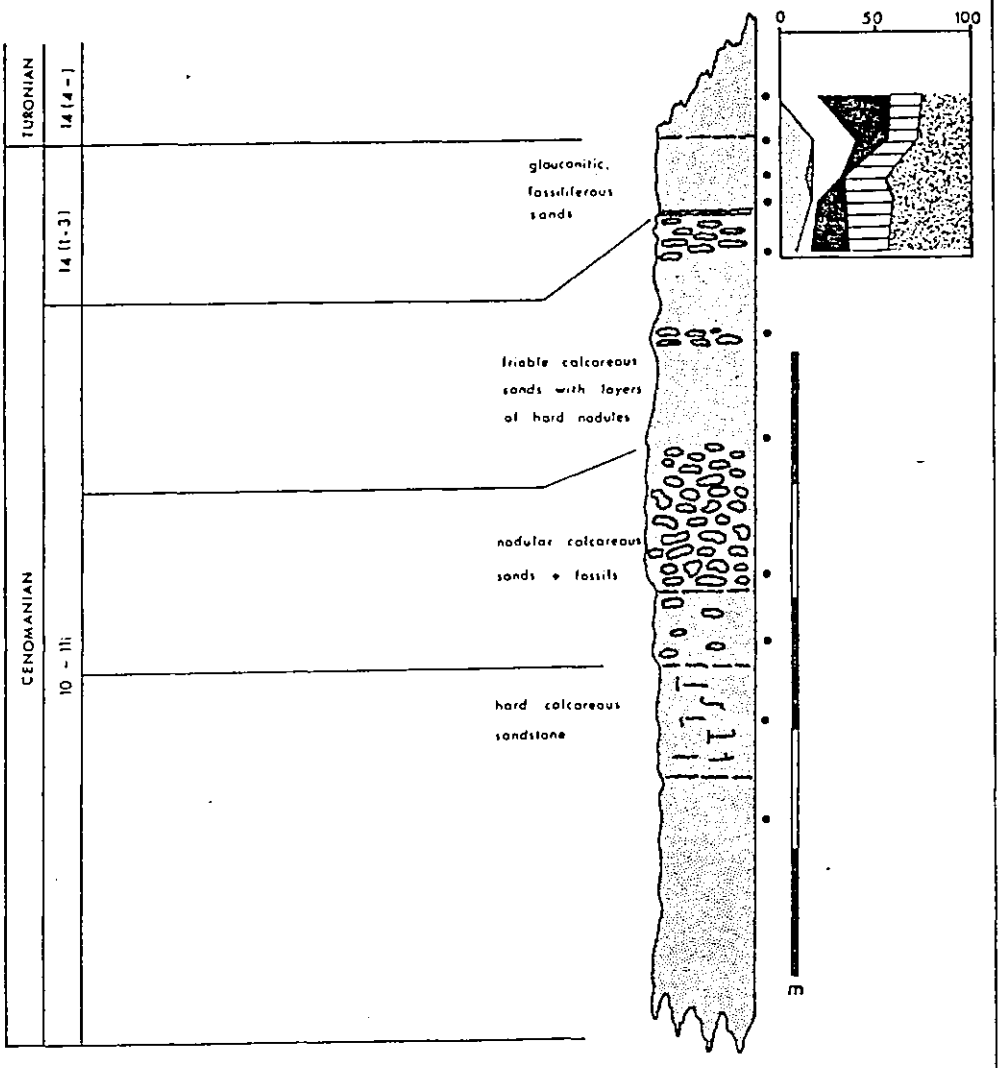

WILMINGTON (HUTCHINS PIT) - DEVON
ST. 216 003
badly weathered chalk - 'calcispheres'
BASEMENT BED with derived Acanthoceras spp., Calycoceras spp. & Scipanoceras spp.
Limestone & GRIZZLE (with abundant Schloenbachia spp. & Mantelliceras spp.)
almost totally decalcified
EGGARDON GRIT
TURONIAN
CENOMANIAN
14
11i
10?
nodular calcareous sandstone
calcareous sands
calcareous sandstone
m

TEXT-FIG. 39. The Pinnacles on the South Devon coast provide a good section through the top of Bed A to Bed C and illustrates the marked variation in lithology within these beds.

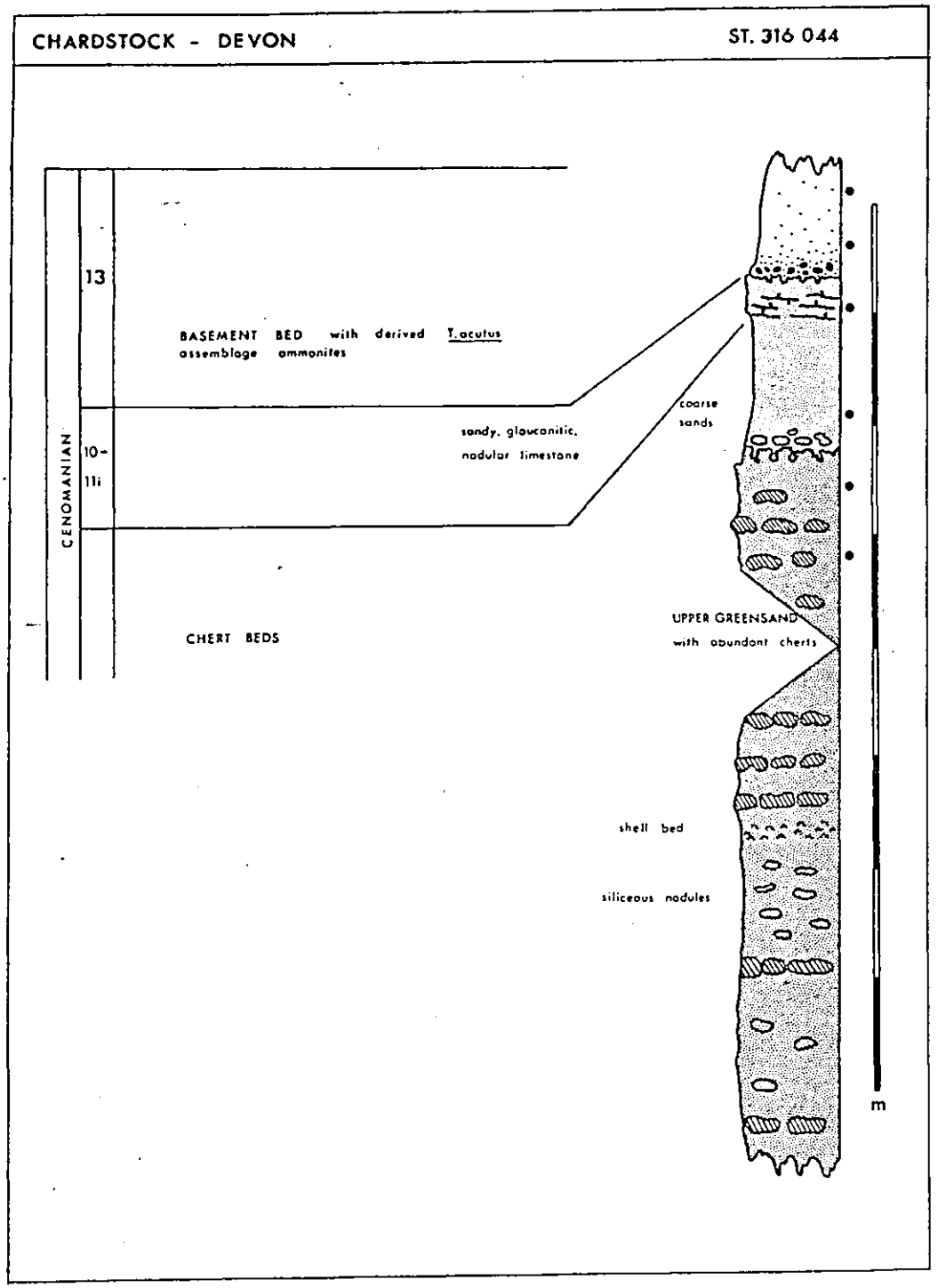

PINNACLES - DEVON
ST. 220 879
TURONIAN
CENOMANIAN
14 4-8
14 2-3(?)
14 1-2(?)
10 - 11
nodular chalk
nodular glauconitic limestone
glauconitic limestone
BED C
glauconitic limestone with basal layer of abundant phosphates
BED C
intensely bioturbated glauconitic limestone
BED B
nodular limestone
BED B
nodular limestone with phosphatized fossils & cobbles
BED A2
0
50
100
m

TEXT-FIG. 40. The section at Bovey Lane Sandpit, Devon, is no longer visible but the beds have been recorded by Smith (1961). The top fossiliferous sands are the equivalent of Bed C at the coast and equate with Bed 6 of Smith.

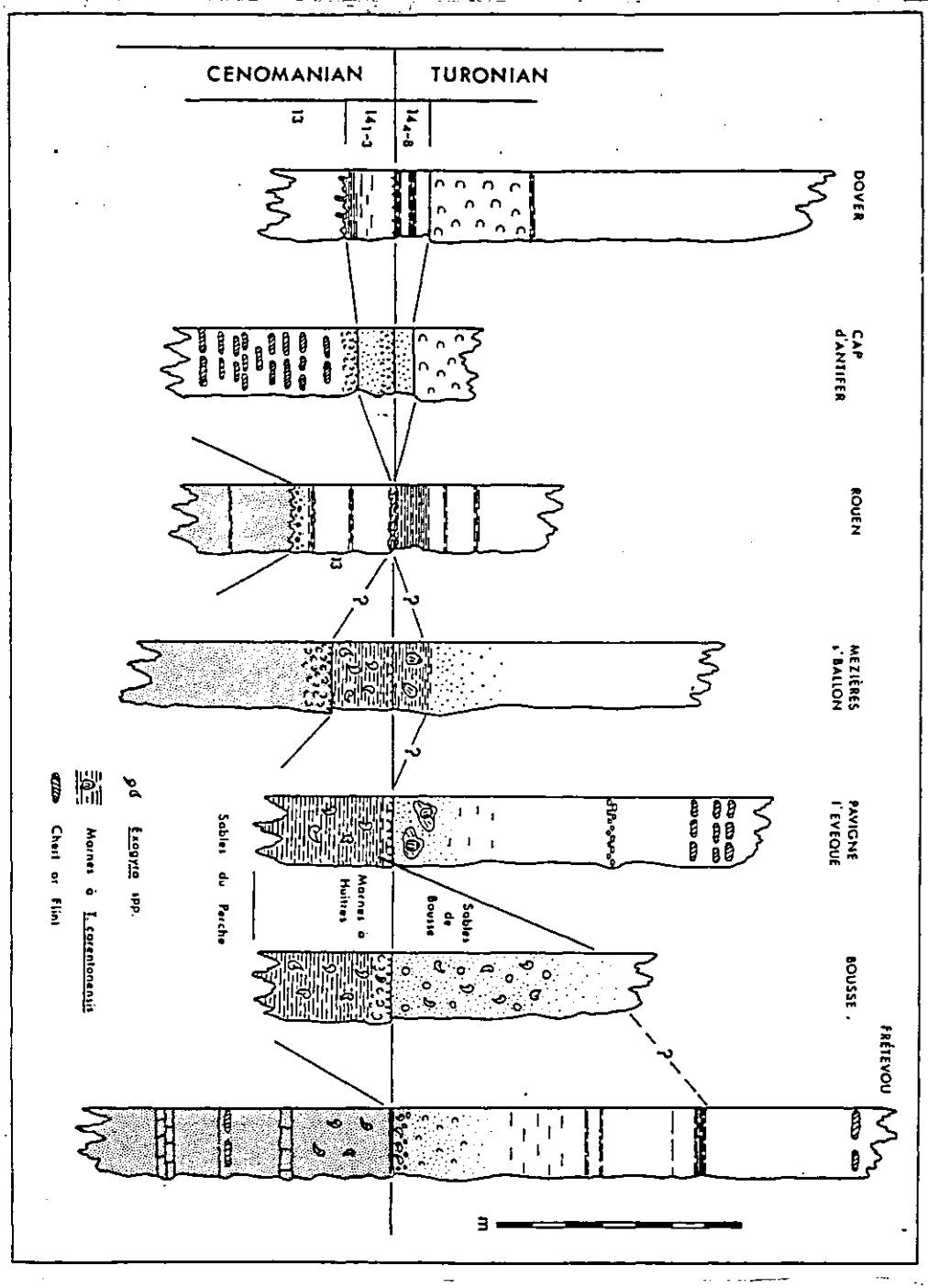
BOVEY LANE SANDPIT - DEVON SY. 217 900



TEXT-FIG. 41. The *Turrilites acutus* assemblage Basement Bed is shown in relation to the underlying glauconitic sands of the Lower Cenomanian and Chert Beds of the Upper Greensand at Chardstock, Devon.


CHARDSTOCK - DEVON
ST. 316 044
CENOMANIAN
13
10-
11i
BASEMENT BED with derived T. acutus assemblage ammonites
sandy, glauconitic, nodular limestone
CHERT BEDS
coarse sands
UPPER GREENSAND with abundant cherts
shell bed
siliceous nodules
m

TEXT-FIG. 42. Correlation of beds of Cenomanian and Lower Turonian age from Dover to Bousse and Frétevou, France.


CENOMANIAN
TURONIAN
DOVER
CAP D'ANTIFER
ROUEN
MEZIÈRES S' BALLON
PAVIGNE L'EVEQUE
BOUSSE
FRÉTEVOU
Sables du Perche
Marnes à Huitres
Sables de Bousse
Exogyra spp.
Marnes à T. carentonensis
Chert or Flint
m

GLOSSARY OF LOCALITIES

SOUTHEASTERN CENOMANIAN LOCALITIES.

Beddingham Limeworks, Sussex (TQ 440073 -440062). Lime working pit, with exposure of the Upper Gault, Upper Greensand, mantelli (part), rhotomagense (part), and naviculare Zones, Lower Chalk, plenus marls and Middle Chalk.

Bluebell Hill, Burham, Kent. (TQ615735). Five enormous disused pits on the east bank of the Medway. The lower pits expose a total of almost 50m. of Lower Chalk (mantelli, rhotomagense and naviculare Zones), plenus Marls and Middle Chalk.

Bordean Limeworks, Langerish, Hampshire (SN 703241). A disused pit exposing naviculare Zone, Lower Chalk.

Brockham and Betchworth Limeworks, Surrey (TQ 196510 -207517). A partially disused complex of pits exposing rhotomagense Zone, Lower Chalk to Chalk, Lower Chalk to Chalk Rock. Lower and Middle Chalk are accessible.

Buckland Limeworks, Surrey (TQ 220527). A disused pit exposing naviculare Zone, Lower Chalk, plenus Marls and Lower Chalk.

Buriton Limeworks, Hampshire (SU 734200, 735198). Two disused pits exposing naviculare Zone, Lower Chalk.

Bury, Sussex. (TQ 008182). A disused pit on the west side of the A29, 400m. south of the White Horse Inn. This exposes

15m. of naviculare Zone Lower Chalk, plenus Marls and Middle Chalk.

Colley Hill, Reigate, Surrey (TQ 242520). Natural exposures of the Orbirhynchia mantelliana Band, Lower Chalk, rhotomagense Zone.

Compton Bay, Isle of Wight, Hampshire (SZ 365854). Upper Greensand, Lower and Middle Chalk are well exposed.

Coombe Farm (TQ 126495). A small disused pit 41m. west of Dorking, exposing rhotomagense Zone, Middle Chalk costatus and acutus assemblages and the Orbirhynchia mantelliana Band.

Culver Cliff, Isle of Wight, Hampshire (SZ 630855). Upper Greensand, Lower and Middle Chalk are well exposed.

Dorking Greystone Limeworks, Surrey (TQ 160503). A disused pit exposing naviculare Zone Lower Chalk, plenus Marls and Middle Chalk.

Eastbourne, Sussex coastal section. Upper Gault, Upper Greensand, Lower and Middle Chalk are well exposed in cliff sections and foreshore south of the town.

Eastwoods Cement Works, Southerham, Sussex. This working pit is 500m. south of the cement works, on the south side at the A27. High mantelli, rhotomagense and perhaps naviculare zones in the Lower Chalk are well exposed.

Elbourne House, Washington, Sussex (TQ 120124). Working pit exposing 15m. of naviculare Zone, Lower Chalk, plenus Marls and Middle Chalk.

Folkestone, Kent. Upper Gault, Lower Chalk (76m.) and Middle Chalk are well exposed in the cliffs and foreshore north and eastwards from Folkestone to Dover.

Gore Cliff and Rockan End, Isle of Wight, Hants. (SZ497759 & 429755). Upper Greensand, Glauconitic Marl and the basal 4m. of the Lower Chalk can be examined on Gore Cliff and in boulders in the Undercliff.

Greystone Limeworks, Oxted, Surrey (TQ 295542). A working pit exposing 16m. of naviculare Zone, Lower Chalk, plenus Marls and Middle Chalk.

Holborough Cement Works, Kent. (TQ 717638). This working pit exposes Upper Gault and the whole of the Lower Cahlk, plenus Marls and Middle Chalk.

Margetts Pit, Burham, Kent (TQ 723625). A very large disused pit 600m. northwest of Burham Village, 30m. of Lower Chalk (rhotomagense and naviculare Zones), plenus Marls and Middle Chalk are exposed.

Merstham Greystone Limeworks, Surrey (TQ 295542). A disused pit exposing the top of the Lower Chalk (naviculare), plenus Marls and Middle Chalk.

Newington's Pit, Glynde, Sussex (TQ 460080). A working pit exposing rhotomagense and naviculare Zones, Lower Chalk.

Newtimber Limeworks, Sussex (TQ 274137). A large working pit exposing naviculare Zone, Lower Chalk, plenus Marls and Middle Chalk.

Novington Farm, Plumpton, Sussex (TQ 373137 - 373131). Roadside ditches exposing mantelli Zone and rhotomagense Zone, Lower Chalk.

Offham, Sussex, just north of Lewes (TQ 408121). A long overgrown locality, the source of the Calycoceras naviculare; it probably exposed horizons high in the Lower Chalk.

Peter's Pit, Wouldham, Kent (TQ 715633). A disused pit exposing Lower Chalk (rhotomagense and naviculare Zones), plenus Marls and Middle Chalk.

Southerham 'Grey' Pit, Sussex (TQ 430922). Working pit exposing high rhotomagense Zone (jukes-browni assemblage) and naviculare Zone, Lower Chalk, plenus Marls and Middle Chalk.

Steyning Limeworks, Sussex (TQ 176104). Working pit exposing the top of the Lower Chalk, naviculare Zone, plenus Marls and Middle Chalk.

Stoneham, Sussex; just north of Lewes (TQ 425119). Museum material suggests the mantelli Zone.

Undercliff, Isle of Wight. Blocks of the Upper Greensand/ Glaùconitic Marl contact and the base of the Lower Chalk are visible at Binnel Point (SZ 758527), Woody Bay (SZ 533760), Woody Point (SZ 532759) etc.

SOUTHWESTERN CENOMANIAN LOCALITIES.

Askerswell, Dorset (SY 529923). A temporary section 300m. south of Askerswell Church, 25m. north of the A26. This exposes Eggardon Grit overlain by Chalk Basement Bed with phosphatized naviculare Zone fossils.

Beer Head to Branscombe, Devon (SY 229890). Cliff section accessible at various points. Upper Greensand, Cenomanian Limestone and Middle Chalk exposed.

Bovey Lane Sandpit, Beer, Devon (SY 217900). The pit is described by Smith (1961:117-120). Expanded equivalents of A_1 and A_2 of the Cenomanian Limestone, overlain by much decalcification and disturbed equivalents of B and C beds still visible.

Buckland Newton, Dorset (ST 703051). A large working pit, exposing dispar-perinfeatum Zone fossils, remanie mantelli Zone fossils and phosphatized and unphosphatized rhotomagense Zone, acutus assemblage forms.

Burnt Bottom, Dorset (ST 008527). A small outcrop on the

north side of the Hooke Valley. A similar sequence to that at Toller Porcorum is seen.

Chilfrome Lane, Maiden Newton, Dorset (SY 979593). A disused pit to the west side of the lane leading north from Maiden Newton to Chilfrome. About 2-5m. of Eggardon Grit are exposed, overlain by Chalk Basement Bed with phosphatized rhotomagense Zone, acutus assemblage fossils and unphosphatized jukesbrownei assemblage fossils.

Compton Valence, Dorset (SY 592931). Natural cliff exposures and lane sections showing Exogyra sandstone, Chert Beds, Eggardon Grit and Chalk Basement Bed with remanie mantelli Zone fossils at the base and a phosphatized and unphosphatized rhotomagense Zone, jukesbrownei assemblage fossils.

Eggardon Hill, Dorset (SY 535952 - 540946). Natural exposures of Chert Beds and Eggardon Grit (with indigenous mantelli Zone fossils) overlain by Chalk Basement Bed with phosphatized rhotomagense Zone, acutus and jukesbrownei assemblage fossils and unphosphatized jukesbrownei assemblage fossils.

Frimley, Devon (ST272042). A disused pit on the east side of the lane leading from Membury to Frimley. Digging exposes Upper Greensand (unfossiliferous) and Chalk Basement Bed (30cm of phosphorite) can be exposed; the Basement Bed yields remanie Lower Cenomanian ammonites and phosphatic forms spanning most of the Middle Cenomanian above a few centimetres of glauconitic chalk yield phosphatized naviculare Zone fossils; this seems to be of plenus Marls age.

Horn Hill, Beaminster, Dorset (ST 440032). A disused quarry on Beaminster Down, east of the road tunnel. This exposes the top of the Chert Beds, Eggardon Grit, a thin conglomeratic bed of the Lower Cenomanian and Chalk Basement Bed with phosphatized acutus assemblage fossils, unphosphatized jukesbrownei assemblage fossils and remanie mantelli Zone fossils.

Humbledon Hill, Childe, Okeford, Dorset (ST 843133). A large disused pit on the north side of Hambledon Hill, exposing the Orbirhynchia mantelliana Zone of the Lower Chalk.

Humble Point, near Seaton, Devon (SY 305898). Fallen blocks on the foreshore and crags on the landslip behind show A and B beds of the Cenomanian Limestone and very fossiliferous Bed C and Middle Chalk.

Hutchin's Pit, Wilmington, Devon (ST 212003). Badly overgrown pit north of Wilmington Village by the South Devon Water Board pumping station; also known as the "Waterworks Pit". Digging will expose Upper Greensand (Upper Albian?) basal shell bed and mantelli Zone, saxbii assemblage, Wilmington Sands, grizzle and beds of A_2 of the Cenomanian Limestone. Bed C and the basal beds of the Middle Chalk can also be seen.

Rock Cottages, Evershot, Dorset (ST 578050). A disused pit behind the cottages alongside the eastern fork of the unmelted track running north from the eastern end of the village. This exposes Exogyra sandstone and dispar-perinflatum subzone, Upper Greensand, overlain by Chalk Basement Bed with phosphat-

ized rhotomagense Zone, acutus assemblage and unphosphatized ?jukesbrownei assemblage fossils.

Snowdon Hill, Chard, Somerset (ST 313089). A disused pit on the north side of the A30 west of Chard. This exposes Chert Beds, Eggardon Grit and Chalk Basement Bed with phosphatized rhotomagense Zone, acutus assemblage fossils.

Storridge Hill, Chardstock, Devon (ST 316044). Two disused quarries on the eastern side of Storridge Hill. The lower pit exposes Chert Beds, the upper pit shows the extreme top of the Chert Beds overlain by sands (Eggardon Grit), Bed A_2 of the Cenomanian Limestone and Chalk Basement Bed with a phosphatized rhotomagense Zone, jukesbrownei assemblage and remanie Lower Cenomanian and Middle Cenomanian ammonites.

Toller Fraterum, Dorset (SY 581978). A small, almost completely overgrown pit, north of the lane running southwest from the A356 to Toller Fraterum. This exposes Eggardon Grit overlain by 15cm of phosphatic conglomerate with mantelli Zone fossils, overlain by Chalk Basement Bed with phosphatized rhotomagense Zone, acutus assemblage fossils.

Toller Porcorum, Dorset (SY 567982). A small, almost completely overgrown pit about 250m. north of the lane leading down to Toller porcorum. This exposes Eggardon Grit overlain by 25cm of phosphatic Lower Cenomanian conglomerate. Above this is a band of Chalk Basement Bed with derived mantelli Zone fossils, phosphatized rhotomagense Zone, acutus assemblage fossils and unphosphatized jukesbrownei assemblage fossils.

White Cliff, Seaton, Devon (ST 235894). Fallen blocks of Upper Greensand and Bed A and B of the Cenomanian Limestone; also sections of same towards Beer Head.

White Hart Sandpit, Devon (SY 208999). Western end of the village of Wilmington opposite White Hart Inn. Exposure of chert and sands of the Upper Greensand, Grizzle, Beds B and C of the Cenomanian and the basal beds of the Middle Chalk are exposed.

Wynford House, Dorset (SY 574953). A small disused roadside quarry near Wynford House, exposing Eggardon Grit overlain by Chalk Basement Bed with phosphatized and unphosphatized rhotomagense Zone, jukesbrownei assemblage fossils.

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PLATES 1 - 28

PLATE 1

1-3 Cyclothyris punfieldensis sp.nov. Glauconitic Marl,Undercliff, Isle of Wight. BB 82244 X 1½.

4-6 Cyclothyris punfieldensis sp.nov. Ur.Albian, Dispar Zone, Punfield Cove,Dorset. HOLOTYPE BB 82245 X 1½.

7-9 Cyclothyris punfieldensis sp.nov. Basal Cenomanian, Cap de la Hève, Normandy. BB 82183. X 1½.

10-12 Cyclothyris cf.punfieldensis sp.nov. Bottom Bed of Upper Albian, Cap de la Hève, Normandy. BB.82182 X 1½

13-15 Cyclothyris difformis (Val. in Lamarck) Upper Greensand, Compton Bay, Isle of Wight. BB 82339 X 1½

16-18 Cyclothyris sp. Albian, Castellas, Narbonne, S.W.France. BB 82367 X 1.

19-21 ? Cyclothyris sp. Lower Cenomanian, Chardstock, Devon. B 8218 X 2.

22-24 Burrirhynchia wilmingtonensis sp.nov. Lower Cenomanian,White Hart Pit, Devon. HOLOTYPE. BB 82252 X 2.

25-27 Burrirhynchia cf. sigma (Schloenbach) Lower Cenomanian, Annopol,Poland. BB 82340 X 2

28-30 Burrirhynchia leightonensis (Walker) Lower Albian, Shenley Hill, Leighton Buzzard, Bedforshire B 26575 X 1

Plate 1

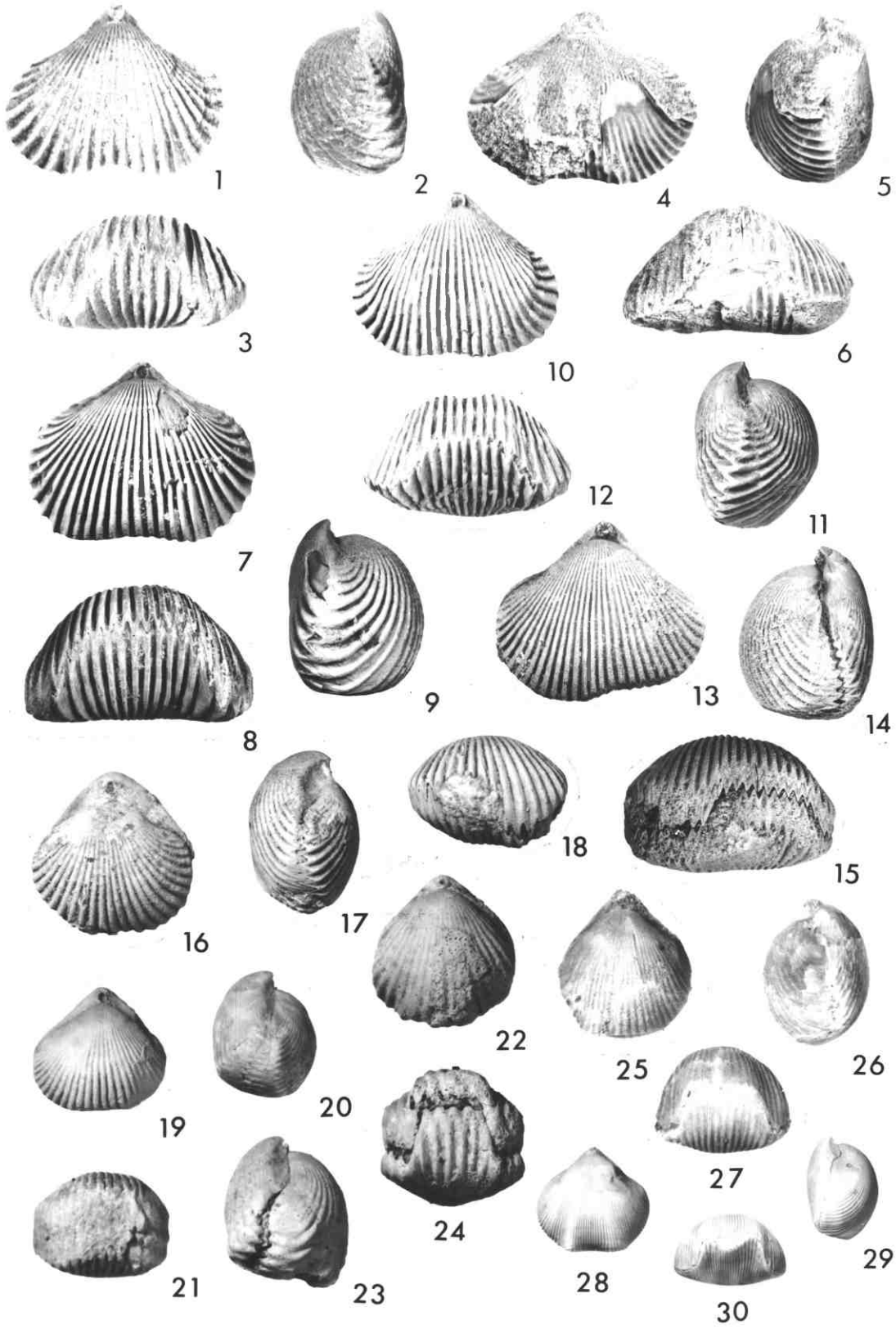

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PLATE 2

1-3 Cyclothyris cf. difformis (Val. in Lamarck)
Upper Greensand, Compton Bay, Isle of Wight.
BB 82248

4-6 Cyclothyris difformis (Val. in Lamarck)
Chalk Basement Bed, Snowdon Hill, Chard,
Somerset. BB 82242 X 1½

7-9 Cyclothyris scaldisensis (d'Archiac)
Bed B equivalent, Cenomanian, St.Jouin,
Normandy. BB 82184 X 1½

10-12 Cyclothyris difformis (Val. in Lamarck)
13-15 Lower Cenomanian, High Melcombe,Dorset.
BB 82243 X 1½

13-15 Cyclothyris difformis (Val. in Lamarck)
Middle Cenomanian, nodular limestone,
Bovey Lane Pit, Devon. BB 61120 X 1½.

16-18 Cyclothyris punfieldensis sp. nov.
(gerontic specimen) Upper Albian,
Punfield Cove,Dorset. BB 82341.

19-21 Cyclothyris sp.
Belfast district, Northern Ireland.
X 1½ B 82291.

Plate 2

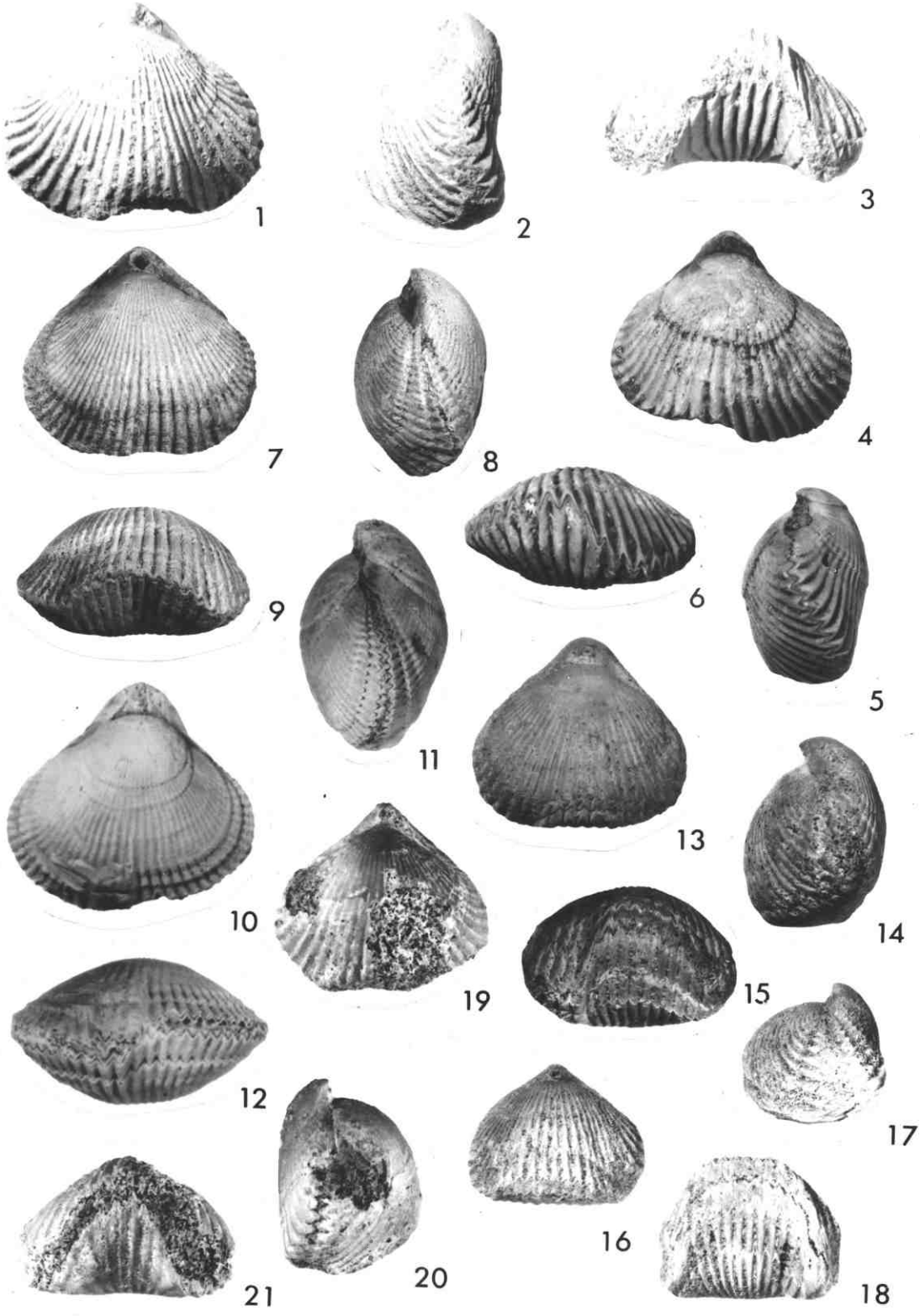


PLATE 3

1-3 Cyclothyris formosa sp.nov.
Cenomanian, Lennier's Bed 10, St.Jouin, Normandy. BB 82206 HOLOTYPE X1½

4-6 Cyclothyris formosa sp.nov.
As above. Paratype. BB 82207 X 1½.

7-9 Cyclothyris lamarckiana (d'Orbigny)
Marnes à Ostracée Briollay, Sarthe.
BB 82203 X 1½

10-12 As above. BB 82204 X 1½

13-15 As above BB 82205 X 1½

16-18 Cyclothyris juigneti sp.nov.
Cenomanian, T. costatus Zone.
La Perrière (Orne). BB 82208 X 1½

19-21 As above. Paratype. X 1 ½
BB 82209

22-24 Cyclothyris compressa (Val. in Lamarck)
Upper Cenomanian, naviculare Zone,
Marnes à Huitre, Mayet (Sarthe) BB 82210
X 1½

25-27 Cyclothyris compressa (Val. in Lamarck)
As above BB 82211 X 1 ½

Plate 3

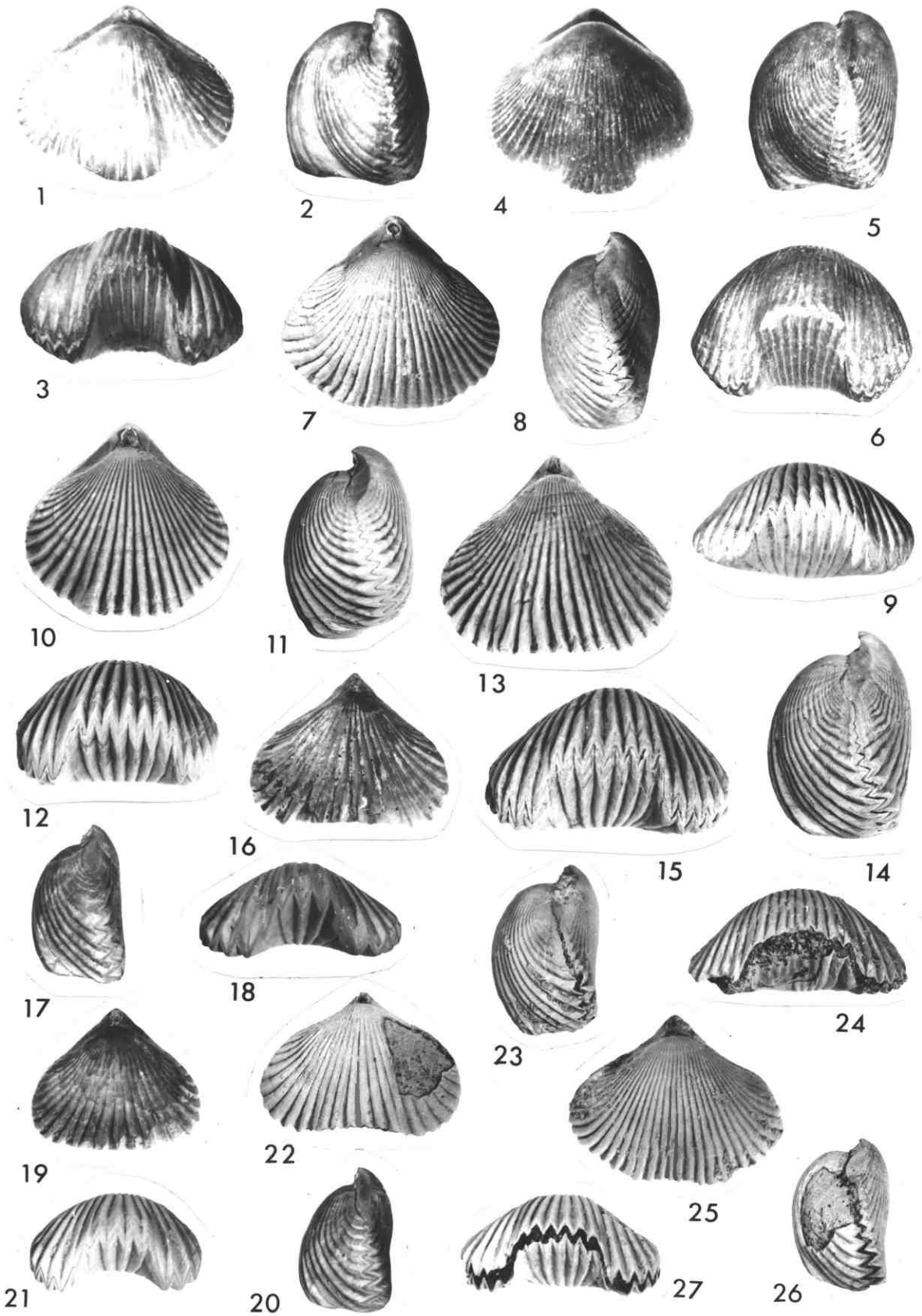


PLATE 4

1-3 Orbirhynchia mantelliana (J. de C. Sowerby)
LECTOTYPE B.M. 61490 Chalk Marl,Hamsey,Sussex.
X 1½

4-6 Orbirhynchia mantelliana (J.de C.Sowerby)
variant from Lower Chalk, rhotomagense Zone.
B.M. BB 82336 X 1 ½

7-9 Orbirhynchia cf. mantelliana (J.de C.Sowerby)
(? paucicosta Roemer) Lower Cenomanian,
Le Mans district, Sarthe. BB 82337.

10-12 Orbirhynchia mantelliana (J. de C.Sowerby)
Totternhoe Stone, Barrington, Cambridge.
BB 81020 X 1½

13-15 Orbirhynchia wilmingtonensis sp.nov.
Craie de Rouen, Côte de St.Catharine, Rouen.
BB 82338 X 1½.

16-18 Orbirhynchia wilmingtonensis sp. nov.
Lower Cenomanian, mantelli Zone.
HOLOTYPE BB 83132 X 1½

19-21 Orbirhynchia boussensis sp.nov.
Ur.Cenomanian, Sable de Bousse,Bousse (Sarthe).
HOLOTYPE BB 82131 X 1½.

22-24 Orbirhynchia sp. Red Rock, Hunstanton,
Norfolk. B 19904 X 1½

25-27 Orbirhynchia wiesti (Quenstedt)
Cenomanian, Bed B, Little Bearch, Beer,Devon.
BB 7126

28-30 Orbirhynchia wiesti (Quenstedt)
Cenomanian Basement Bed,naviculare Zone,
Askerswell, Dorset. BB 82097 X 1½

31-33 Orbirhynchia boussensis sp. nov.
Sable de Bousse,Bousse (Sarthe),France.
BB 61140 X 1½ Paratype.

34-36 Orbirhynchia multicostata Pettitt
Upper Cenomanian, Plenus Subzone, South Ferriby.
BB 82342 X 1½

37-39 As above. Plenus Marl, Marham,Norfolk.
BB 82343 X 1½

40-42 As above. Plenus Marl,Burwell nr.Louth,Lincs.
BB 82344 X 1½

Plate 4

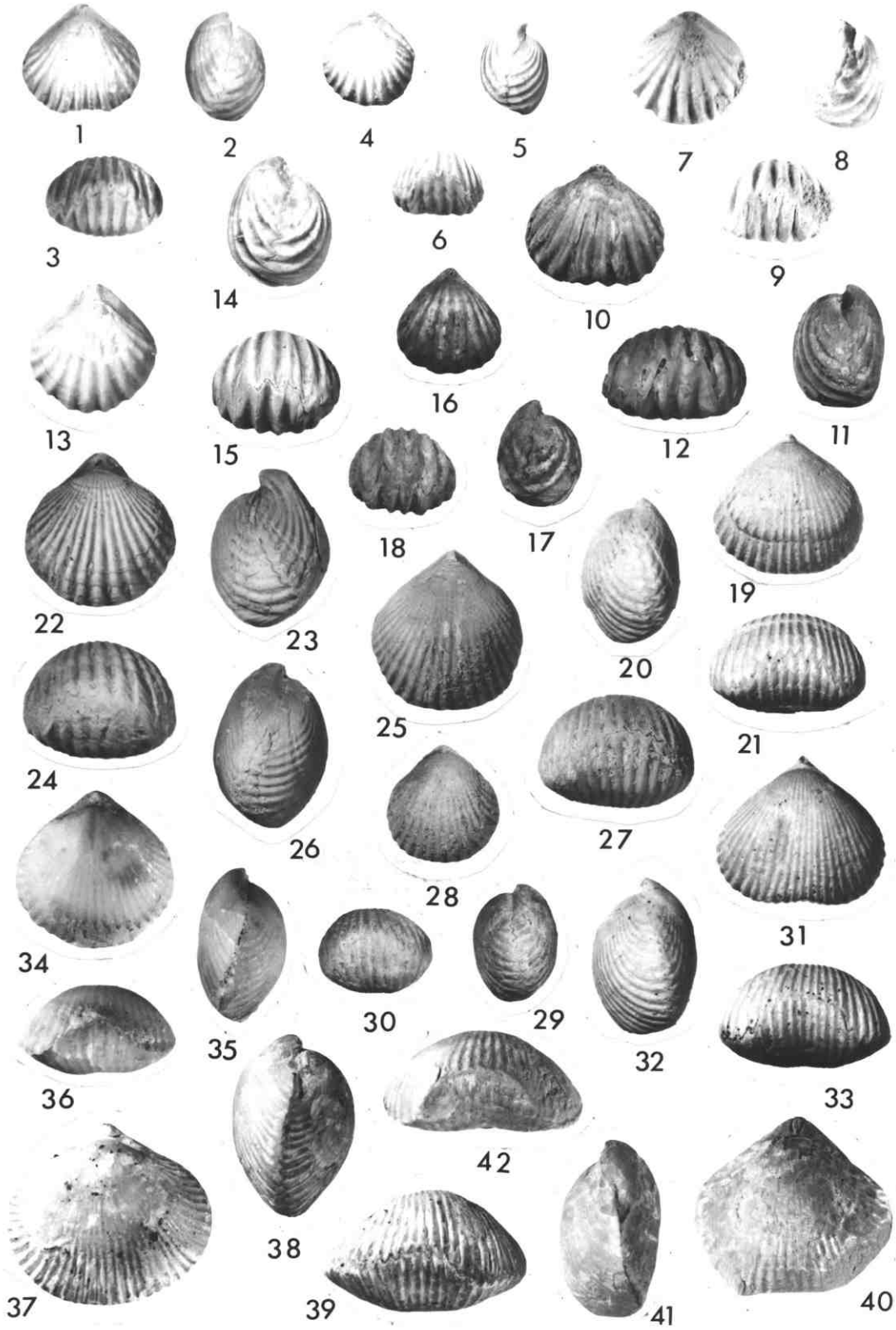

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PLATE 5

1-3 Terebratulina protostriatula sp. nov.
Chalk Marl, Hamsey, Sussex.
HOLOTYPE B 6038 X 1½

4-6 Terebratulina protostriatula sp. nov.
Lower Cenomanian, White Hart Pit, Wilmington, Devon. Paratype BB 82261. X 1½.

7-9 Terebratulina striatula (Mantell)
Upper Chalk, Hamsey, Sussex.
HOLOTYPE B 457 X 1½

10-12 Terebratulina ? auriculata (Roemer)
Tourtia,Tournai,Belgium. B 35491 X 1½

13-15 Terebratulina protostriatula sp. nov.
Essen Greensand, Essen,North Germany.
B 35690 X 1½

16 Terebratulina nodulosa Etheridge
Red Rock, Bed A, Hunstanton, Norfolk.
BB 82368 X 4

17 Terebratulina triangularis Etheridge
Cambridge Greensand, Cambridge.
BB 82369 X 4

18-19 Thecidiopsis essensis Backhaus.
Essen Greensand, Essen, North Germany.
BB 82369 X 10

20-22 Grasirhynchia grasiana (d'Orbigny)
LECTOTYPE Cenomanian, Le Hâvre.
Coll.Inst.de Pal.,Paris No.6497 X 2

20 Grasirhynchia grasiana (d'Orbigny)
Specimen from the Cenomanian of Le Hâvre, showing characteristc auriculation of the foramen by the extension of the deltidial plates. B.M. 25315 X 6.

Plate 5

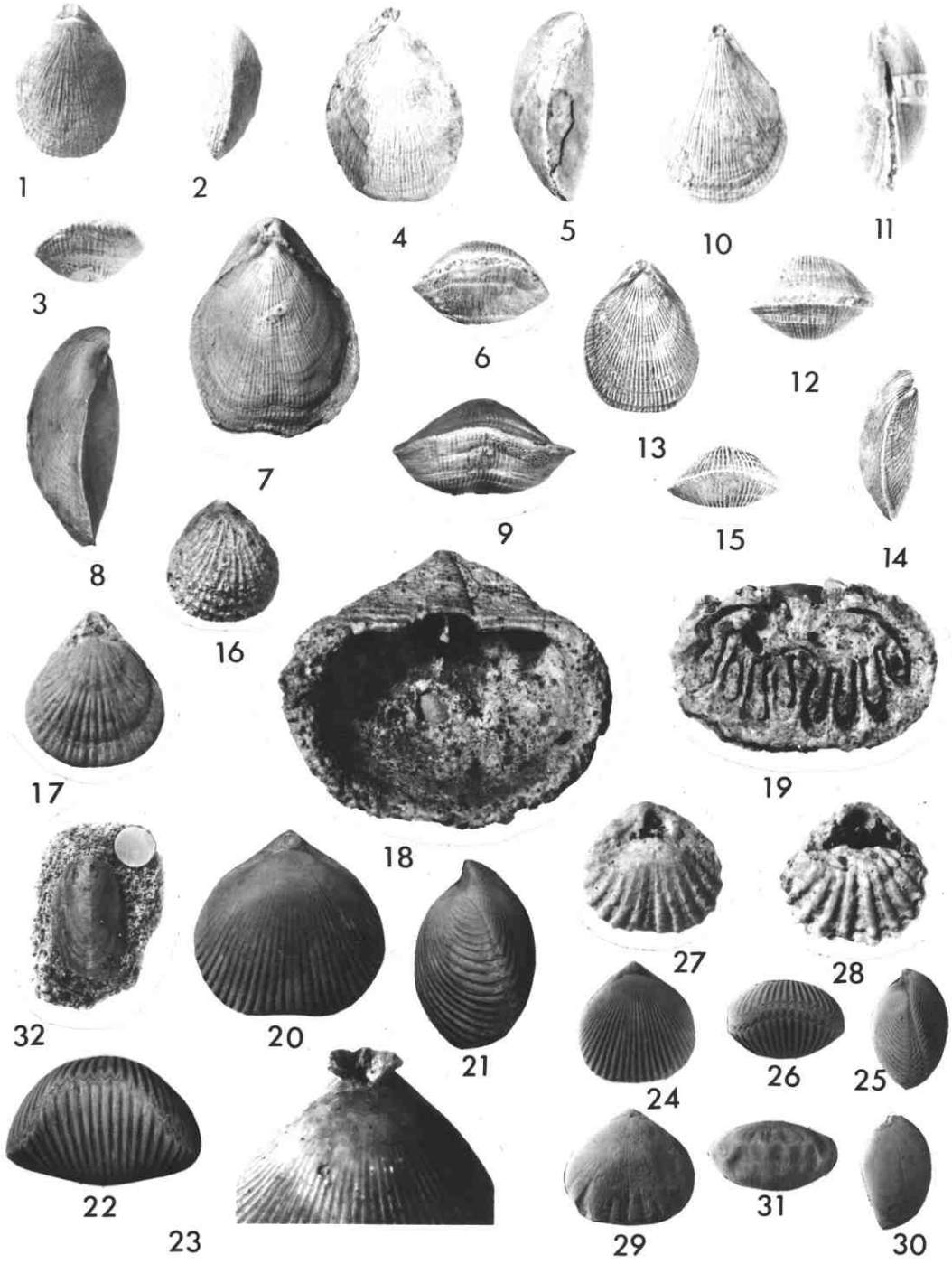

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PLATE 6

1-3 Sellithyris tornacensis (d'Archiac)
Tourtia, Tournai, Belgium, B.85066.
X 1½

4-6 Sellithyris tornacensis var crassa (d'Archiac)
Tourtia, Tournai, Belgium. B 31322 X 1½

7-9 Sellithyris phaseolina (Val. in Lamarck)
Cliff Section at Parte des Barqués,Charente,Fr.
BB 82286. X 1½

10-12 Rectithyris wrightorum sp. nov.
Lower Cenomanian, mantelli Zone,
White Hart Pit, Wilmington,Devon.
BB 82175. X 1

13-15 ? Ornatothyris sp.
Grey-Red Chalk, Speeton Cliff, Yorks.
BB 82346

16-18 Concinnithyris cf. subundata (J.Sowerby)
Lower Chalk, Barrington, Cambridge.
BB 76462 X 1½

19-21 "Ornatothyris" sp. Grey Chalk,Speeton.
BB 43360. X 1½

22-24 Moutonithyris anglia sp.nov.
Bed C, Red Rock, Hunstanton, Norfolk.
HOLOTYPE BB 82262 X 1

Plate 6

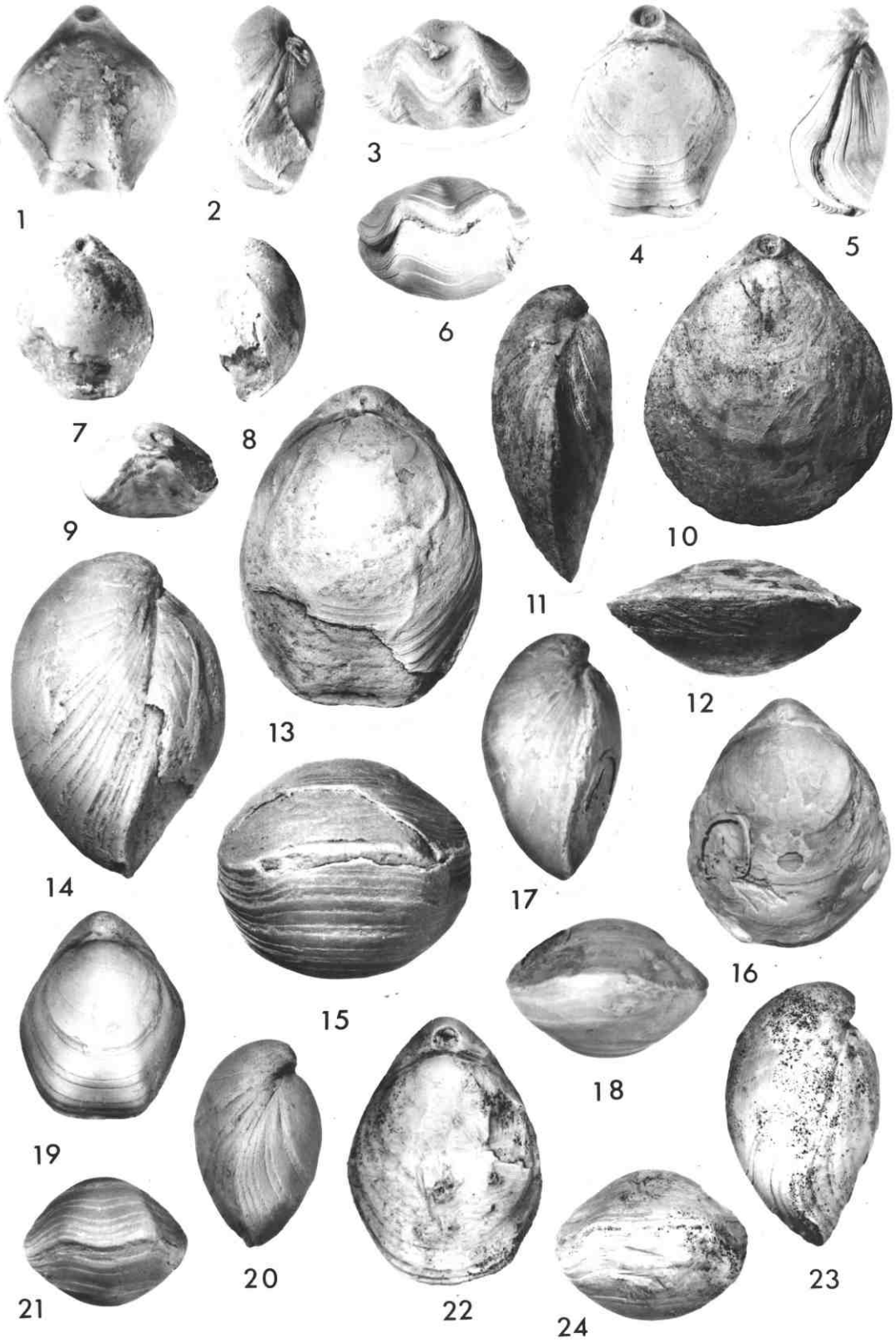


PLATE 7

1-3 Boubeithyris diploplicata sp. nov.
Lower Cenomanian, Vimoutiers (Orne), France. B 6259 X 1.

4-6 Boubeithyris boubei (d'Archiac)
Tourtia, Tornai, Belgium. BB 82370 X 1

7-9 Ornatothyris sulcifera (Morris)
Cenomanian, Fulbourne, Cambridge. BB 6017 X 1

10-12 Ovatathyris potternensis sp. nov.
Glauconitic Marl, Potterne, Wiltshire.
HOLOTYPE B.84129 X 1

13-15 Ovatathyris potternensis sp. nov.
Glauconitic Marl, Riffle Butts, Potterne, Wiltshire. B 25283 X 1

16-18 Ovatathyris potternensis sp. nov.
Glauconitic Marl, Compton Bay, Isle of Wight.
BB 82189 X 1½

19-21 Ovatathyris cf. ovata (J.Sowerby)
? Upper Albian, Perte du Rhone, Switzerland.
Geneva Museum (Nat.Hist.) coll. No.CB 57. X 1½

22-24 Ovatathyris ovata (J.Sowerby)
Warminster Greensand, Warminster, Wilts.
B . X 1½

Plate 7

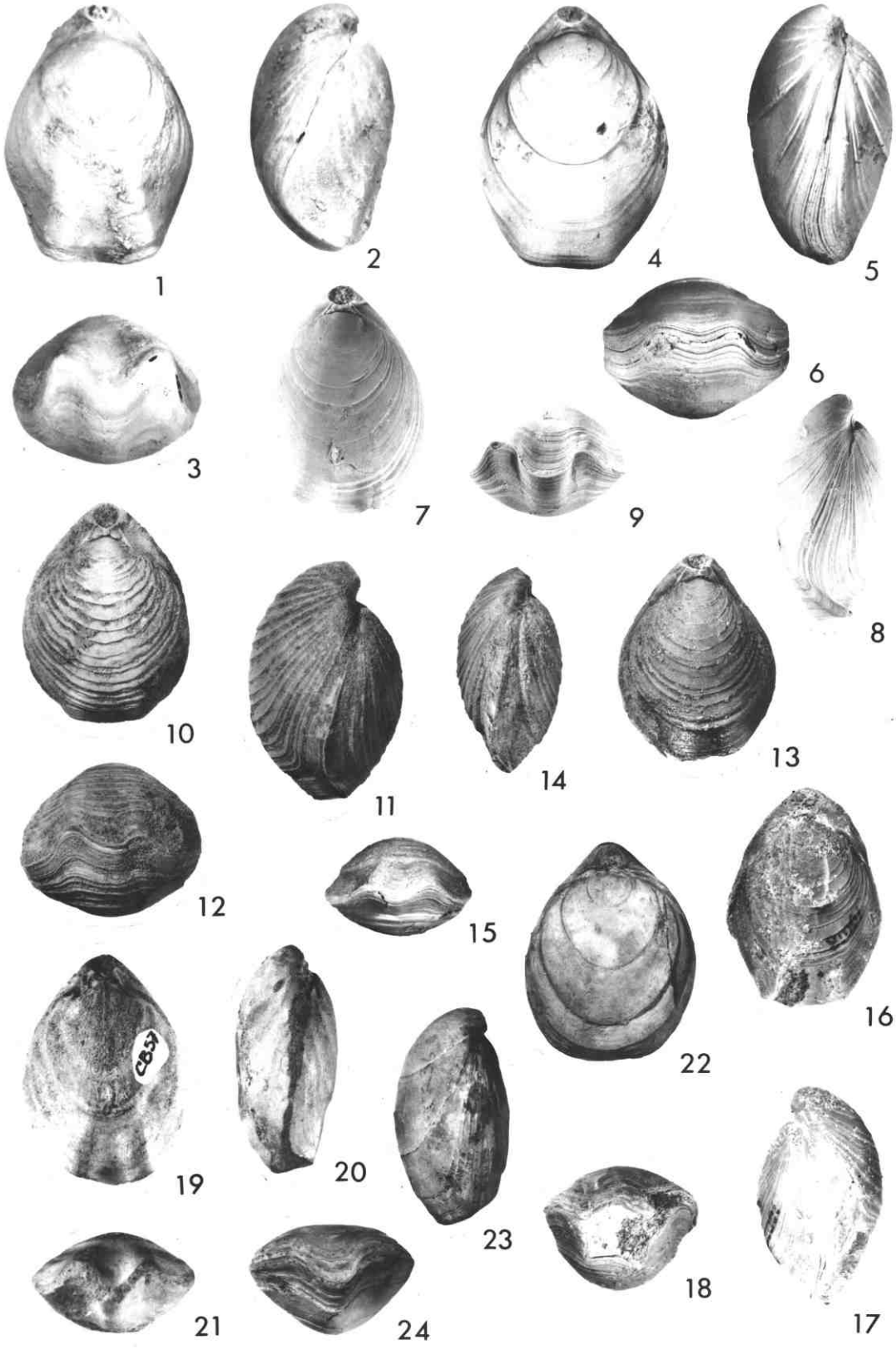


PLATE 8

1- 3 Tropeothyris vectis sp. nov.
Lower Cenomanian, Mont St. Catharine, Rouen, France. B.M. B.6156 X 1½

4- 6 Boubeithyris diploplicata sp. nov.
Upper Greensand, Compton Bay, Isle of Wight. B.M. B.25281 X 1½

7- 9 As above.
Upper Greensand, Warminster, Wilts. B.M. B.95597 X 1½

10-12 As above.
Lower Cenomanian, Vimoutiers (Orne), Normandy X 1½ B.M. B.6289.

13-15 As above.
Upper Greensand, Rocken End, Isle of Wight. B.M. BB.69002 X 1½

16-18 As above.
Cenomanian, Auberville, Normandy. B.M. B.85265 X 1½

19-21 As above.
Glauconitic Marl, Eastbourne, Sussex. B.M. BB.82349.

Plate 8

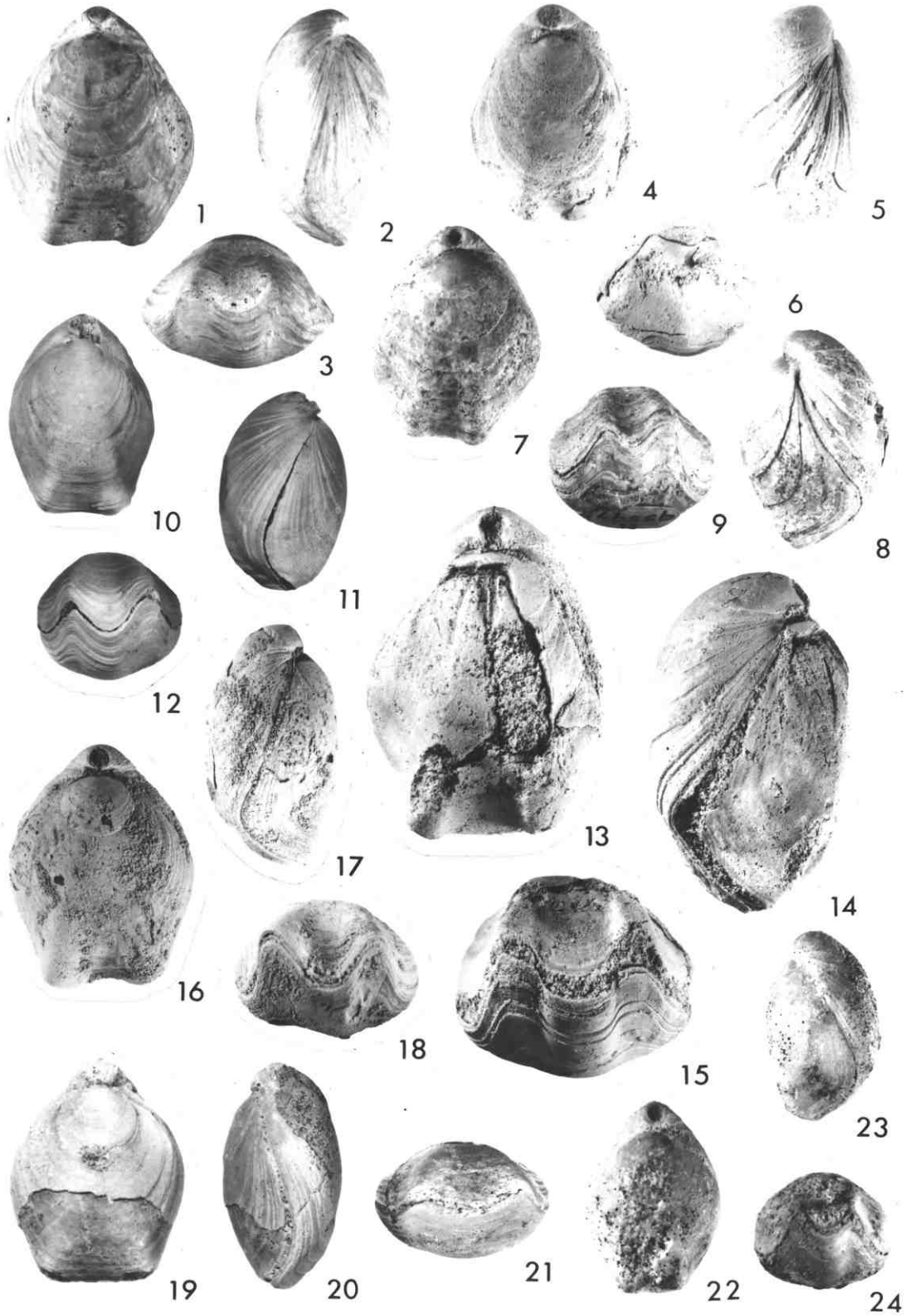


PLATE 9

1- 3 "Tropeothyris vectis" (= Terebratula carteri Davidson). Lower Cenomanian, Folkestone, Kent. B.M. B.6126 X 1½

4- 6 Tropeothyris vectis sp. nov. Upper Greensand, Rocken End, Isle of Wight. B.M. B.6221 X 1½

7- 9 Undescribed species, Lower Cenomanian, Julianka, Annopol, Poland X 1½

10-12 Tropeothyris vectis sp. nov. Glauconitic Marl, Gore Cliff, Isle of Wight. B.M. 82185 X 1½

13-15 As above. Glauconitic Marl, Folkestone Warren. B.M. B.24944 X 1½

16-18 Tropeothyris sp. Cenomanian, Loudon Road Pit 19, near Louth, Lincolnshire X 1½

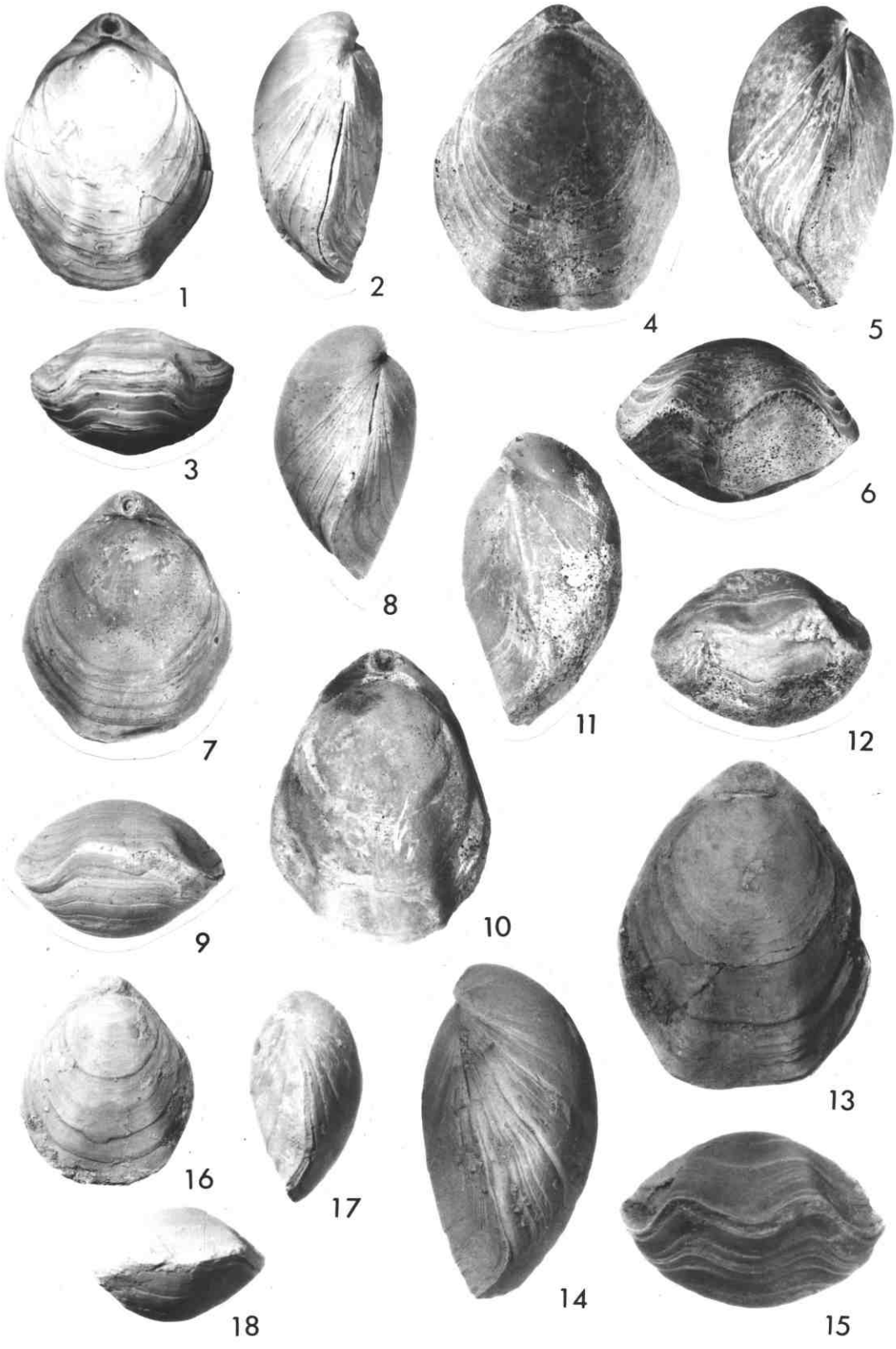

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PLATE 10

1- 3 Moutonithyris dutempleana (d'Orbigny)
Bed B, Red Rock, Hunstanton Cliff,
Norfolk. B.M.BB.82345 X 1½

4- 6 As above.
Cenomanian, Cambridge Greensand,
Cambridge. B.M. BB.21188 X 1½

7- 9 As above.
Cambridge Greensand, Cambridge
B.M. B.25177 X 1½

10-12 As above - variant.
Cambridge Greensand, Cambridge
B.M. B.25161 X 1½

Plate 10

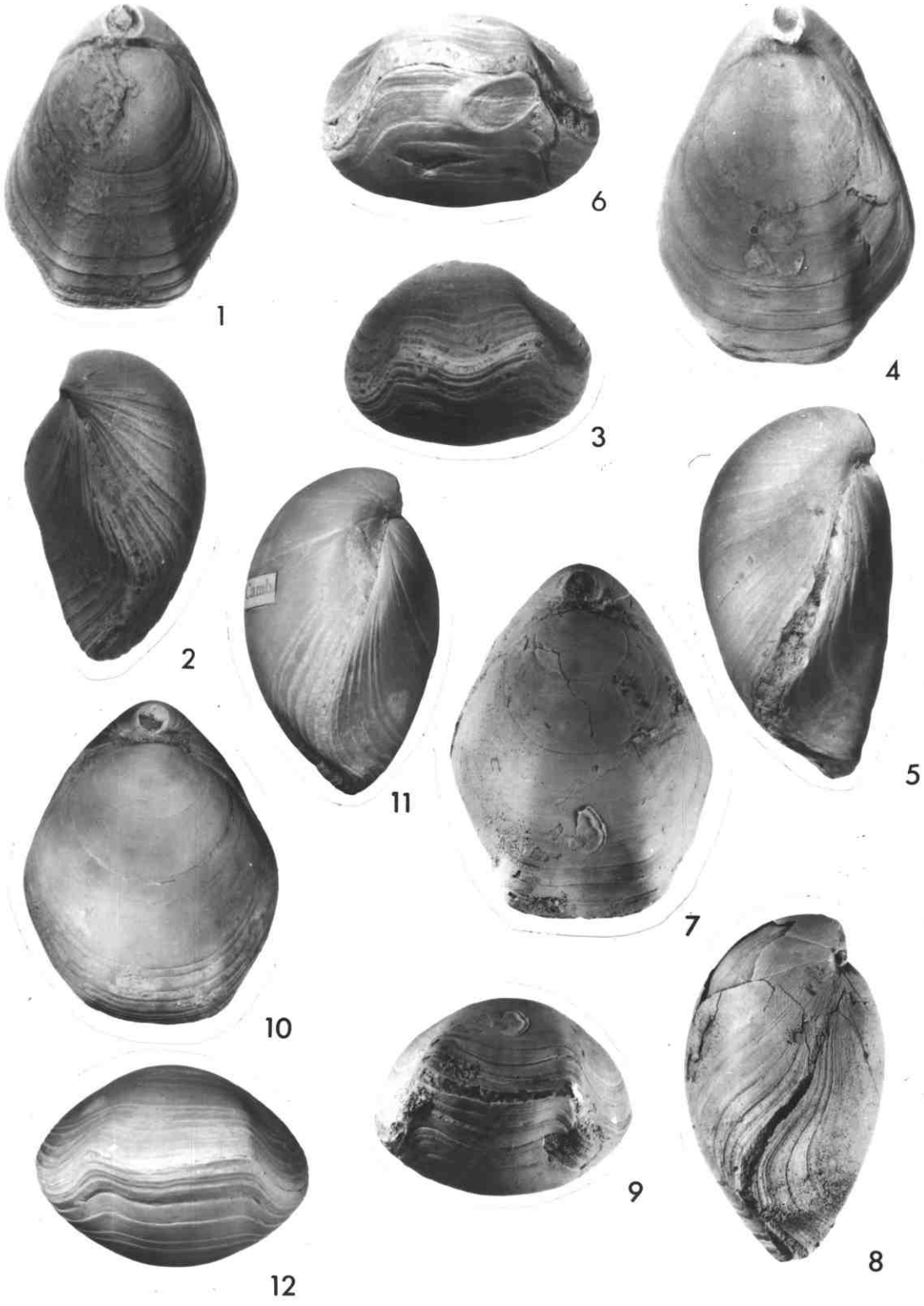


PLATE 11

1- 3 Ornatothyris sabinensis (Parent)
Tourtia, Tournai, Belgium.
B.M. BB.82188 X 1½

4- 6 Moutonithyris dutempleana (d'Orbigny)
Bed A, Red Rock, Hunstanton Cliff,
Norfolk. B.M. BB.82180 X 1½

7- 9 Moutonithyris obtusa (J. Sowerby)
Cambridge Greensand, Cambridge
B.M. BB.6005 X 1

10-12 Concinnithyris davidsoni (Rollier)
Tourtia, St. Aybert, Belgium.
Inst. Sci. roy. Belg. I.G. 8261 X 1½

Plate 11

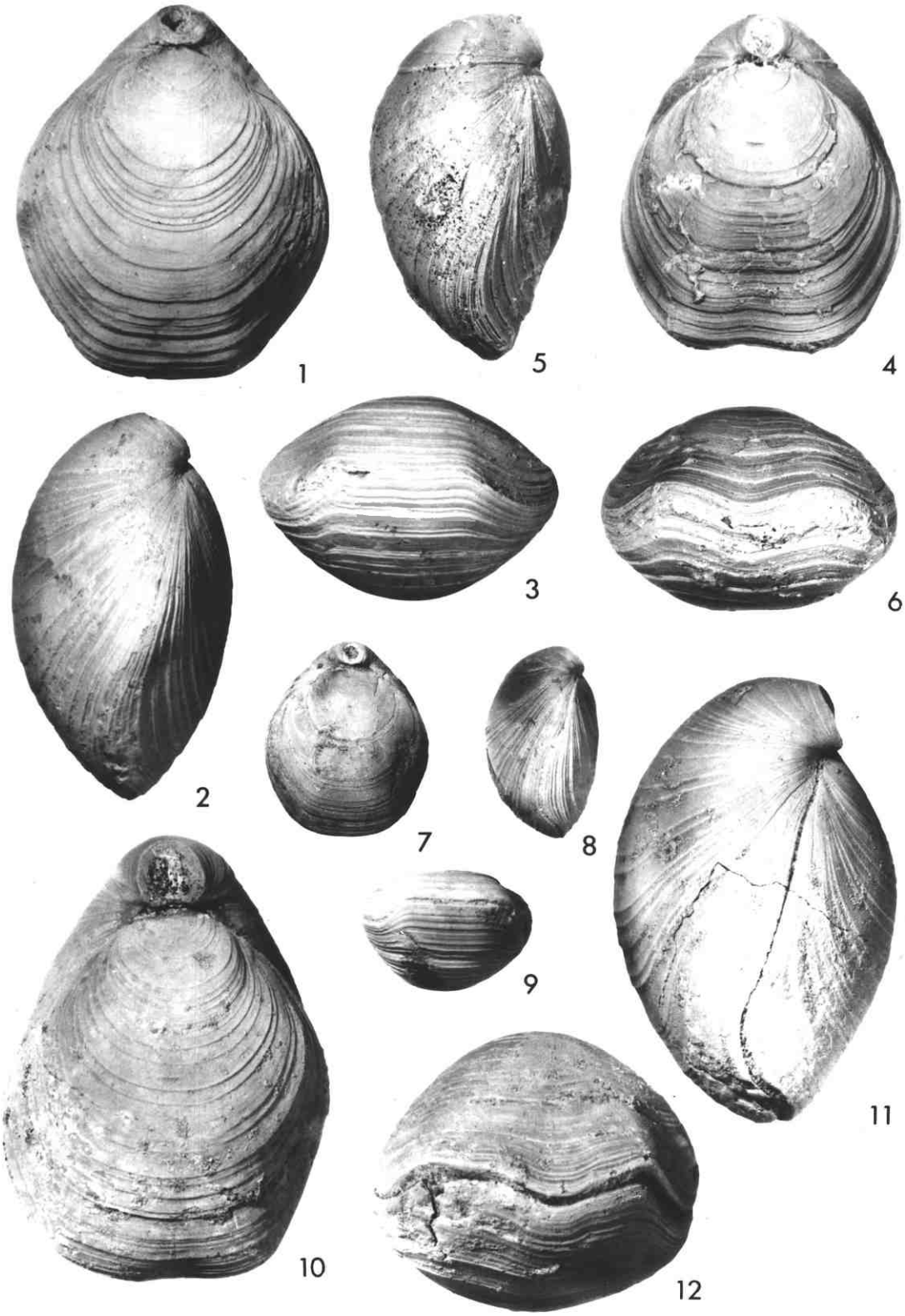


PLATE 12

1- 3 Ornatothyris latissima Sahni
South Ferriby, Yorks
B.M. BB.82202 X 1½

4- 6 Moutonithyris obtusa (J. Sowerby)
Cambridge Greensand, Cambridge
I.G.S. unregistered sp^{n}. X 1½

7- 9 Concinnithyris obesa (J. Sowerby)
L3. Cenomanian, Storridge Hill,
Chardstock, Devon. B.M. BB.82410 X 1½

10-12 Concinnithyris obesa (J. Sowerby)
Bed C, Cenomanian, Shapwick Farm,
near Uplyme, Dorset. B.M. BB.82411
X 1½

13-15 Ornatothyris cf. pentagonalis Sahni
Ist Inoceramus Bed, Lower Cenomanian,
Hunstanton Cliff, Norfolk. B.M.
BB.82302 X 1½

Plate 12

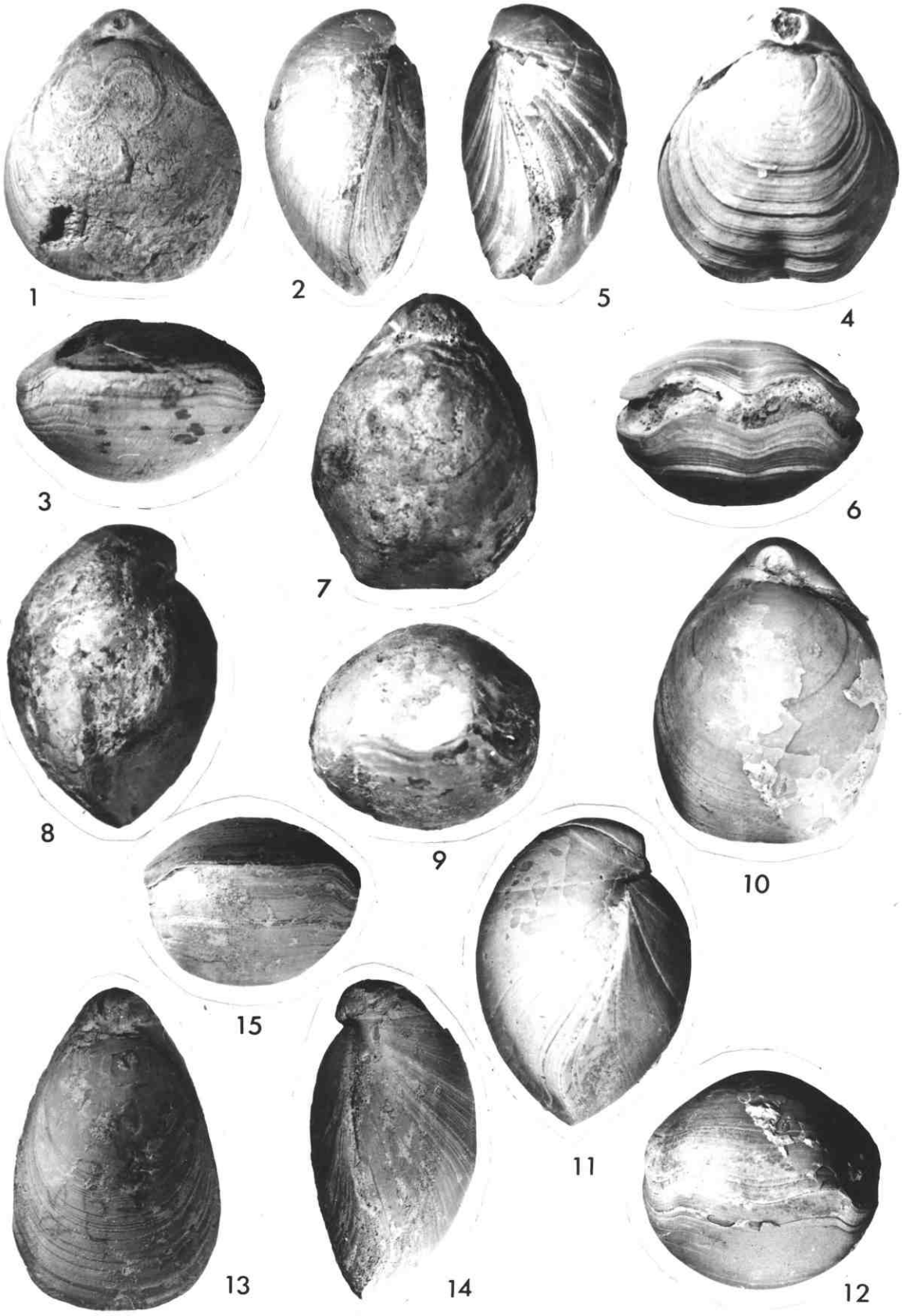


PLATE 13

1- 3 Ornatothyris cf. sulcifera (Morris)
Cenomanian, Cassis, Southern France
B.M. BB.82174 X 1½

4- 6 Ornatothyris sp.
Craie de Rouen, Cote St. Catharine,
Rouen, B.M. BB.82200 X 1½

87- 9 Ornatothyris sulcifera (Morris)
Cenomanian, Fulbourn, Cambridge
B.M. BB. X 1½

10-12 Ornatothyris cf. sulcifera (Morris)
Middle Cenomanian, Grove Mill Pit,
Hitchin, Herts. B.M. BB.82190 X 1½

13-15 Ornatothyris sp
Brunni Alp Bernese overland,
Switzerland. C.B. 366 Geneva Nat.
Hist. Mus. X 1½

16-18 As above
C.B. 369

Plate 13

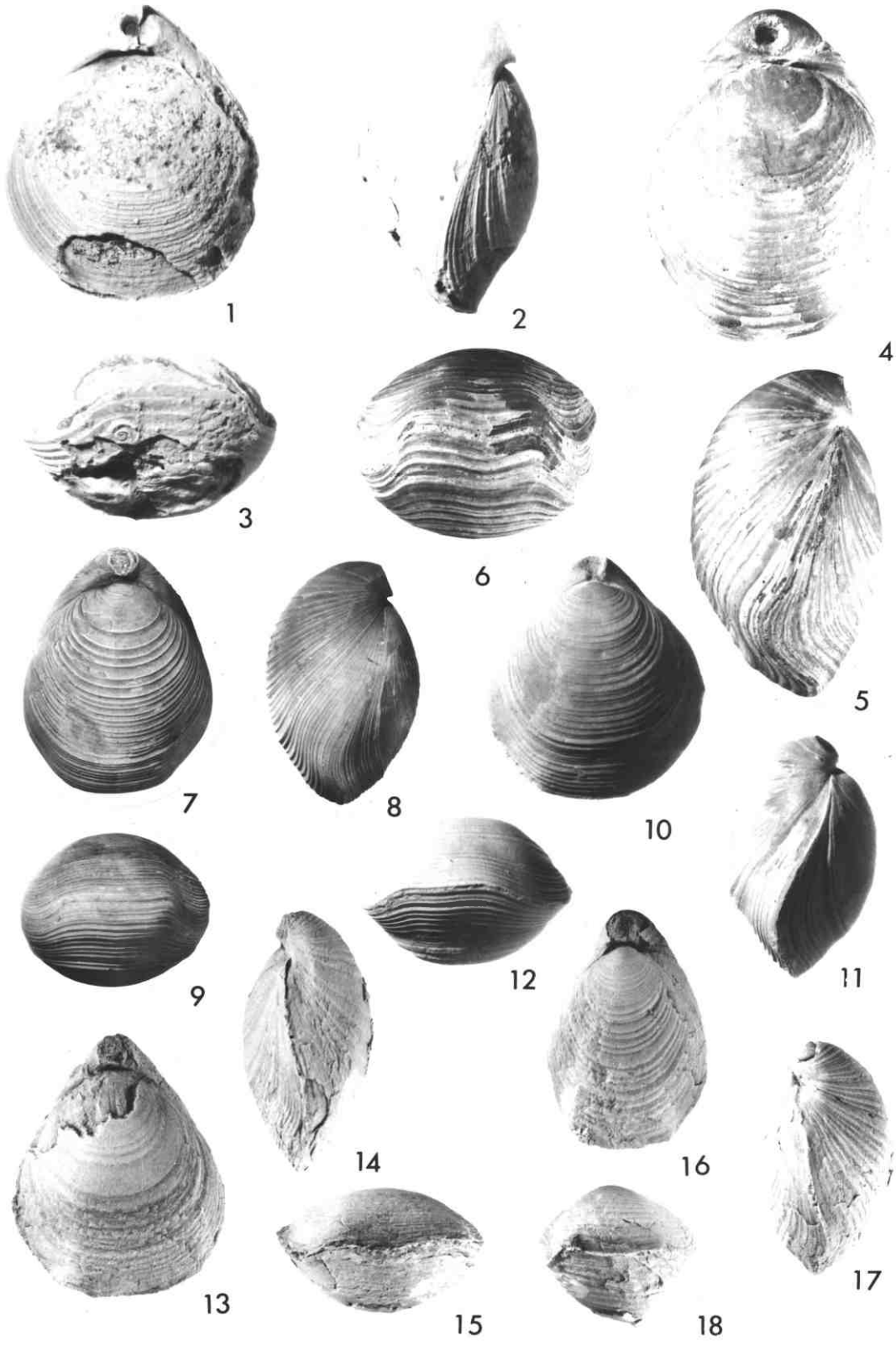


PLATE 14

1- 3 Concinnithyris obesa (J. de C. Sowerby)
HOLOTYPE. Lower Chalk, Norton Bavant, Wilts. B.M. B.49832 X 1

4- 6 As above
Craie de Rouen, Côte St, Catharine, Rouen. X 1

7- 9 Concinnithyris obesa (J. de C. Sowerby)
Middle Cenomanian, Rigstead, Dorset. B.M. BB.45120

10-12 Concinnithyris obesa (J. de C. Sowerby)
Craie de Rouen, Rouen. B.M. B.5701.

13-15 As above.
Middle Cenomanian, Isle of Wight.

Plate 14

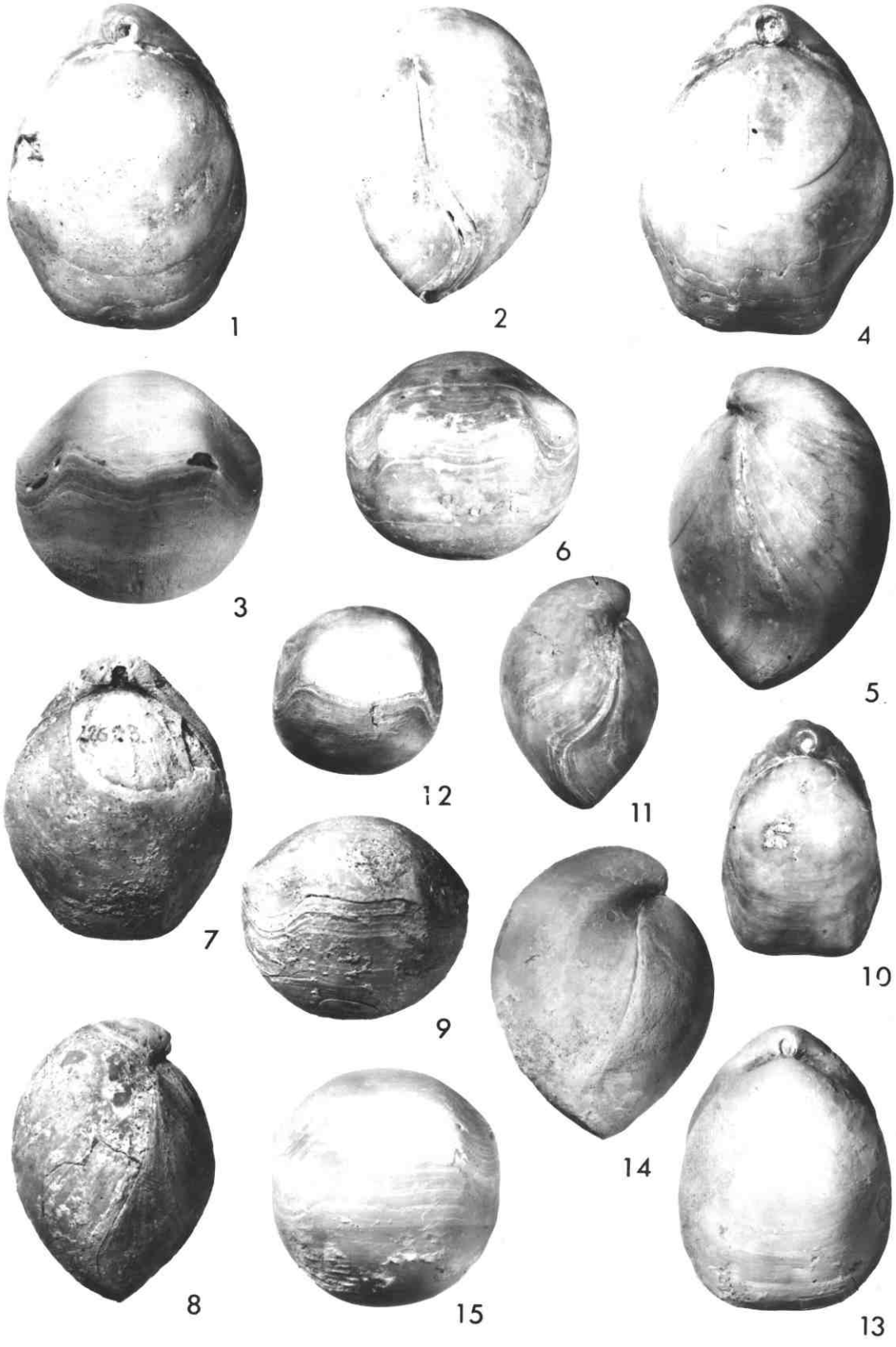


PLATE 15

1- 3 Specimen suggested by Sahni (1929) as LECTOTYPE of Concinnithyris subundata (J. Sowerby) B.M. B.49826 X 1½ (Sowerby Coll.)

4- 6 Concinnithyris subundata (J. Sowerby) Middle Cenomanian, Oxted, Surrey. B.M. B.44830 X 1½

7- 9 As above. Large example from Lower Chalk, Lewes, Sussex. B.M. 96789 X 1½

10-12 As above. Chalk Basement Bed, Snowdon Hill, Chard, Somerset. B.M. BB.82171

Plate 15

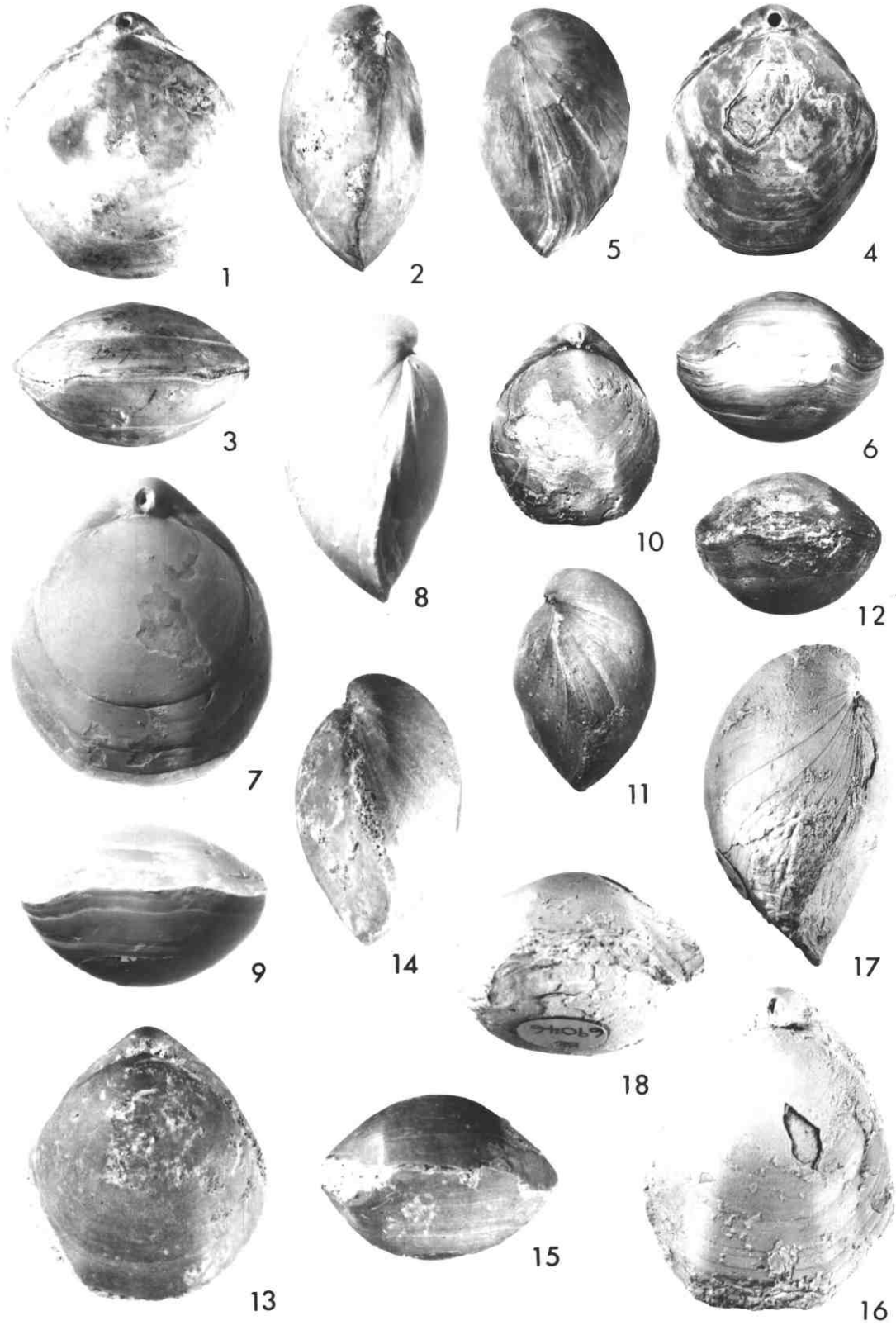


PLATE 16

1- 3 *Concinnithyris subundata* (J. Sowerby) LECTOTYPE here suggested. Specimen from Sowerby Coll. B.M. 49827 X 1½

4- 6 As above.
Eggardon Grit, Eggardon Hill, Dorset.
B.M. BB.82170.

7- 9 As above - (*C. burhamensis* aspect)
Middle Cenomanian, Glynde, Sussex.
B.M. BB.82347.

10-12 As above.
Grey/Red Chalk, Speeton Cliff, Yorkshire.
B.M. BB.82412.

13-15 *Concinnithyris* cf. *subundata*
Pit 3, Hallington, Louth, Lincs.
B.M. B.55145.

Plate 16

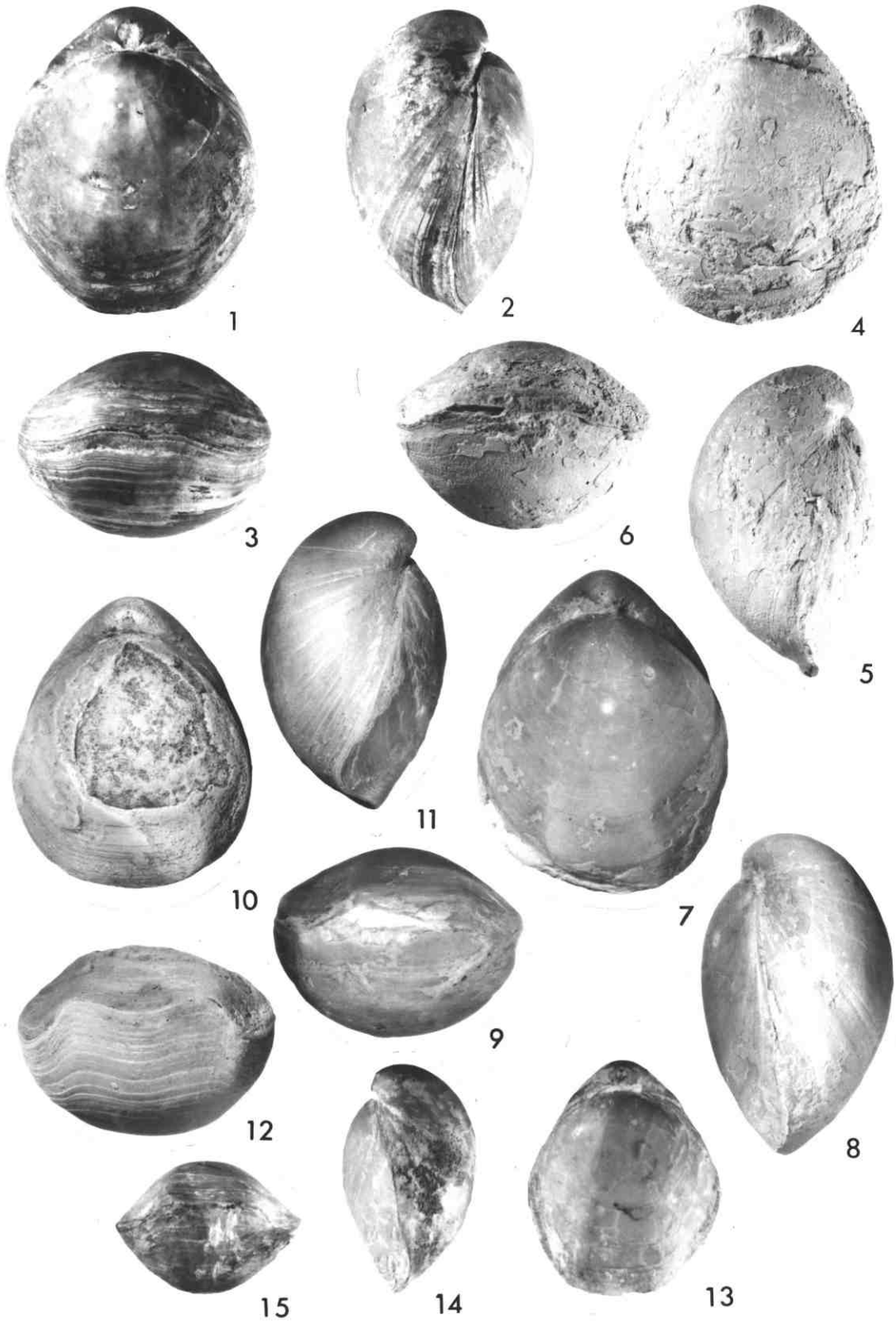


PLATE 17

1- 3 Gemmarcula carantonensis (d'Orbigny)
Upper Cenomanian, Port des Basques, Charente, France. BM.BB.45960 X 2.

4- 6 Gemmarcula menardi (Lamarck)
Sable du Mans, Le Mans (Sarthe) X 2
BM.BB.35152.

7- 9 Arenaciarcula beaumonti (d'Archiac)
An enlarged specimen from the Cenomanian of Drap near Nice. X 1½

10-12 Dereta pectita (J. Sowerby)
Middle Cenomanian near Warminster, Wiltshire B.25263 X 2.

13-15 Dereta pectita (J. Sowerby)
Specimen from type locality at Horningsham, Wiltshire, from the Upper Greensand. BM. BB.4199 X 1½

16-18 Dereta pectita ballardensis subsp. nov.
Ur. Albian, S. dispar Zone, Ballard Point, Swanage, Dorset. BB.82371 X 2

19-21 Gemmarcula canaliculata (Roemer)
Tourtia, Tournai, Belgium. Bm.B.25731 X 1½

22-24 Gemmarcula canaliculata (Roemer)
Lower Cenomanian, White Hart Pit, Wilmington, Devon. BM. BB.82193 X 2

25-27 Dereta incerta (Davidson)
Glauconitic Marl, Chardstock, Devon.
BB.82146 X 2

28-30 Arenaciarcula beaumonti (d'Archiac)
Tourtia, Tournai, Belgium. X 2
BM. BB.45970

Plate 17

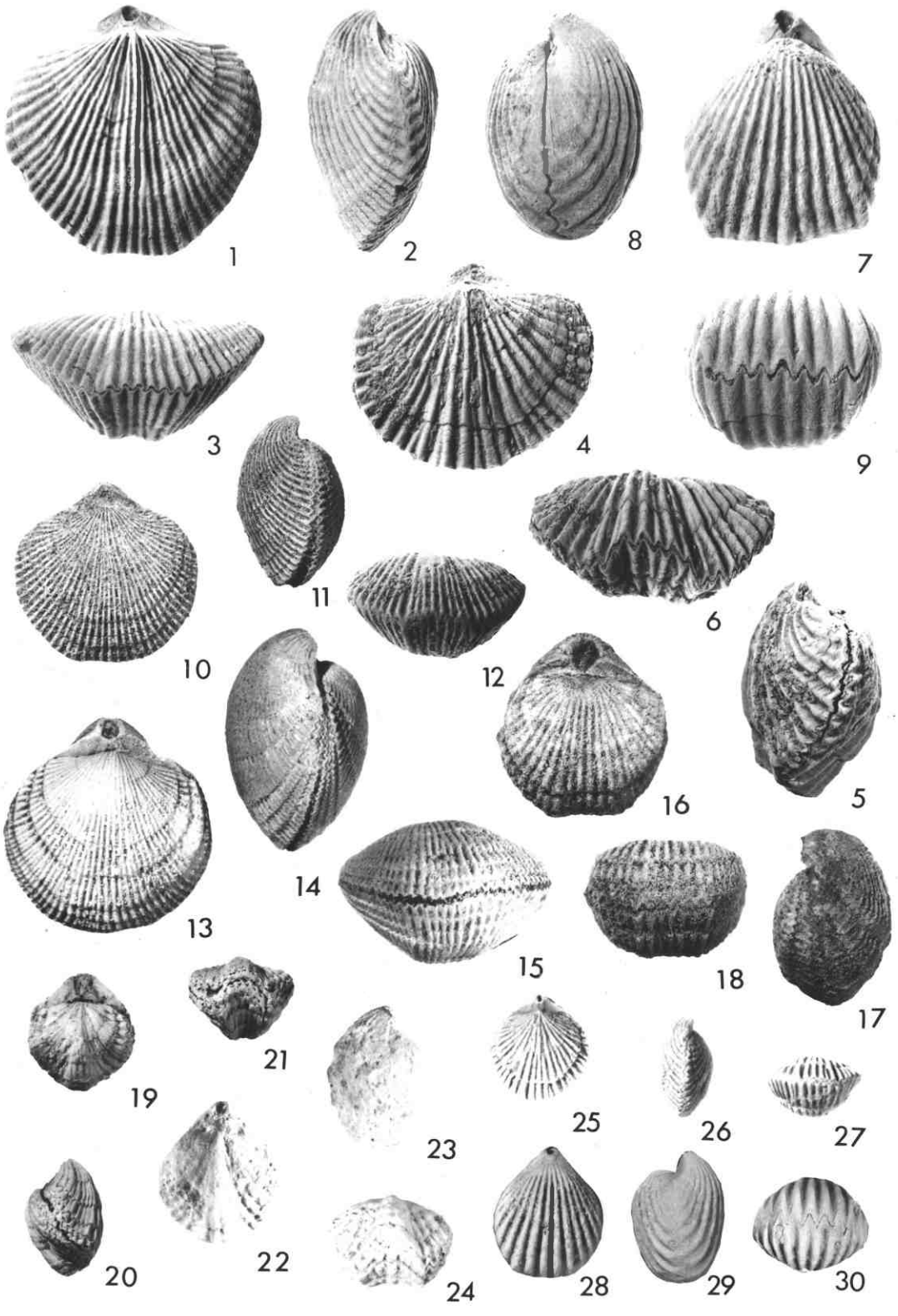

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PLATE 18

1 Terebrirostra lyra (J. Sowerby)
A specimen seen associated, either accidently or in life position, with the sponge Exanthesis labraso (T. Smith) from the Upper Greensand, Warminster. BM. B.25273 X 1½

2-4 Terebrirostra lyra (J. Sowerby)
A specimen from the Lower Cenomanian of Wilmington, Devon showing the extraordinary angle of the umbo. X 2

5, 6. Terebrirostra incurvirostrum (Walker) from the Lower Albian, Shenley Hill, Leighton Buzzard, Bedford. Although deeply embedded in matrix it is not suggested that these are in life position. Shown for comparison X 2.

Plate 18



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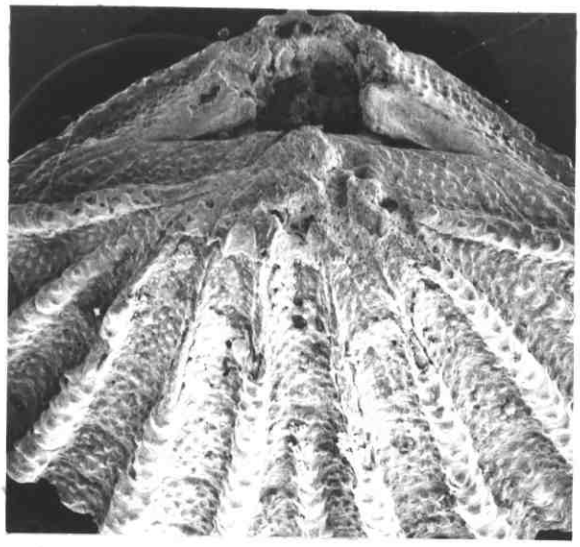


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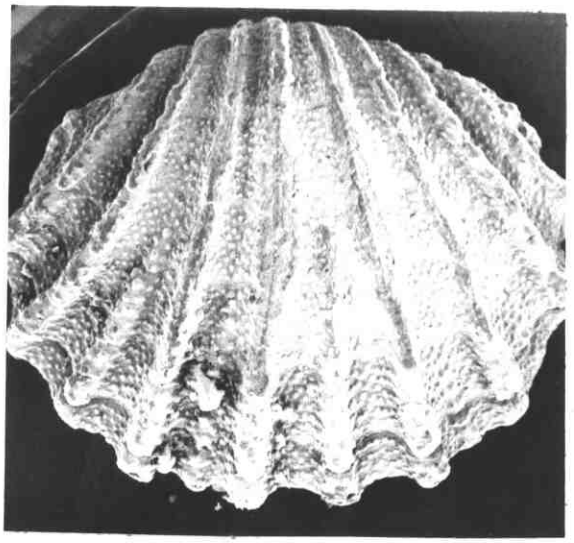
PLATE 19

1-4 Shell surface ornament of a specimen from the Cambridge Greensand, and formerly assigned to Argiope by authors. It resembles an immature Terebratulina sp. and supports the additional ornament of intercostal papillae seen in T. imbricata from the Lower Pink Band, of Yorkshire. X 22, X 16, X 50, X 100 respectively.

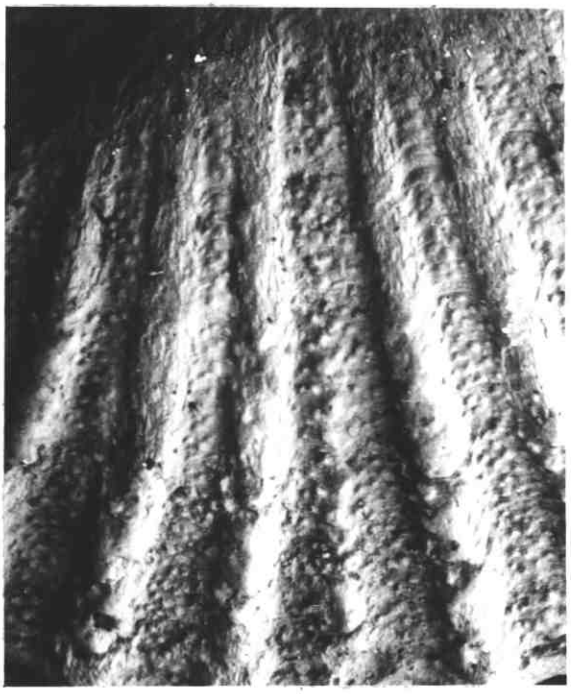
Plate 19



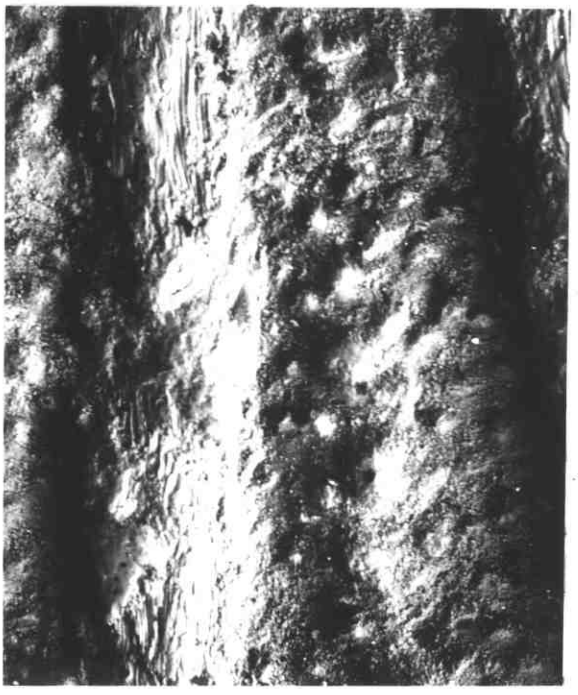
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PLATE 20

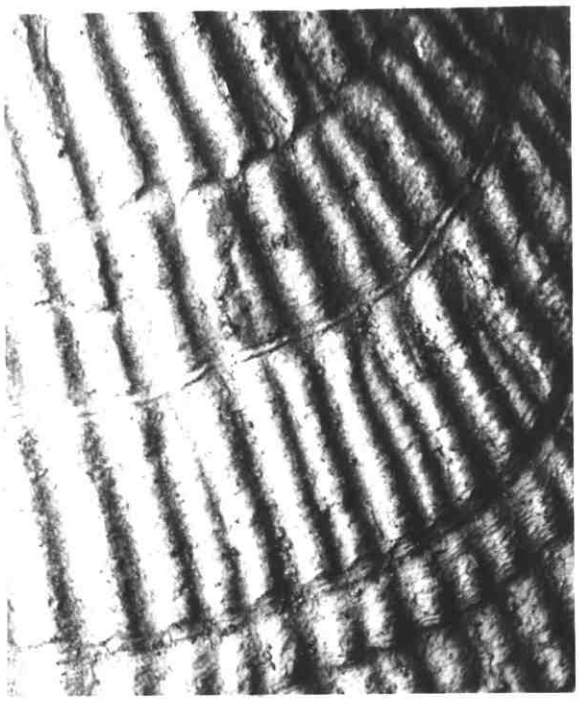
1. Shell surface ornament on brachial valve of Terebratulina protostriatula sp. nov. from the Chalk Marl, Hamsey, Sussex X 30. BM. BB.82416

2. Nodulose ornament from umbonal region of same specimen X 40.

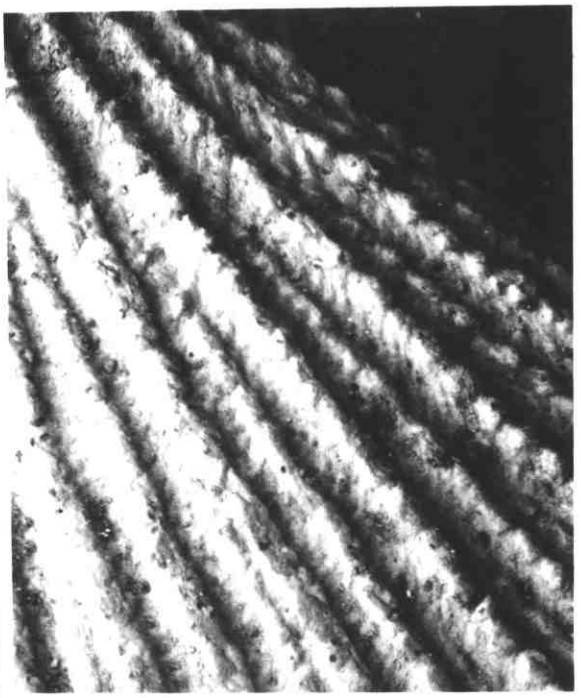
3. Shell surface ornament of brachial valve of Terebratulina striatula (Mantell) now assigned to the Upper Chalk (taken from Holotype B 457) X 35.

4. Enlarged shell surface of the brachial valve of specimen of Terebratulina striatula from the Upper Chalk, Cortestudinarium Zone, Wiltshire. The angular nature of the striae contrasts with those of T. protostriatula from the Lower Chalk. BM. BB.82417 X 35.

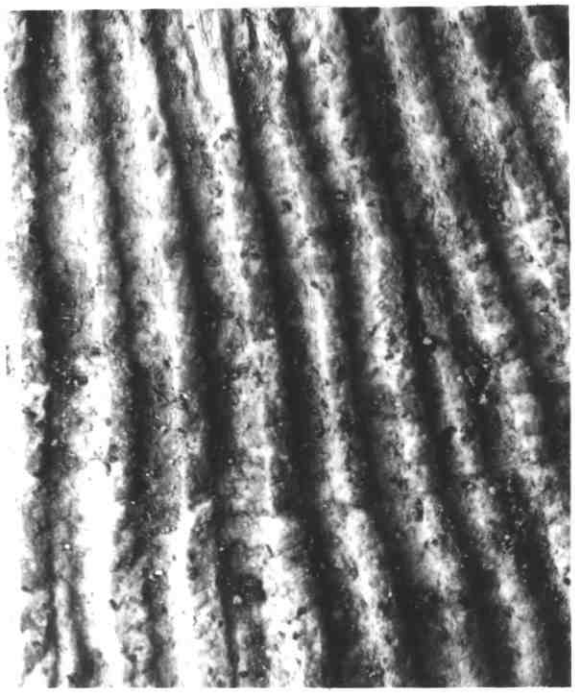
Plate 20



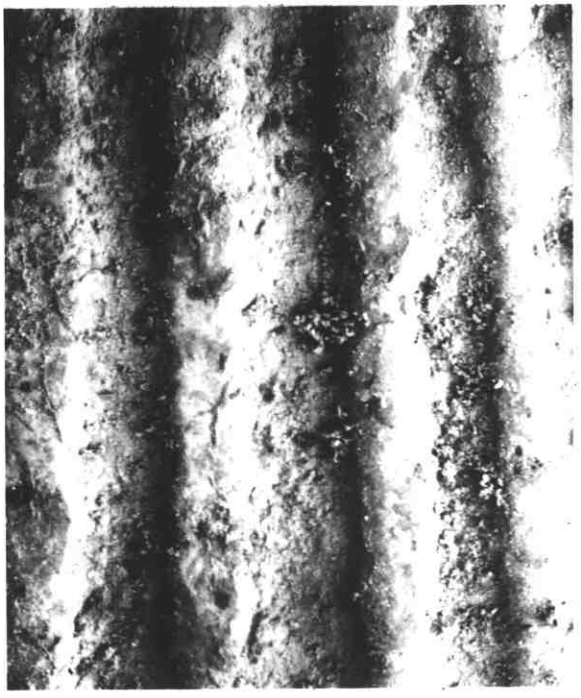
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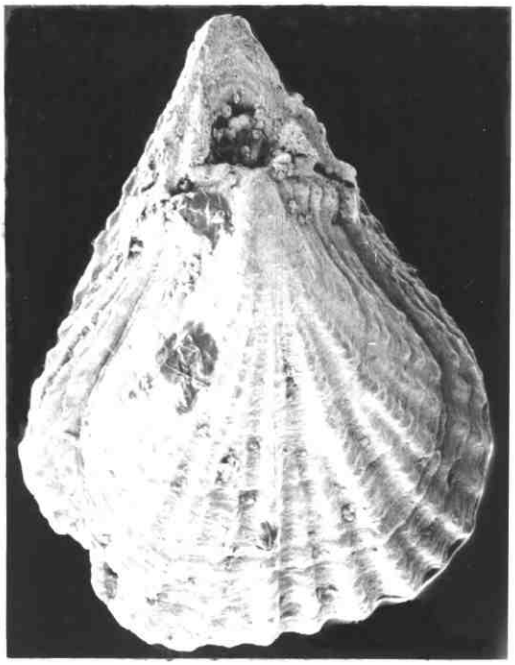
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PLATE 21

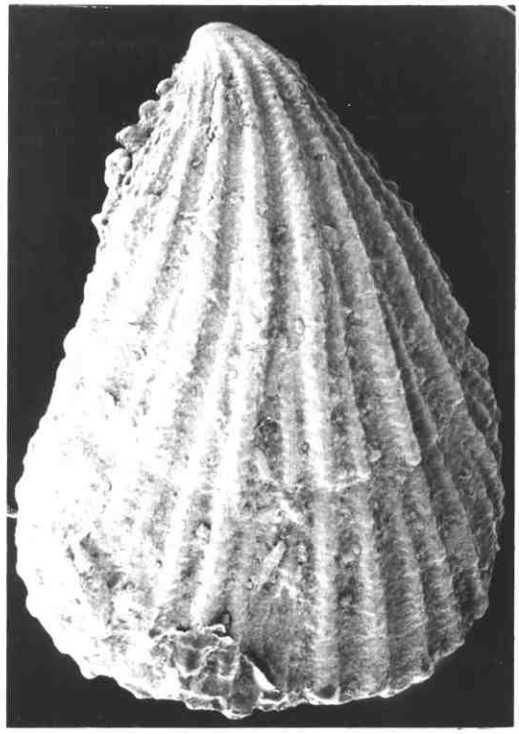
1, 2. Immature Terebratulina sp. from the Cambridge Greensand. These are thought to be embryonic T. triangularis Etheridge X 40

3, 4. Similarly immature Terebratulina sp. probably of T. nodulosa Eth. also from Cambridge Greensand X 35

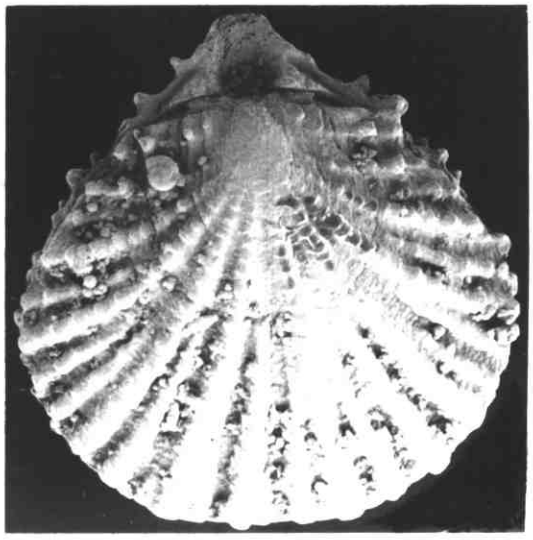
Plate 21



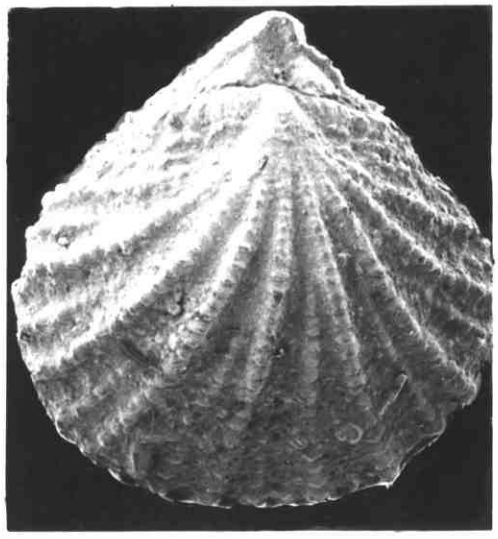
1



2



3



4

PLATE 22

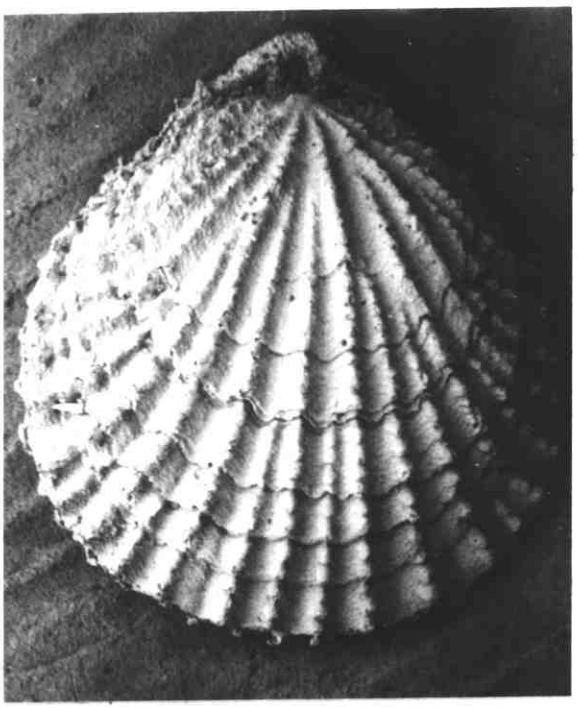
1. Terebratulina imbricata sp. nov to show shell ornament of imbricate growth-lines and additional intercostal papillae. HOLOTYPE, BB.82196 from the Lower Pink Band, Rifle Butts Pit, Market Weighton, Yorkshire. X 15

2. Enlargement to show intercallation of costae and bifurcation. X 35

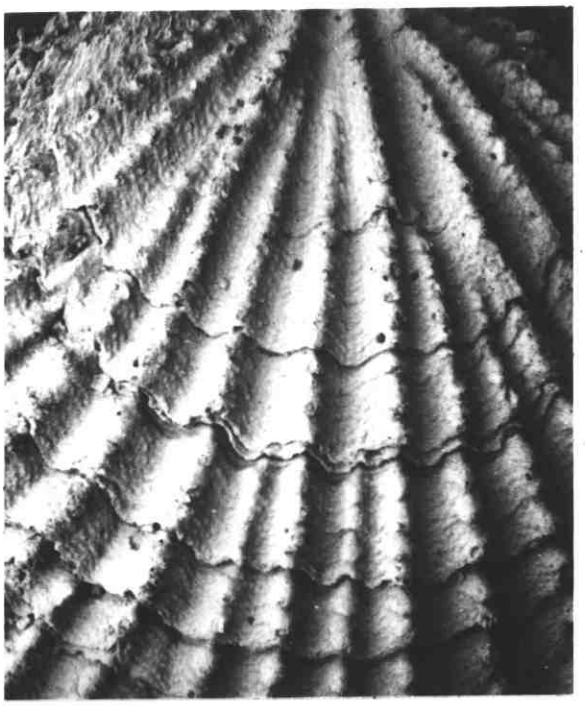
3. Same shell surface to show imbricate growth-lines at margin. X 38

4. Enlargement to show small intercostal papillae. X 45

Plate 22



1



2



3



4

PLATE 23

1. Shell surface of Ovatathyris potternensis sp. nov. X 20, from the Glauconitic Marl, Potterne, Wilts.

2. Shell margin of same specimen showing immature remnants of spinules X 25.

3. Shell surface showing arrangement of spinules along shell margin X 30.

4. Shell surface of similar specimen from same locality showing spinules on brachial valve arranged in pairs X 35.

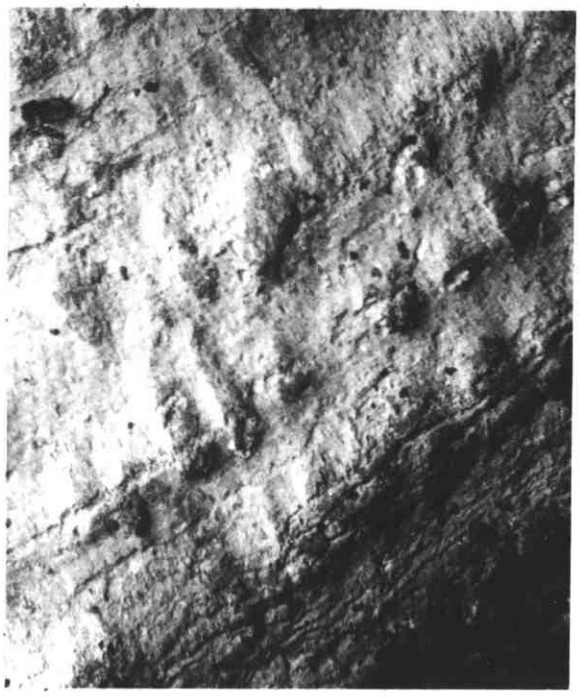
Plate 23



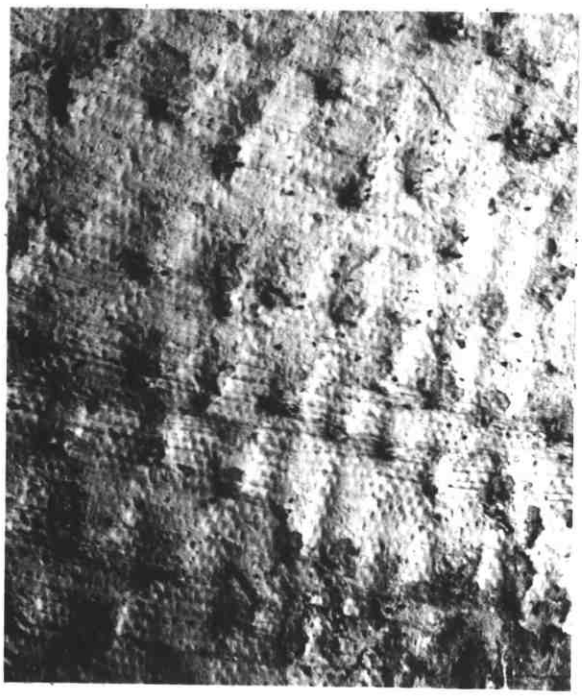
1



2



3



4

PLATE 24

Arcuatothyris arcuata (Roemer)

1. Shell surface ornament of spinules showing the indiscriminate arrangement and direction X 15

2. Area of accelerated growth between two growth-lines devoid of mature spinules X 30

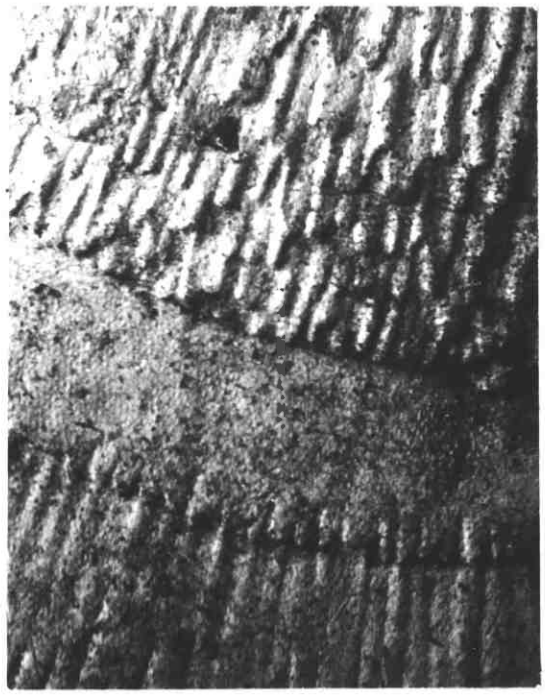
3. Enlargement of shell surface ornament showing interdigitation of spinules and relative length X 38

4. Enlargement of ornament and growing edge of shell to show shortening of spinules X 50

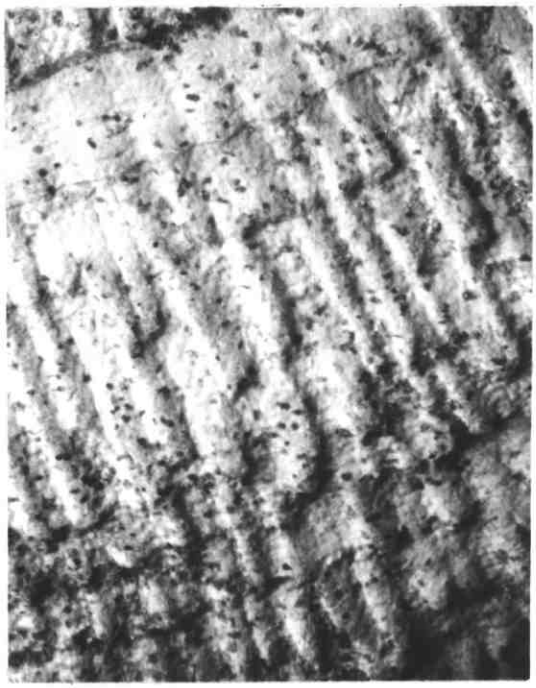
Plate 24



1



2



3



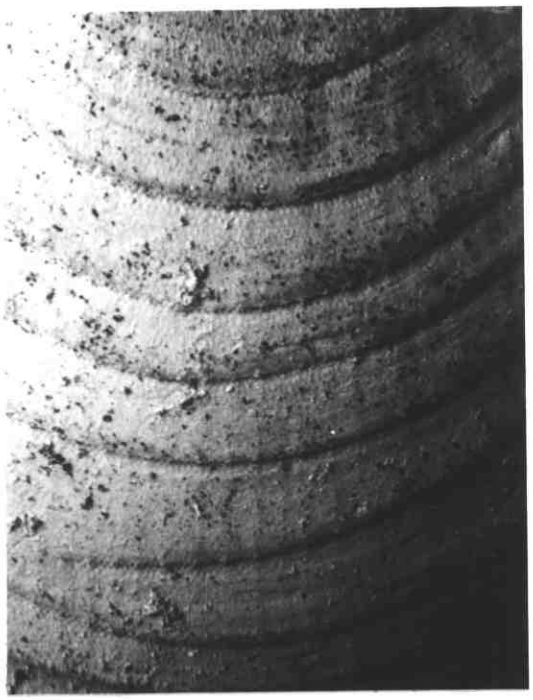
4

PLATE 25

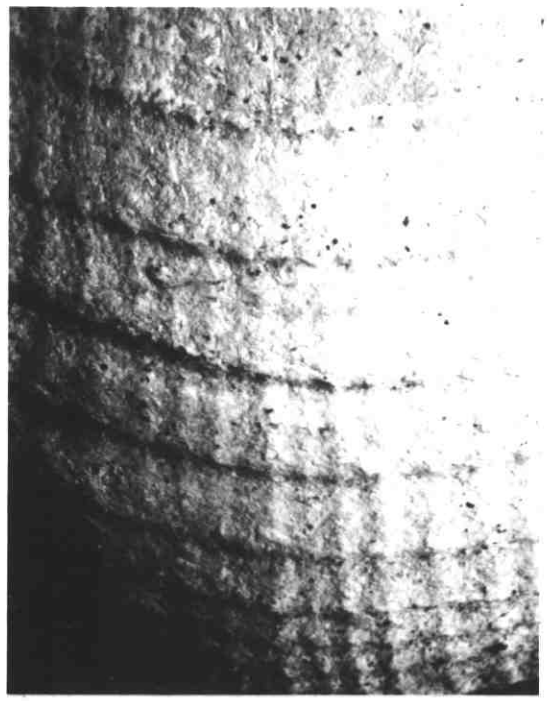
1, 2 *Platythyris squamosa* (Mantell)
Shell surface of specimen from Chalk Marl of Folkestone showing "capillate" ornament X 15.

3, 4 Enlarged view of growing edge of same specimen to show intercapillary cuspidation of the ornament of concentric growth-lines X 200, 220 respectively.

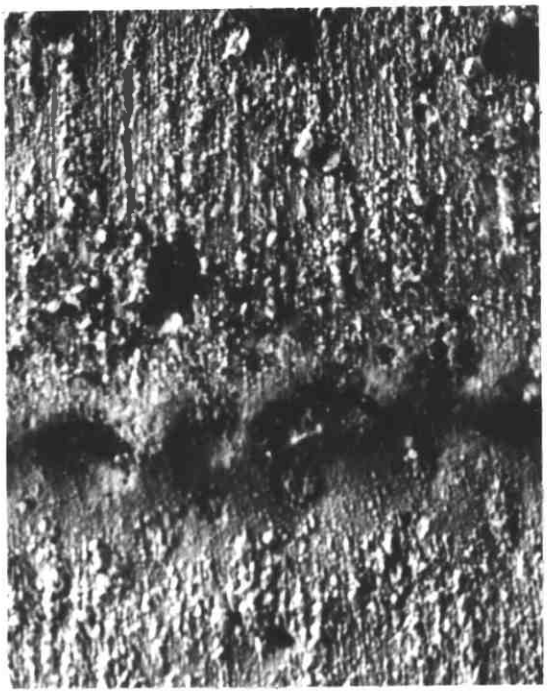
Plate 25



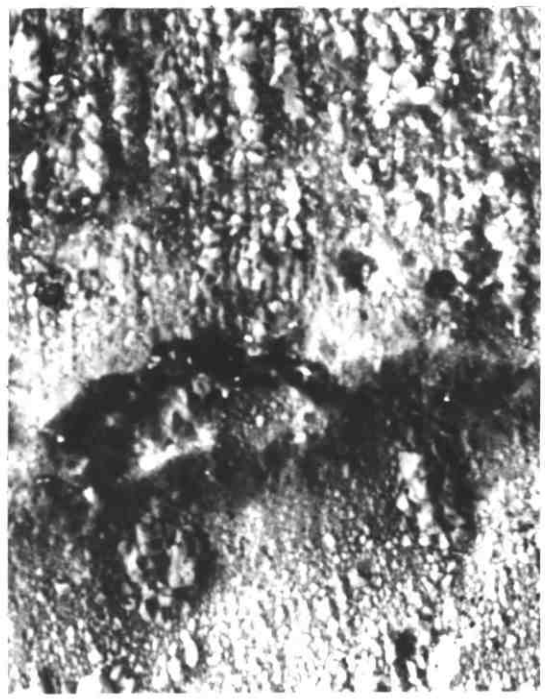
1



2



3



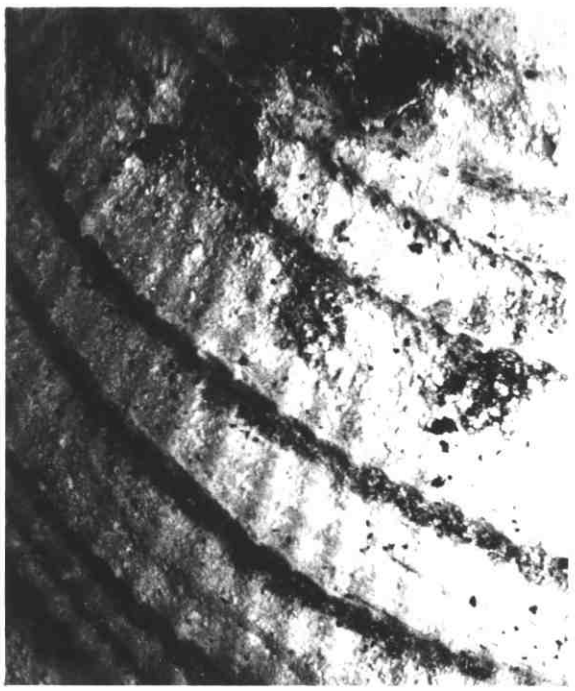
4

PLATE 26

1, 2 Platythyris disparilis (d'Orbigny) Shell surface enlarged X 15 and X 20 respectively, showing similar cuspidation of capillate ornament as seen in P. squamosa.

3, 4. Enlarged views of zig-zag capillae noted only in this species and often situated marginally X 20 and 15 respectively.

Plate 26



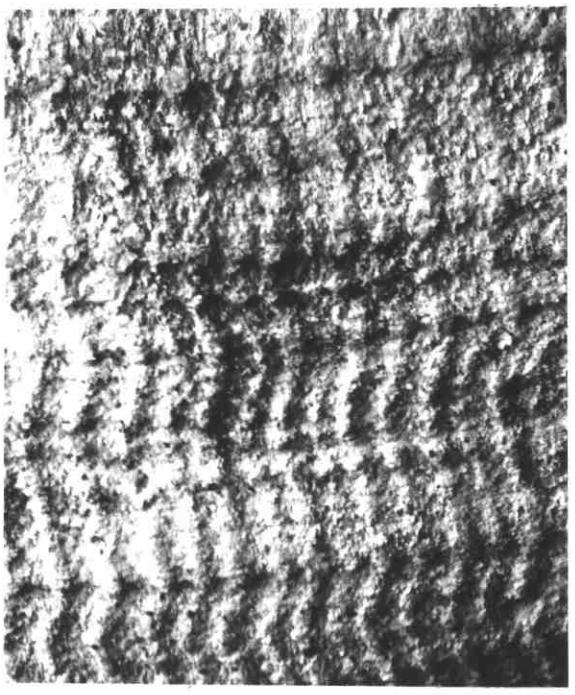
1



2



3



4

PLATE 27

1. Terebratulina nodulosa Etheridge
Specimen from Middle Cenomanian, Flöteberg, Germany X 12

2. Terebratulina nodulosa Etheridge
NEOTYPE here selected from Totternhoe Stone, Burwell, Cambridge. I.G.C. Coll. No. 117521 X 12

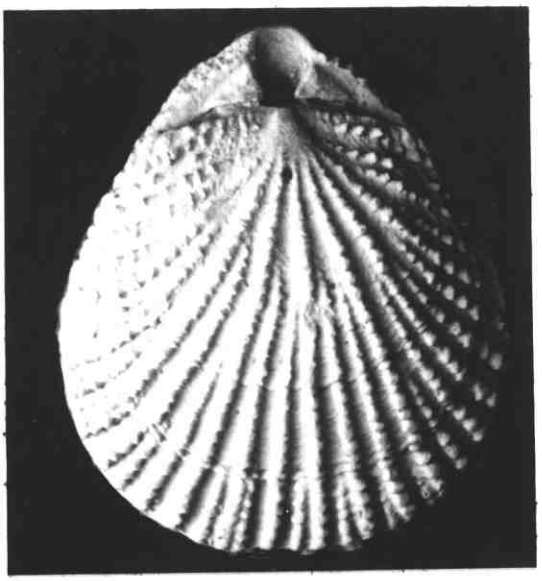
3. Enlargement of shell surface of above specimen to show nodular ornament X 25

4. As above X 50.

5. Terebratulina triangularis Etheridge
Cambridge Greensand. B.M. BB,82413 X 10

6. Enlargement of shell surface ornament of above X 25.

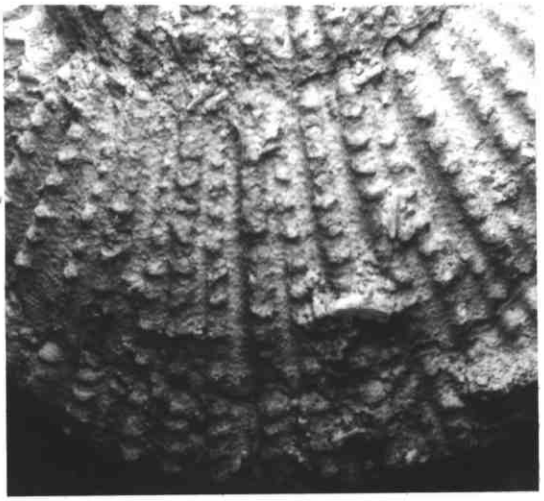
Plate 27



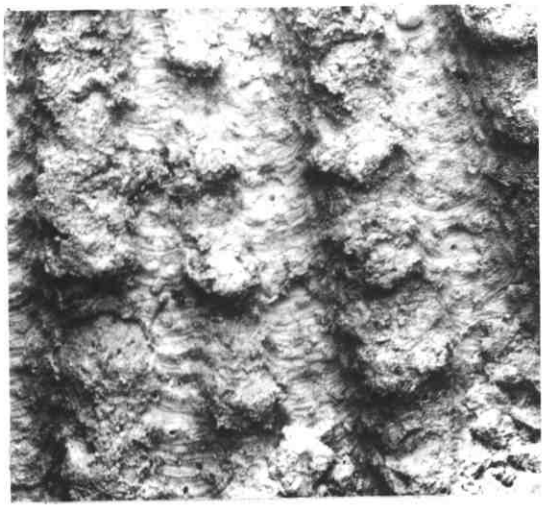
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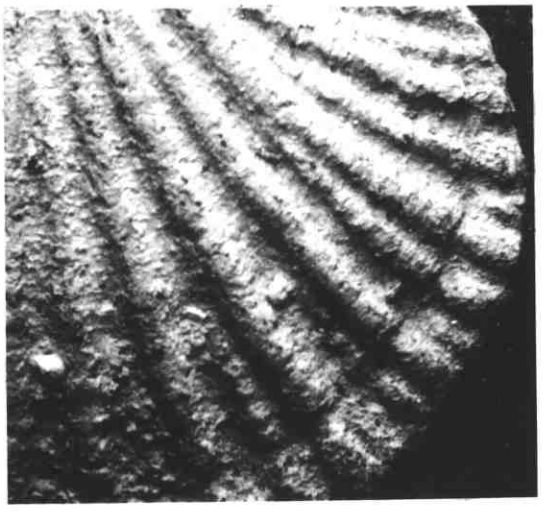
3



4



5



6

PLATE 28

1- 3 Capillithyris capillata (d'Archaic)
Tourtia, Tournai, Belgium. X 1½

4 Monticlarella brevirostris (Roemer)
Chalk Marl, Folkestone.
B.M. 82144 X 5

5- 7 Concinnithyris sp.?
Specimen from Bed B, Red Rock,
Hunstanton, Norfolk. B.M. BB.82145
X 2

8-10 Similar specimen to above from Lower
Cenomanian, Brockterbek, North Germany.
B.M. BB.82146 X 2

11-13 Sellithyris cf. phaseolina (Lamarck)
Possibly an elongated variant from Ur.
Cenomanian, Charente. B.M. BB.82147
X 1½

14-16 Platythyris squamosa (Mantell)
Lower Chalk, Folkestone.
B.M. BB.82148 X 2

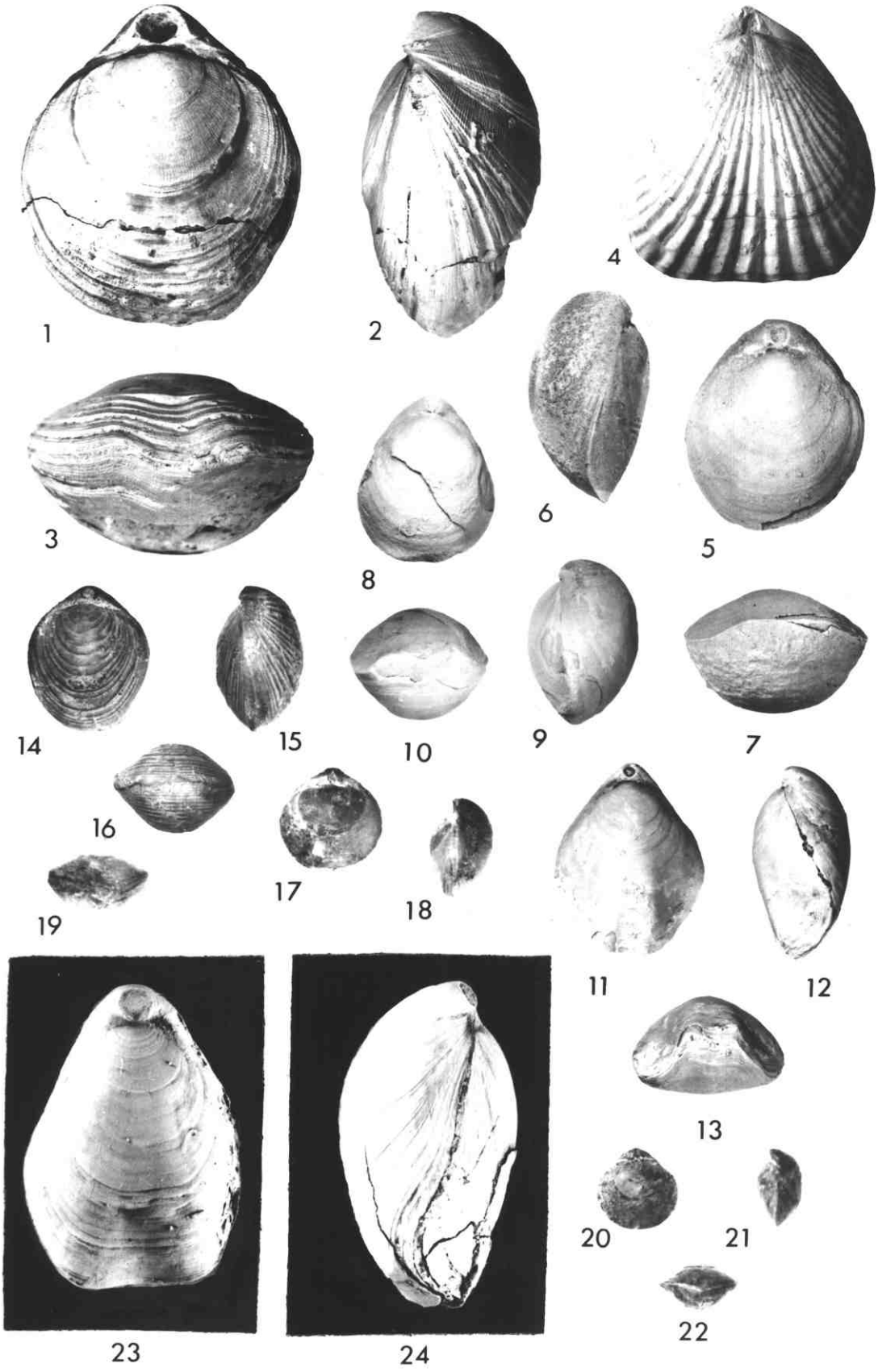
17-19 Modestella geinitzi (Schloenbach)
Lower Chalk, Folkestone
B.M. BB.82214 X 2

20-22 As above from the Essen Greensand,
Essen, Germany. B.M. BB.82213 X 2

23 Moutonithyris dutempleana (d'Orbigny)
Ur. Gault, Folkestone.
B.M. B.1132 X 1½

24 As above. B.M. B.2221 X 1½

Plate 28



Genera and species	UPPER ALBIAN	CENOMANIAN							
		Lower		Middle		Upper			
	dispar zone	zone		zone		zone			
		M. mantelli	*M. orbignyi*	*A. rhotomagense*	*A. jukesbrownei*	*C. guerangeri*	*M. geslinianum*	*N. juddi*	
Cyclothyris difformis		□ ▲							
" *formosa*					○				
" *juigneti*				▲					
" *punfieldensis*	▲								
" *compressa*						▲	○		
Grasirhynchia grasiana		● □		▽					
" *martini*				▽					
Burrirhynchia wilmingtonensis		□							
Monticlarella brevirostris				▽					
Orbirhynchia mantelliana				▽					
" *weisti*						○			
" *multicostata*						○ ▽			
" *boussensis*					▲	▲			
Sellithyris tornacensis					▲	▲			
" *phaseolina*						▲	○		
Boubeithyris diploplicata		●							
Tropeothyris vectis		●							
Ovatathyris ovata		● □		■					
" *pottermensis*		●							
Rectithyris wrightorum		□							
Ornatothyris sulcifera						○	▽		
" *latissima*						○	▽		
" *pentagonalis*						○	▽		
Concinnithyris obesa				○					
" *subundata*				○	■				
" *davidsoni*		□							
Moutonithyris dutempleana	● ▽								
Platythyris squamosa				▽					
" *disparilis*				■					
Arcuatothyris arcuata		□			■				
Dereta pectita	▲	●							
Modestella geinitzi				▽					

○ = Chalk & sandy chalk □ = Coarse Sandy Lst. ▲ = Glauconitic sands. ▽ = Marl ■ = Phosphatic Congl. ● = Glauconitic marl.