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THE LOWER TERTIARY FLORAS
OF SOUTHERN ENGLAND

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PALAEOCENE FLORAS
LONDON CLAY FLORA (Supplement)

BRITISH MUSEUM (NATURAL HISTORY)

THE
LOWER TERTIARY FLORAS
OF SOUTHERN ENGLAND

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PALAEOCENE FLORAS
LONDON CLAY FLORA (*Supplement*)

BY

MARJORIE ELIZABETH JANE CHANDLER

With an Atlas of thirty-four plates
and fifty-four figures in the text

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PREFACE

A quarter of a century has passed since publication of the *London Clay Flora* by the late Mrs. E. M. Reid and the present author. This volume is the sole responsibility of Miss M. E. J. Chandler and is the first of a series entitled *The Lower Tertiary Floras of Southern England*. It deals, in particular, with angiosperm fruits and seeds of the Palaeocene floras and with those of the London Clay not previously described. The work is published in two parts, text and atlas, for convenient handling.

Leaf impressions are not dealt with in this work except where species have been already recorded, or link up with fruits and seeds. Petrified woods, lignites, spores and diatoms are left for future investigation.

Volumes on the Lower Bagshot flora, and on the Eocene Freshwater and Marine floras of Bournemouth are already in an advanced state of preparation.

It would be unjust not to mention the support given to Miss Chandler by my predecessor, the late Mr. W. N. Edwards, who was vastly interested in these projects; while great credit is due to Mr. F. M. Wonnacott without whom, as Miss Chandler readily acknowledges, 'it would have been impossible to prepare the manuscript for the press', or to pass the volumes through the press in a reasonable time.

ERROL I. WHITE,
Keeper of Palaeontology



AUTHOR'S PREFACE

THIS volume dealing with the Palaeocene and London Clay floras of Southern England is a supplement, in part at least, to the London Clay Flora by E. M. Reid & M. E. J. Chandler (1933).

The delay of a quarter of a century between the two publications is chiefly explained by war and successive economic crises. Frustrating as it has been, ultimate gain has resulted, for in the long intervening years plants have been found in important new localities, and significant additions have been made from those previously known.

Recent research by the writer and others has made it necessary to correct or modify some views put forward in 1933. This has been done in the text. The term Poltavian flora, originally suggested by Kryshstofovich (1929) and adopted by Edwards (1955), covers the type of flora which bordered the Tethyan sea in the Eocene characterized especially by *Nipa*, *Mastixioideae*, and other plants related to the living flora of South-east Asia (Tethyan flora of Chandler, 1954).

How much in this work is due to others cannot adequately be expressed, for the debt is a large one. Especial mention must be made of the late Eleanor Mary Reid who provided facilities for the work to be carried out and whose collaboration and inspiration had been enjoyed for so many years. Then too, the help and kindly constructive criticism of the late W. N. Edwards calls for full acknowledgement. Again, without F. M. Wonnacott it would have been impossible to prepare the manuscript for the press. Dr. K. I. M. Chesters has given valuable help especially with the preparation of the Bibliography and Index.

G. F. Elliott, D. Curry and H. A. Toombs have looked at parts of the Introduction and made helpful criticisms. Many collectors (recorded in the text) have generously given their plant finds for investigation.

Finally I owe much to the authorities of the British Museum (Natural History) and to successive Keepers of the Department of Geology (now Palaeontology) for furthering this work in every possible way, and to the Keeper of the Herbarium at Kew where comparison of fossil with living material has from time to time been made.

MARJORIE E. J. CHANDLER

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A. General Matters

1. INTRODUCTORY REMARKS

In the study of fossil floras as in any other investigation, it is difficult to judge when the time has come to pause, digest and survey the available evidence. For however prolonged an investigation may be, nature is inexhaustible, and there is no such thing as complete evidence or finished work. Always in geological studies new exposures and new specimens are to be found, while fresh discoveries may be made as to the relationship of the fossils.

War conditions in 1940 put an end for a time to the accumulation of material which had been going on during the previous eight years, and gave an opportunity for surveying and interpreting the evidence which had been collected. But more material has been added since 1944 when the coast sections were once more accessible, and subsequent work has been particularly fruitful. Indeed, the wealth of palaeobotanical evidence in the Tertiary beds of the South of England appears to be unlimited. The pioneers tended to concentrate on leaf deposits and dealt incidentally only with some of the more conspicuous fruits and seeds. Now, however, the importance of these organs has been recognized and beds formerly completely overlooked which yield them in greater or lesser numbers are continually being discovered.

2. MODE OF OCCURRENCE OF FOSSILS AND METHODS OF COLLECTING

Only experience can show which strata are likely to yield a harvest. Sometimes these strata reveal themselves by the presence, in quantities visible to the naked eye, of minute specks of carbonaceous matter, as at Cliff End, Mudeford. Sometimes they can be detected by the purplish tinge which the presence of much fine and evenly distributed plant detritus imparts, as in beds at Colwell and Hordle. Under certain conditions of weathering an incrustation of yellow pyrites over a surface may be associated with the presence of plants. Where such indications are seen it is usually worth while to boil and sift samples of matrix so as to discover whether the beds will repay a more extensive search. If the plants of a given horizon are but little known it may be well worth while to boil and sift batch after batch of matrix even if the yield is poor, for an occasional specimen here and there may throw light on the character of the associated flora. An example is provided by the Upper Headon Beds of Colwell Bay which yield fruits and seeds of water-plants rather sparsely. But occasional land-plants have also been swept by chance into the deposit and their discovery is of considerable value.

In some types of plant bed, on the other hand, remains are so abundant that they form conspicuous black accumulations of twigs, fruits and seeds, such as the pocket formerly exposed at Sandbanks, Dorset, to be described later.

Even purely marine beds may yield plant remains. Noteworthy among such, of course, is the London Clay but there are less obvious cases which may escape all but the most vigilant

and industrious observer, e.g. at Hengistbury Head unpromising looking clays have recently produced a few plants in response to Mr. D. Curry's persistent efforts. They had previously been overlooked, and knowledge of this flora was almost nil.

It is usually highly desirable, when possible, to handle the matrix gently. Plants are far more fragile than many shells and bone fragments. They are commonly carbonized and often only partially impregnated with pyrites. Hence they may readily be crushed and damaged, or even completely destroyed by pressure due to too vigorous crumbling or pounding of the clay or sand which contains them. When the matrix is so intractable that it will not yield to prolonged boiling with strong soda followed by repeated sifting, shaking and washing, and more drastic pressure is required, it will be found that only the most resistant plant fragments will survive. Delicate tissues such as cuticles and wings of seeds or fruits will have disappeared.

As a general rule unconsolidated sands yield the best preserved and the greatest variety of specimens. They may be relatively uncrushed, although sometimes rather sand-pitted, with cavities and canals clearly visible. Clays usually yield fewer species which may be somewhat compressed. Hence if a seed-bearing sand is available in the same deposit, it may not be worth while to spend much time over a clay unless it yields good plant impressions. But by far the greater part of the writer's experience is based on actual fruits or seeds themselves washed from the matrix.

In addition to these organs there is a rich harvest of detached cuticles, wood and pollen awaiting the attention of the enterprising research worker. This field has been scarcely touched at all, e.g. some of the Alum Bay Lower Bagshot Beds with finely disseminated plant fragments yield pollen grains and cuticles but few or no seeds or larger remains.

Unfortunately, although nature is so generous, man in an increasing number of places is putting a stop to the investigation of the rich productive sites. The natural desire of local authorities to slow down coast erosion results in the building of sea-walls and other coast defences. The desire for profit and pleasure also leads to the building of huts and other erections which defeat the zeal of the geologist. Hence the necessity of collecting as much as possible while the sections are still open to investigation.

The best time for collecting is normally in winter, provided care be taken not to sink too deeply into the soft sands and clays which can be very treacherous indeed. The frequent slips of cliff ensure the exposure of fresh surfaces so that the specimens will not have had time to rot as the result of drying; the moist conditions preserve the fossils which always tend to crack and deteriorate seriously if they dry too suddenly or too thoroughly. This is most noticeable at Colwell. When the best beds occur at the cliff foot or in the foreshore, winter storms sweep away sand and shingle from time to time so that excellent opportunities for collecting are temporarily available. This is true at Lake and Arne, Dorset, where the conspicuous carbonaceous seams in the cliff are full of battered wood with relatively few fruits. But lower down in the foreshore at Lake small seeds, conifers, fruiting fern fragments and cuticle fragments abound when the conditions are favourable, and can be extracted by sifting.

A few other practical points may be worthy of mention. The typical round household sieve is not a very satisfactory piece of equipment. It usually has a treacherous crevice between the wooden edge and the wire mesh. Into this crevice specimens drop and are difficult to extract. There is always danger, therefore, with such sieves that deposits may become contaminated from one another. The ideal sieves are all metal with the perforated bases (of varying coarseness

in a set of sieves) welded to the metal sides. These provide no lurking place for impurities, and the danger of contamination is eliminated. They also conveniently fit one into the other for carrying. The undesirability of sizing specimens, or of fixing them with any kind of glue to a card, may be stressed. The ultimate result of sizing the surface of a fruit, leaf or scale seems to be that the specimen curls and contracts away from the matrix. It also contracts at a different rate from that of the coat of size as specimen and size gradually dry. But owing to the attachment to the film of size the natural contraction of the specimen is hindered, so to accommodate itself it cracks, often into minute fragments which each adhere to the film of size. Cuticles cannot often be obtained from sized specimens owing to this process of disintegration.

It is desirable to keep material for examination moist until it is to be studied. Drying may result in serious deterioration and distortion of the average carbonaceous specimen extracted by washing.

When picking over concentrate from the preliminary sifting process, it is much easier to make the examination in a shallow dish under water, using a hand lens. Form and pattern of seeds or fruits show in this way better than when the concentrate is dry.

3. EVALUATION OF PIONEER WORK

In spite of innumerable gaps in the knowledge of fossil and living plants still remaining, great advances have unquestionably been made in the study of the British Tertiary floras since the days of the pioneers, Heer and Starkie Gardner, and even since the more recent work of C. & E. M. Reid on the Bovey lignites (1910), of the writer on the Hordle Beds (1925–26), and of Reid & Chandler on the Bembridge Beds (1926) and London Clay Flora (1933).

Fresh material from new and old localities in the London and Hampshire Basins makes it possible to present accurate scientific evidence from certain horizons for the first time. For although plants are freely named in older literature relating to these horizons, the records are all too frequently mere names unsupported by descriptions or figures, e.g. 'Willows', *Hightea*, *Cucumites* and *Petrophiloides* reported by Gardner from the Bournemouth Beds (1879: 209–228; 1879–82: 17). It follows, therefore, that while the determinations of experienced older palaeobotanists may often have been correct, in many instances there is no real evidence by which later workers can test their records. Therefore the early determinations cannot invariably be accepted. This is particularly to be regretted since the specimens themselves were often extremely perishable. Many have long since deteriorated so as to be unrecognizable: in some cases they have completely disappeared. Moreover many of the sections from which they were collected are no longer workable. Much pioneer work was admirable, but there were inevitable mistakes, both through insufficient examination of the fossils, poor technique and equipment, as well as through inadequate knowledge of comparable living plants, and the inevitable errors of judgment which occur in any work. Occasionally, perhaps, incorrect determinations may have been due to over-eagerness to link up two localities by the recognition of plants common to both. Thus there seem to have been insufficient grounds for uniting leaves named *Apeibopsis* from Alum Bay, with fruits named *Cucumites* from the London Clay (Heer, 1859: 314, footnote), and for recording *Hightea*, *Petrophiloides* and *Cucumites* in the Bournemouth Marine Beds (Gardner, 1879: 222, 223). Unfortunately such erroneous or doubtful determinations have sometimes been accepted on the authority of the great names with which they are connected. Consequently they may be quoted again and again in palaeobotanical literature. In

order to minimize future difficulties of a similar kind, great care has been taken in the present work to give evidence as fully as possible in figures and descriptions even when the same plant occurs at closely adjacent localities. Such exact records may come to have a value and significance which cannot at present be foreseen.

4. THE VALUE OF CONSTANT OBSERVATION

The collections of Messrs. E. St. John Burton, the late G. W. Colenutt, J. E. Cooper, D. Curry, the late A. G. Davis, G. F. Elliott, D. J. Jenkins, H. E. Taylor, the late Mr. and Mrs. J. G. Turner, E. M. Venables, Miss H. Wilkinson, the writer, and others, show that further knowledge can still be accumulated as the result of continuous observation by local workers or others who are able to take advantage of new sections or developments of old sections as casual visitors are usually unable to do. Plant-bearing beds are so commonly lenticular, or of such limited extent, that they may be available for a short time only before they are removed by denudation. Their evidence may be lost if no one is on the spot to profit by new and temporary exposures. At the same time it is usually untrue to say that a bed is 'worked out', a remark sometimes made in regard to the once famous Alum Bay leaf bed. If some particular fossiliferous pocket has been eroded, or exhausted, another may appear, as actually happens from time to time in the Pipe-clay of Alum Bay. Until the section has been walled in, or otherwise destroyed by human agency, there is always hope. But as referred to above, protection against coast erosion, and the progress of building or other structural works tend year by year to conceal more strata. Thus at Sandbanks a fine lenticular seed bed, first noticed in 1936, was considerably reduced by erosion in 1938, and completely obliterated by the building of concrete steps and platform during the war years between 1939 and 1945.

In the present work, therefore, separate lists have been kept of the plants from each exposure so as to make possible a general survey of the whole period under review with its gradual changes of climate and physical conditions.

In the consideration of individual floras which will follow stage by stage, earlier work, if any, will be summarized. Mere names unsupported by evidence, also determinations now judged unsatisfactory, or originally regarded by contemporary palaeobotanical opinion as doubtful and not since confirmed, will be omitted from the revised plant-lists. As far as possible well authenticated determinations only will be used in any general consideration of the floras and their conditions of growth. Names discarded on the above grounds will be listed separately in a forthcoming catalogue for convenient reference. As a rule no attempt is made to deal with leaves, a specialized study which the writer is not qualified to undertake; where leaves are included it is for some specific reason.

B. Geological Considerations

1. SUMMARY OF THE PLANT DEPOSITS STUDIED

The strata containing the long series of plant beds under review now occur in two distinct basins, the London Basin and the Hampshire Basin. They range in age from Palaeocene to Oligocene, the younger beds being found only in the Hampshire Basin, the older only in the

London Basin. Originally some of the formations in the now separate basins were in part at least continuous when they were first deposited in that section of the Anglo-Franco-Belgian Basin which covered the south and south-east of England. Subsequently as the result of post-Oligocene earth movements followed by erosion, separation of these Tertiary strata into the two distinct existing basins took place while some of the youngest strata were removed by erosion especially in the London Basin. The relative positions of the beds are shown in the Table on p. 8.

The earliest beds within this series are from the oldest Tertiary strata of Britain—the Thanet Beds of Kent—the newest are the most recent Oligocene beds of Britain—the Hamstead Beds of the Isle of Wight. Floras, florules and newly discovered or isolated specimens from the following horizons and localities will eventually be described:

Thanet Beds of Herne Bay, Kent.

Woolwich and Reading Beds of long known, and of new localities.

Oldhaven Beds of Bishopstone and *Blackheath Beds* of Chislehurst.

Basement Beds of the London Clay at Harefield, N. Harrow and Watford.

London Clay including a new and rich locality at Bognor and a small flora at Nursling, both in the Hampshire Basin, and additions from new and old localities in the London Basin including Bracknell.

Lower Bagshot Beds of the Hampshire Basin, including Studland (Dorset), Lake near Hamworthy and Arne on the opposite shore of the Wareham channel (both new Dorset localities). There are also a few records from Selsey and the Isle of Wight. *The Lower Bagshot Beds* of Alum Bay are briefly mentioned, but little or no new work has yet been possible here.

Bournemouth Freshwater Beds from Sandbanks (Dorset) to Branksome Dene (Hants.), and some scanty evidence from other sites between Branksome Dene and Bournemouth Pier. These deposits which lie between Poole and Bournemouth are all part of the famous Bournemouth Freshwater Beds which, thanks to the neglect of the usual tending and planting of the cliffs during the war, have yielded some new finds notably at Branksome Dene. Sandbanks is also a new locality.

There are a few plants in Bracklesham Lignitic Bands at Alum Bay, but this flora is at present virtually unknown.

Bournemouth Marine Beds east of the East Cliff lift at Bournemouth, at Boscombe and Southbourne, also the Highcliff Sands at Cliff End near Mudeford. A lignitic layer with abundant crushed and battered plants overlying the Boscombe Sands at Southbourne and the Highcliff Sands at Cliff End are both new localities for plants. There are a few records from Hengistbury Head which may belong to this horizon or to the Bartonian.

Barton Clays, truly marine, of Barton Cliff which have yielded only a few poorly preserved plants.

Lower Headon Freshwater Beds of Hordle Cliff.

Upper Headon of Headon Hill (a single species) and of Colwell Bay where a considerable flora has lately been discovered.

Finally a few plants from Oligocene localities in the *Bembridge Beds* (limited new material) and the *Hamstead Beds* (limited new material). The *Bovey Tracey Lignites* of Devon have been treated in a separate paper (Chandler, 1957).

TABLE SHOWING RELATIONSHIPS OF TERTIARY BEDS IN DIFFERENT AREAS

			HAMPSHIRE BASIN		LONDON BASIN	
Continental Stages as indicated by: Wrigley & Davis (1937, p. 220, pl. 18)	Wrigley & Arkell (1947, p. 217)	<p>← LUTETIAN →</p> <p>← AUVERSIAN →</p> <p>← LUTETIAN →</p> <p>← AUVERSIAN →</p> <p>← LUTETIAN →</p> <p>← AUVERSIAN →</p> <p>← LUTETIAN →</p> <p>← AUVERSIAN →</p>	<p>← RUPELIAN →</p> <p>← LATORFIAN →</p> <p>← TONGRIAN →</p> <p>← SANNOSIAN →</p> <p>← STAMPPIAN →</p>	<p>Western End of Hampshire Basin, continental development in Cuisian, Lutetian</p> <p>Precise limits of these formations therefore not defined</p>	<p>Eastern End of Hampshire Basin, with marine development in Cuisian, Lutetian and Auversian. Limited plants.</p>	
				<p>Dorset & Hampshire Mainland (West of Lymington)</p> <p>Middle Headon no plants</p> <p>Lower Headon Hordle Cliff (plants)</p> <p>Upper Bartonian G-L. (plants in K & L)</p> <p>Middle Bartonian (marine) C-F. few plants</p> <p>Lower Bartonian (marine) B.</p> <p>A3 Barton (plants) with <i>Nummulites rectus</i> (Hengisbury*)</p> <p>A2 Barton (plants) Marine Upper Hengisbury Beds (plants)</p> <p>A1 Barton with <i>Nummulites presteuichi</i> & <i>Pinus dixoni</i> presteuichi (Curry, 1942) (plants)</p> <p>Cliff End Beds* in Highcliff Sands near Mudford (plants) <i>Boscombe Sands</i> in part?</p> <p>Ironstone at base rarely exposed</p> <p><i>Boscombe Sands</i>—Plant rafts at Southbourne</p> <p><i>Bournemouth Marine Beds</i> including Honeycomb Chine with <i>Nipa</i> and plant beds at Southbourne cliff base</p> <p>? in part equivalent to</p>	<p>Western End of Isle of Wight and Southampton area Hamstead Beds</p> <p>Bebridge Beds: plants at Gurnard & Thorness Bays</p> <p>Osborne Beds</p> <p>Upper Headon—Colwell (plants)</p> <p>Middle Headon Marine (Latorfian fauna at base, Brockenhurst)</p> <p>Lower Headon—Totland & Colwell (few plants)</p> <p>No plants</p>	

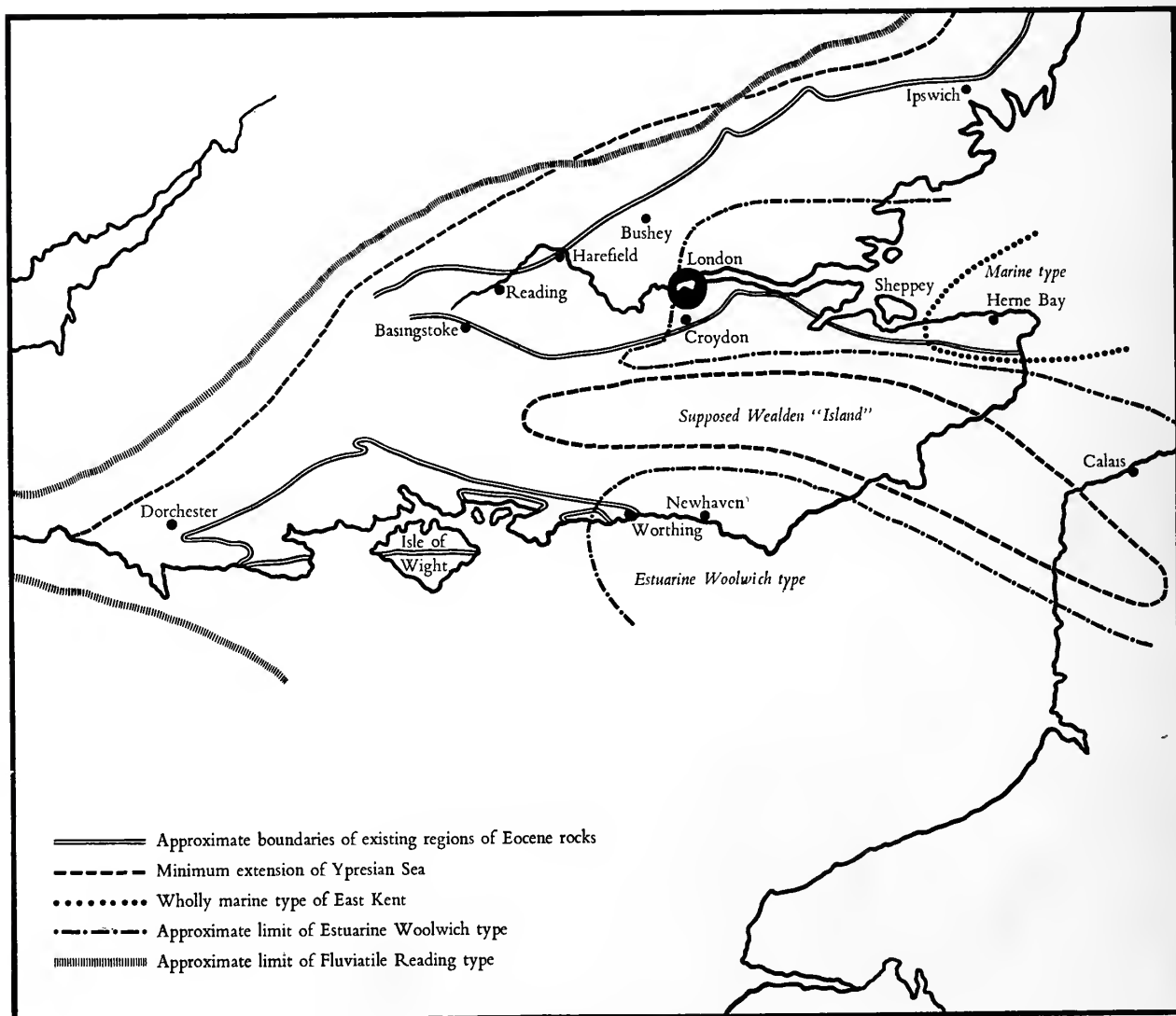
LUTETIAN	Middle Bagshot Beds of Gardner, 1879:211; 1881:87 <i>Bournemouth Freshwater Beds</i> Plants at intervals, notably west of Pier at Bournemouth, Branksome Dene, Sandbanks: Finely laminated silt with Cyperaceae at Poole Head	?Bracklesham Alum Bay sands & clays (Lignite bands include rare plants)	Part of Lower Bracklesham Marine Beds with <i>Nimmulites laevigatus</i> (no plants yet)	Part of Lower Bracklesham Marine Beds (Fisher 6) with <i>Nimmulites laevigatus</i> (no plants yet) Fisher 4 with <i>Nipa</i> (Curry, 1958: 15)	Middle Bagshot Beds with <i>Nimmulites laevigatus</i> in Bagshot District of Surrey & Berks also Lower Bagshot of fluvial type in Surrey & Berks (pars)	LUTETIAN
LUTETIAN	(Lower Bagshot Beds of Gardner, 1879:16; 1882:3) including: Aggleshon Grits (barren) Pipe-clay series (Plants at Lake, Arne, Corfe) Studland grey clays—Plants Sand Rock = Red End Sandstone (No plants)	<i>Lower Bagshot Beds</i> Alum Bay with plant bearing Pipe-clay seam, Lower Bagshot Beds of inland Hampshire west of River Test and possibly beds at Swanwick with <i>Blysmus</i>	Part of Lower Bracklesham Marine beds with <i>Nimmulites planulatus</i> and <i>N. lucasianus</i> in Fisher iv (<i>Linnocarpus</i> only plant yet) Lower Bagshot Beds	Beds with <i>Araucarites</i> <i>in situ</i> at E. Wittering Part of Lower Bracklesham Cakeham Beds (B) with <i>Nimmulites planulatus</i> , Cakeham Beds (A) with <i>Nipa</i> , etc. See Wrigley & Davis (1937:215, footnote)	Lower Bagshot of fluvial type in Surrey & Berks (pars)	LUTETIAN
LUTETIAN	London Clay Studland (No plants yet)	London Clay (Nursling) Plants near top of series (ex. lit. A. G. Davis) London Clay (Alum Bay) No plants yet	London Clay No plants yet	London Clay Plants at Bognor	London Clay plants many localities <i>Basement Beds</i> —florules <i>Blackheath Beds</i> —one plant <i>Oldhaven Beds</i> —plants at Bishopstone	LUTETIAN
LUTETIAN	Reading Beds Studland (No plants yet)	Reading Beds Alum Bay (No plants)	Reading Beds No plants	<i>Woolwich Beds</i> at Bognor and Newhaven Plants	<i>Woolwich Beds</i> —plants at Tooting, Beddington, Dulwich etc. and <i>Reading Beds</i> —plants at Reading	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN
LUTETIAN	Missing	Missing	Missing	Missing	Missing	LUTETIAN

* Cliff End and Hengistbury Beds fauna of Bartonian aspect (Prestwich, 1849: 43; Cowper Reid, 1913: 101; ex. lit. St. J. Burton, 1937)

The beds which contain no plants are only shown in as far as is necessary to make the position of the plant-bearing beds clear. The placing of the Hengistbury Beds is based on Curry 1942, and on conversations with Mr. Curry. He has seen this Table and is willing for his views to be recorded in this manner. The arrangement of the Table as a whole has been checked by G. F. Elliott. The correlation with continental stages is speculative and based on works stated in left hand column. The plants give no information, the flora being fairly uniform throughout.

2. PHYSIOGRAPHIC BACKGROUND AND GEOLOGICAL RECORDS OF THE POLTAVIAN FLORA

Since the broad outlines of the physiographic and climatic changes which have occurred in Tertiary Europe were first worked out from evidence yielded by animals, more especially by marine animals, it will be useful at this point to summarize the results of this basic work. Palaeontologists have for many years recognized (see Gardner, 1878: 285; 1883: 198) that during Lower and Middle Tertiary times two seas characterized by distinct faunas existed in north-western Europe: a northern sea indicated by a cold fauna, and a southern warm or tropical sea connected through the Mediterranean with the Indian Ocean, indicated by a tropical fauna (Morley Davies, 1930). The boundary between these two seas is supposed to have lain within the Anglo-Franco-Belgian Basin. At times they appear to have been connected so that their waters and their two types of life intermingled. According as the influence of one or the other sea prevailed over the area under review, so the climate, vegetation and animal life were thought to have varied.



The influence of the warm sea, known as the Tethys, appears to have reached its maximum in Ypresian–Cuisian times when, it is said, warm currents from the Indian Ocean brought a tropical marine fauna into north-western Europe to mingle with the boreal elements.

The effects of this Tethyan connexion on climate and flora have been discussed by Thistleton Dyer (1878), and in greater detail by Reid & Chandler (1933).

We now have definite evidence (Chandler, 1954; Chesters, 1955) that a tropical flora of present-day Indomalayan type (Poltavian of Kryshstofovich—see Edwards, 1955) was present in Egypt in the Danian and in West Africa in the Maestrichtian. As Edwards (p. 9) points out it probably occupied the whole area bordering the Tethys sea. To what extent it was exterminated temporarily and locally in north-west Europe by the Cretaceous marine transgression remains to be worked out in detail. There is every reason to think that with the withdrawal of the Upper Cretaceous sea any newly exposed land surfaces in that region would have been recolonized by the Poltavian flora persisting in Indomalaya and in any unsubmerged coasts and islands between the Far East and western Europe. Wherever the climate remained appropriate due to the tropical Tethyan currents this Poltavian flora would have recolonized the ground.

Although evidence from the Palaeocene is strictly limited in quantity in Britain the few reliable data now available suggest that a Poltavian flora was present in the Woolwich and Reading Beds, as witness the occurrence of Schizaeaceae, Icacinaceae, Flacourtiaceae and other plants of less definitely tropical affinity which are nevertheless associated in later beds with distinctly tropical elements, e.g. such plants as *Sequoia*, *Carpinus*, Lauraceae, *Phellodendron*, *Sambucus* and *Vitis*. At a later period the withdrawal of the Tethys enabled a flora of less tropical character to establish itself, while there was a corresponding withdrawal and destruction of the tropical elements.

3. CONDITIONS OF DEPOSITION OF SUCCESSIVE BEDS AND THEIR CHARACTER

Throughout the Eocene and Oligocene, as already stated, a shifting boundary between land and sea lay within this Anglo-Franco-Belgian Basin. Consequently three types of sediment were deposited concurrently at each successive horizon: lacustrine and fluviatile sediments laid down in freshwater on the land; estuarine or lagunal sediments in brackish waters near the boundary of sea and land; marine sediments beneath the sea. At some horizons all three types of contemporaneous sediments occur within the present shore lines of southern England, but at other horizons one or two of the three types are absent. The chief reasons for their absence are: (1) that for some positions of the sea-board one or more of the types must have been formed beyond the present coast-line of Britain; (2) that much material has been removed by erosion since the beds were originally deposited. Gardner long ago suggested (1878: 286; 1881: 92) that the land area from which the British Tertiary plants were derived included the drainage system of a great river, but Davis & Elliott (1958) point out that a series of rivers may have been concerned, at least in the Ypresian. During the deposition of the Lower Bagshot Beds and later, drainage appears to have been from a granite area somewhere to the west, as evidenced by the decomposition products of granite rocks (kaolin and quartz-sand) which form so large an element in the fluviatile deposits. The river, or rivers, flowed eastward or south-eastward to the Tertiary Sea within which marine beds (some containing

plant-remains) were deposited. The development of the three types of deposit in the successive periods under consideration appears to have been as follows:

(i) In the period covered by the Thanet Sands and Woolwich and Reading Beds the marine deposits were the least extensive of the three types in Britain. They occur only in a small area in the east of Kent, south of East Anglia and Hertford and are represented by the Thanet Sands below, and by the marine representatives of the Woolwich Beds around Herne Bay above. The contemporaneous estuarine beds seem to have surrounded them at least on their northern and western margins, and are now represented by the Woolwich Estuarine Beds between Croydon and Sittingbourne in the London Basin, and also by beds in Essex beneath the covering of London Clay, and by beds in the Newhaven area in the south-east of the Hampshire Basin. The fluviatile or freshwater beds are preserved in a broad band of Reading Beds to the north, north-west and west of the estuarine beds. The type locality is at Reading. Typical exposures have also been seen as far apart as Ipswich (Suffolk); at Bushey (Herts.) and Harefield (Middlesex); and in the London area to the west of Croydon. The beds extend westwards to the confines of the once united London-Hampshire Basin (cf. Stamp, 1921). The general distribution of the three types of deposit in Palaeocene times is shown in a map (after Stamp, 1921) on p. 10.

The contemporaneity of the continental Reading with the estuarine Woolwich Beds is shown by the lateral passage of the one into the other in the west and north-west, and by actual inter-bedding of the two series in places (Stamp, 1921: 65, 69).

(ii) In the Ypresian a phase of marine transgression is revealed by a great development of marine clays over the London-Hampshire Basin of deposition, almost to its western limits (see map, p. 10). Towards the west and north-west there are indications of shallowing of the sea both in the thinning and character of the sediments, and in the character of the fauna. The earlier stages of the transgression are marked by the formation of the Oldhaven and Blackheath pebble beds. A hypothetical island over the Weald to explain their distribution is discussed by Stamp (1921: 71-73) who quotes Prestwich (1854) and Whitaker (1872). As might be expected, the fauna of the pebble beds shows an admixture of Woolwich estuarine or lagoon forms with marine forms typical of the succeeding London Clay (Stamp, 1921: 97). According to Wrigley the later stages of transgression are indicated by the Basement Beds (as opposed to the Oldhaven Beds). Although in the London Clay fauna there are heat-loving species such as cowries, volutes and nautili, the tropical forms differ generically and specifically from those in the succeeding Bracklesham Beds (Gardner, 1883: 198). Boreal forms are still present. Abundant and varied plant-remains were swept out to sea and were deposited with the remains of the contemporary marine fauna (cf. Reid & Chandler, 1933: 20).

(iii) In the Lower Bagshot and Lower Bracklesham period both marine and freshwater deposits are well represented within the Tertiary Basin of Britain. The freshwater beds are as follows:

- (a) The massive sands and thinner pipe-clays of the Dorset coastal region (Lower Bagshot) and the succeeding Bournemouth Freshwater Beds of Dorset and Hampshire. All of these are derived from the detritus of granite rocks (see p. 11).
- (b) The Lower Bagshot Beds and the succeeding and apparently fluviatile Bracklesham Beds of the western end of the Isle of Wight as seen at Alum Bay (see Wrigley & Davis, 1937, pl. 18; Curry, 1942, pl. 3).

- (c) The Lower Bagshot deposits of inland Hampshire west of the River Test (Wooldridge, 1924: 367) and possibly deposits of doubtful age with *Blysmus* overlying London Clay at Swanwick Brickpit near Southampton discovered by Curry and Davis.
- (d) The Lower Bagshot Beds of fluviatile type in Surrey and Berkshire (Stamp, 1921a: 194; Wooldridge, 1924: 365) and those west of the Lea Valley (Wooldridge, 1924: 364–366) all in the London Basin. Plant-remains occur only in Dorset, Hampshire and the Isle of Wight.

The marine deposits are represented by the following Cuisian and Lutetian Beds lying to the east of, and partially encircled by, those mentioned above:

- (a) The marine Lower Bracklesham Beds with *Nummulites planulatus*, *N. lucasianus* and *N. laevigatus* of Whitecliff Bay, Isle of Wight (Wrigley & Davis, 1937: 203–228, especially pl. 18).
- (b) The corresponding horizons at Selsey (Wrigley & Davis, 1937: 203–228, pl. 17).
- (c) Possibly beds of doubtful origin (overlain by Bracklesham Beds) east of the Test Valley in the Hampshire Basin (Wooldridge, 1924: 367).
- (d) The beds above the Ypresian with *Nummulites laevigatus* in the Bagshot districts of Surrey and Berkshire (the London Basin) the upper parts of which show evidence of shallowing conditions (Stamp, 1921a: 195), and the unequivocally marine Lower Bagshot Beds of Essex (Wooldridge, 1924: 363–4, 366; Wrigley & Davis, 1937: 219).

Plant-remains in the marine beds have so far been recorded only from Selsey, and from the Isle of Wight, and are scarce even in these localities.

This third period was clearly influenced by the maximum Tethyan connexion. The fauna, including *Nummulites planulatus* and *N. laevigatus*, shows relationship with that of the Sables de Cuise and the Calcaire Grossier of the Paris Basin in which the same Nummulite zones occur; also the same mollusca of Tethyan type. The Tethyan sea in Bracklesham times spread northward over the Hampshire Basin to within twenty or thirty miles of London (Gardner, 1883: 199). Its deposits, unlike the London Clay, appear to thin in an easterly direction.

(iv) In the Upper Bracklesham (Auversian and Bartonian) the deposits are essentially marine owing to renewed marine transgression which culminated in the Bartonian. In the Hampshire Basin the fauna suggests relatively deep water, and shows, once again, an admixture of boreal with Tethyan types. The beds include: (1) The Upper Bracklesham (Auversian) of Selsey with *Nummulites variolarius*. (2) The Bournemouth Marine Beds (Auversian?) part of which, according to Gardner (1879: 227), mark a zone of debatable ground between sea and land, whereas other parts, together with the succeeding Boscombe Sands (regarded in this paper as part of the Bournemouth Marine Series) he considered to be truly marine. With the Bournemouth Beds may perhaps be included the Cliff End Beds with a few *Nummulites* preserved as pyritic internal casts found (by washing) by the writer. (3) The Hengistbury Beds. (4) The Barton Beds of Barton Cliff and the Isle of Wight. Here there are two well-marked Nummulite zones, that of *N. prestwichianus* below, and that of *N. rectus* above (Curry, 1937; 1942, pl. 3).

Throughout these marine beds plant-remains are sparsely scattered, usually much battered and drifted, except in the main mass of the barren Boscombe Sands where they are very rare but have been noted by E. St. John Burton in an unpublished MS. At the base of the

Boscombe Sands, however, and immediately overlying them, dense matted 'rafts' of compressed and decayed vegetation are found. The plants, like the animals, also show that the Tethys still strongly influenced the climate of Eocene Britain.

In the London Basin extensive erosion appears to have occurred so that remains of the higher beds are scanty. Apart from the Upper Bagshot (formerly called 'Barton Sands') of the Bagshot area (Prestwich, 1847: 393) which are of doubtful age (Auversian or Bartonian, Stamp, 1921: 195) and more or less indistinguishable from the Middle Bagshot Beds below them, there are virtually no deposits from this time onward. After the Barton Beds, Gardner considered that an Eocene estuary lay over the Hampshire Basin where it may well have occupied a tract at least seventeen or eighteen miles wide (Gardner, 1883: 199).

(v) In the Lower Headon, fluvial or estuarine beds are well-developed, and the coastline of the Eocene sea had receded again to the south and south-east. The deposits are best seen at Hordle Cliff, Hampshire, and in the cliffs of the Isle of Wight. They are interbedded fresh and brackish-water beds. From time to time in the upper part of the series, salt water apparently invaded the estuary or delta area, as evidenced by the marine bands, sometimes referred to the Middle Headon Beds, near the top of the Lower Headon Series at Milford (cf. Chandler, 1922, where a full bibliography of the subject is given). For palaeobotanical purposes the Lower Headon is included in the Bartonian following Wrigley & Davis (see Table, p. 8).

(vi) In the indisputable Middle Headon a slight northward transgression of the sea is indicated by fossiliferous marine limestones of the Isle of Wight; also by the Brockenhurst Beds of the Hampshire mainland which include a high proportion of southern forms, and by a sandy deposit with marine and estuarine fossils found 35 feet below the land surface in a temporary sewer trench at Keyhaven in 1939-40. The fossils from this trench were identified by L. R. Cox as a typical Middle Headon assemblage (Chandler, 1948: 23-26).

Plant-remains have recently been found in the Upper Headon at Colwell; more almost certainly await discovery.

(vii) In the Bembridge and Hamstead Beds of the Isle of Wight there is evidence of further recession of the sea together with the re-establishment of estuarine and fluvial conditions. The Bovey Tracey freshwater Lake Basin with its lignite and plants stands in a category all by itself but belongs to this period.

No British deposits of later Oligocene or of Miocene age are known.

The succession of events summarized above differs in some slight degree from the succession of cycles of sedimentation postulated by Stamp for the Hampshire Basin (1921), based on a comparison with the Paris Basin (a true basin of deposition with marginal deposits according to Wrigley & Davis, 1937: 213, footnote). The clear marine character of the Highcliff Sands (Cliff End Beds) as shown by the sparse occurrence of *Nummulites* and other marine fossils, forbids the ascription of this horizon to a continental phase (see Curry, 1942, pl. 3) and it may form part of a marine cycle which included the Barton and Hengistbury Beds and perhaps also the Bournemouth Marine Beds.

However, the Boscombe Sands with their underlying and overlying rafts of battered and broken vegetation may, as Stamp suggests, represent a continental phase with an accumulation of subaerial shingle-banks left by the retreating Lutetian (Stamp) or Auversian sea (compare and contrast Stamp, 1921: 136). St. John Burton (ex lit. 27 Sept. 1945) refers to them

as 'littoral deposits'. Against this view has to be set the opinion of some of the workers most familiar with this coast section, who regard them as marine or estuarine indicating a marine invasion (Ord, 1914), or the continuation of marine conditions (cf. Osborne White, 1917: 33; Gardner, 1879: 209). The teredo-bored, macerated, matted vegetation may well represent rafts which have for long drifted about in salt water. The general consensus of evidence suggests a continuance of marine conditions from the onset of the Bournemouth Marine Beds to the beginning of the Lower Headon with the maximum transgression in the Bartonian.

4. LOCAL CONDITIONS WHICH HAVE AFFECTED THE CHARACTER OF SOME OF THE FLORAS

Apart from the sequence of changes outlined above, attributed to broad physiographic factors, peculiar variations due to local circumstances sometimes occur even in floras in close proximity and of similar age, where closely identical characters might have been expected. Such variations may be due to differences of gathering ground, or to differential sorting by the various agencies of transport and distribution, or to the presence of a grove or clump of some particular plant or plants in the neighbourhood. Thus striking contrasts exist between the Lower Bagshot flora of Lake and Arne, on the one hand, and of the adjacent Poole and Corfe Pipe-clays of approximately the same age on the other. The general aspect and mode of preservation are remarkably different. The Lake and Arne material mostly occurs in thick carbonaceous seams embedded in a coarse quartz sand. The seams yield abundant battered and sand-pitted twigs and wood, fruits and seeds. The Pipe-clay plants, on the contrary, are impressions of leaves and winged fruits in a fine china-clay matrix. Although beautiful in appearance, they show little detailed structure to aid their determination. Since the two types of deposit have little in common, satisfactory comparison is difficult. On the other hand the beds which yield the Bournemouth and Hordle floras show in some seams a facies and mode of preservation rather similar to those of the sandy Lower Bagshot. They have therefore much in common in spite of difference of age. These three floras actually share a number of genera and species which, on the whole, appear to be plants of wide distribution. But, in addition, a few plants not of this category, and of definite tropical type, are also shared. They probably indicate that between the Lower Bagshot and the Lower Headon there was relatively little change of climate and that the Poltavian flora persisted throughout this long period.

Gardner erroneously supposed that whereas there was a clear gradual transition in the botanical character of the flora in passing *upwards* from the Bournemouth Beds to the Oligocene, in passing downwards there was a sharp line of demarcation between the Bournemouth flora (his 'Middle Bagshot') and that of the Pipe-clay (his 'Lower Bagshot') since few of the specimens he recognized at Bournemouth could be traced in the beds below (Gardner, 1882: 3). But evidence now available shows that while in passing upwards from the Bournemouth Beds through Cliff End and Hordle, gradual botanical changes perhaps occur as he supposed, in passing from the Lower Headon to the Oligocene the changes are far more marked than those between the Middle Bagshot Bournemouth Beds and the Lower Bagshot Beds of Lake and Arne.

C. The Eocene Flora

I. *Palaeocene or Pre-Ypresian*

Chiefly found in the London Basin (Lower London Tertiaries) up to but not including the Oldhaven Beds.

1. INTRODUCTORY REMARKS

So far as evidence is yet available, the pre-London Clay British Tertiary floras certainly include a few definitely tropical forms, although *Nipa* itself has not yet been found. The characteristic family Icacinaceae is present in the Woolwich, Oldhaven and Blackheath Beds. *Lygodium*, *Oncoba* and *Jenkinsella* occur in the Woolwich and Reading Beds. Hence the flora of these deposits can scarcely have been almost temperate as Hooker (1854) and Gardner (1879: 2) at one time suggested. In the light of these records there are no grounds for postulating a cool climate during the Palaeocene (cf. Reid & Chandler, 1933: 59). This conclusion will be seen to have some support from other lines of evidence. Knowledge of the older Tertiary floras is very limited, because the plants are often so poorly preserved, fragmentary, and macerated, as to be difficult of determination. Consequently form-names have had to be used rather freely, e.g. *Myrtospermum*, *Menispermicarpum*, *Laurocarpum*. But such 'determinations', although of value, do not yield the maximum botanical information. Since the plant beds of these Lower London Tertiaries occur largely in what are now 'built-up' areas, the sections which formerly yielded plant-remains are no longer exposed. Gardner states (1883: 1) that below the London Clay the floras were homogeneous and with relatively few species, but his conclusion must have been based on inadequate material. There is reason to think that if a few more good plant localities could be found, the floras would prove to be as rich as any. Gardner adds that on the whole the aspect was temperate, and quotes, in support of this statement, the occurrence of planes, and of leaves and fruits identical with Greenland fossil forms. The occurrence of planes has not, so far, been confirmed, but one supposed plane from the Reading Beds of Reading may be referable to Hamamelidaceae.

The connexion with Greenland species has yet to be satisfactorily established, and, as stated above, there is evidence among recently determined plants for modifying this earlier opinion as to the temperate character. By 1886 Gardner (p. 400) had reached a different conclusion himself for he writes '... the Reading Flora no longer appears so completely distinct from that of Bournemouth'. In the same paper he figures *Anemia subcretacea* from the Reading Beds, and *Lygodium prestwichi* from the Woolwich Beds of Croydon, both tropical forms. There seems no reason to doubt these determinations for he also recorded them at Bournemouth where their presence has now been confirmed. Moreover *Lygodium prestwichi* has recently been described from the Woolwich Beds of Newington (Chandler, 1955: 309).

2. FLORAS OF SUCCESSIVE HORIZONS

(a) THANET BEDS

The oldest British Palaeocene strata are the Thanet Sands which rest unconformably upon the Chalk. According to Gardner (1878: 283) they indicate a very temperate climate, an

opinion which must be regarded with suspicion. He compares them with the Sables de Bracheux and the Lower Landenian. The only plants at present known are the cones of Abietineae, including two species of *Pinus*, and a silicified stem of *Osmundites* (for a list of references, see p. 51). Silicified wood was at one time common near Reculvers and at Richborough (Carruthers, 1866: 540), and a small piece of silicified *Pinus* wood has recently been found at Hampton, Swalecliff, by D. J. Jenkins. However, Morley Davies (1930: 308) draws attention to the likeness of the Thanet marine fauna to that of the Copenhagen Palaeocene in which cooler forms mingle with those of warmer seas.

White (1931: 32-37, 42) notes the occurrence of tropical and subtropical marine fish-remains in the Thanetian and overlying beds. In regard to the flora, further evidence is much needed; the few plants known give little information, but it is perhaps not without significance that *Pinus macrocephalus* probably also occurs in the tropical London Clay.

The abundant cones of this species in the Thanet Beds may point to an adjacent land covered by pine-woods with marshy patches inhabited by the fern *Osmundites*. Here it may be noted that Richards (1952) refers to pine-forests on the inland margin of the mangrove zones in Florida where the vegetation becomes non-halophytic.

Gardner (1883: 208) suggested that the beds were deposited in a shallow sea beyond the estuary of a river but not outside the sphere of its influence. In such a position, wave action and attrition by coarse sediments would have militated against the preservation of abundant plant material or of any, except the stoutest, in good condition. Wrigley, however, thought (1949: 42) that the presence of some glauconite, and the character of the molluscan fauna indicate still water and slow deposition. He considered that the sea must have been shallow and near to a low land surface 'without the great river which drained its western extension throughout the later Eocene'.

Wrigley comments (p. 45) on the very diverse views about Thanetian climate. Some of the more boreal mollusca occur also in the London Clay associated with the tropical flora now so well known. Other mollusca are at present confined to warm seas. He points out that Leriche regarded the fishes as subtropical (as did White). Calcareous algae compare with those of the Antilles, Brazil and the China sea.

The Gelinden leaves (base of the Thanetian) are according to Saporta (1873; 1879: 215-217) similar to those of a forest in southern Japan, while the Sézanne flora (equal to higher beds) indicates warm to hot conditions. On balance Wrigley concluded that the indications 'point to a subtropical rather than a temperate or boreal climate'.

Comparison between the almost unknown Thanetian flora of Britain with these richer floras of Belgium and France is impracticable, especially as the preservation of the continental floras is different, and the plants are represented by leaves. It may be noted, however, that in the older Gelinden flora oaks predominate, some similar to the mountain species of the warm temperate zones. Other plants, like *Castanopsis*, have persistent leaves. The Lauraceae, with persistent leaves, are well represented. There are also *Viburnum*, *Aralia*, *Devalquea*, Menispermaceae, Celastraceae and Myrtaceae.

In the later floras of Sézanne and Vervins there are among others several ferns, *Araucarites sternbergi*, fan-palms of *Sabal* type, *Alnus*, *Dryophyllum*, *Juglandites*, *Populus*, *Salix*, *Protoficus*, *Laurus*, *Sassafras*, *Sterculia*, *Grewiopsis*, *Cissus*, *Aralia* and *Viburnum*.

(b) WOOLWICH AND READING BEDS

Somewhat fuller palaeobotanical evidence is available about the Woolwich and Reading Beds, although it is still of a fragmentary and inadequate nature.

To the east lay the sea in which the marine Woolwich Beds were laid down, but passing westwards the marine beds give place to brackish and fluviatile Reading Beds, estuarine beds in between constituting a link between them. As noted by C. Reid (1896: 490-495), at Newhaven and Portslade there are fluvio-marine beds; further west the beds become more fluviatile, while west of Wareham they contain lenticular patches of gravel. These westernmost Reading Beds overlap on to the Chalk. Reid deduced that the rivers in which the Eocene deposits were formed flowed from the west or south-west, as suggested by the increasing coarseness of the gravels in those directions. Hawkins refers to the occurrence of tourmaline and pebbles of schorl rock in the Reading Beds as evidence of their derivation from the south-west (1946: 171).

Attempts have been made to reconstruct the conditions at the time that these beds were deposited. Sherlock (1940) drew a comparison between the Trias with its mottled green and red clays, sands, conglomerates and pebbly sandstones, and the Reading Beds. He infers a common type of origin for both under continental and semi-arid conditions. He quotes Bailey's suggestion (1924) as to the probable aridity of land bordering the chalk sea, and considers that this aridity may have continued into Reading times.

Gardner, on the other hand (1878: 283), referred to the presence of palm-wood, sharks' teeth and turtle-remains in the formation, regarding them as indications of a warm, possibly even subtropical, climate but less warm than that of the London Clay. He regarded the little known Reading flora as valueless for 'climatal inferences'. Hawkins (1946: 169, 170) alludes to jungle conditions in the 'Reading Bottom Bed' and compares it with the Lower Coal Measures.

The evidence up to date from plant-remains as already stated indicates a tropical climate, although Hooker placed another interpretation upon the few data then known to him. Thus there were broad-leaved trees near the base of the formation in the Railway Cutting at Reading. They occurred as a purely local development in a matrix of fine fuller's earth interstratified with sand. They were figured, but not named, by Hooker (1854, pl. 4, figs. 1-23, 29) in an appendix to Prestwich's paper on the Woolwich and Reading Beds. Names subsequently given to some of them by La Harpe (1872: 578) must be regarded as *nomina nuda*. Hooker commented on the apparent absence of tropical elements, pointing out that the leaves were of large size, and that some were of membranous appearance indicating a measure of summer warmth. According to Richards (1952: 79) young leaves may be thin and may hang down and are often quite limp.

It should be noted, however, that of the leaf types figured (over twenty in number) seven or eight at least (cf. Hooker, 1854, pl. 4, figs. 1-3, ?4, 9, 9*, 9**, 10, 15) must now be referred to a single species perhaps belonging to Hamamelidaceae.

Another three of Hooker's species (1854, pl. 4, figs. 19, 20, 20*) are referable to *Haloragis*, herbs of damp places including Australia, New Zealand, south-east Asia and North America. The species, which has dentate leaves, is also figured by Gardner (1886, pl. 2, figs. 5-12) as a fern. It represents the ground herb layer. According to Richards leaves in this substratum of the forest may be soft and thin, while non-entire margins are more frequent than in the upper strata.

Other leaves (Hooker, 1854, pl. 4, figs. 5, 7, 8, 12-14) appear to show the form and entire margin so commonly associated with tropical rain-forest vegetation.

These early recorded facts, taken together, suggest that the climate during the deposition of the Woolwich and Reading Beds must have been very warm and damp rather than cool and temperate.

Hooker further argued that the occurrence of 'leaf-buds' indicated a temperate climate with seasonal changes. But the supposed 'leaf-buds' are probably Lauraceae berries some of which were still attached to peduncles and cupules, some detached showing the limits of the basal scar of attachment (cf. Hooker, 1854: 163, 170, pl. 4, figs. 24-26; and pp. 66, 67, Pl. 5, figs. 8-11 of the present work). In any case, the presence of Lauraceae in the deposit is well established from other well-preserved berries of different types (pp. 65, 66, Pl. 5, figs. 4, 5). Also detached Lauraceae berries whose shining skins simulate bud-scales occur in the Woolwich Beds of Tooting (p. 66, Pl. 5, figs. 6, 7). The presence of this family in such force certainly points to warmth and moisture.

In addition to the leaves and berries from Reading, Gardner also recorded a conifer which he called *Taxodium europaeum* Brongniart (1886: 92, 93, pl. 24). He regarded it as indistinguishable from the Recent *Glyptostrobus heterophyllus* of China. If it was really identical with *Taxodium europaeum* from Bournemouth, then it must be related to Cupressineae as will be discussed subsequently under *Cupressistrobus gardneri* when the description of the Bournemouth flora is published. Paired needles of *Pinus* were mentioned (Gardner, 1886a: 400) and broken but very large needles are preserved on V.15274 and figured (incidentally) by Gardner (1886, pl. 24). Reference was also made to *Platanus* leaves and fruits in abundance. But there are now reasons for regarding these as Hamamelidaceae (see pp. 67-72). There were also leguminous pods (not yet determined) and 'many flowers' (Gardner, 1886a: 400), but what specimens Gardner had in mind cannot now be determined. A fern (Gardner, 1886a: 402, pl. 1) was named *Anemia subcretacea* Saporta and another *Lygodium prestwichi* Ett. & Gard. As already stated there is no reason to doubt these determinations. Both genera were recognized by Gardner at Bournemouth, and their presence there has recently been confirmed on the evidence of fertile pinnules with sporangia and spores. Their occurrence, even more than that of the Lauraceae, suggests warm (perhaps tropical) and moist conditions.

As already mentioned on p. 16, recent work on the Reading plants adds the tropical *Oncoba* to the list. *Jenkinsella*, which is now recorded both in Woolwich and Reading Beds, suggests somewhat tropical conditions, because it is a highly characteristic plant of the Lower London Clay.

There are few other early records to consider but the following, chiefly from localities other than Reading, deserve mention. The early records were summarized by Gardner (1879: 9, 10).

1814, Webster (p. 191) first referred to plants in these beds.

1817, Sowerby (p. 185, pl. 500) figured a type of leaf common at Newhaven and suggested a relationship to *Platanus orientalis*.

1822, Mantell (p. 262, pl. 8) re-figured Sowerby's leaves together with additional material, and re-affirmed the relationship with *Platanus*.

1854, Hooker figured and described leaves and other plant-remains from the Woolwich Beds of Counter Hill, Lewisham, and from Reading.

1855, Hooker (pp. 562-565, pl. 16, figs. 1-19) figured seeds from this locality under the

name *Carpolithus ovulum* Brongniart; he supposed them to be sporangia. Schimper, however (1874: 93), rightly regarded Brongniart's *C. ovulum* as belonging to the Nymphaeaceae. There can now be little doubt that the Woolwich seeds also belong to this family, and possibly to *Palaeonymphaea*, a genus which will ultimately be described from the Bournemouth area.

1883, Gardner (p. 25, pl. 2, figs. 17–20) added *Libocedrus adpressa* from the Woolwich Beds of Bromley to the meagre flora. The record is included in the plant list on p. 21. The foliage of *Libocedrus* is fairly distinctive and the determination may be reliable as Gardner was a most careful observer. Another fern from the Woolwich Beds of Croydon—a mere fragment attributed to *Acrostichum* or *Pteris* (Gardner, 1886a: 403, pl. 2, fig. 1)—is omitted. Its true relationship cannot now be ascertained.

1889, Whitaker (p. 213) gave a list of plants from Lewisham and Counter Hill supplied by Gardner. In addition to those already mentioned are *Aralia?* leaf, *Lygodium prestwichi* (also from Croydon and Dulwich), *Liriodendron gardneri* (Dulwich), Palmetto (Croydon), *Pteris* (Croydon).

Unfortunately none of these plants is figured or described. On p. 211 silicified stems are recorded by Whitaker from the Bottom Bed of the Woolwich and Reading Series, Croydon.

Woolwich Flora of Tooting and other recent discoveries

In 1932, a small sample representing the washings of about one hundredweight of lignitic clay was sent by Davis from a temporary excavation accessible during the enlargement and extension in 1923–25 of the City and South London (Underground) Railway. The section was described by Davis (1928: 339). The grey lignitic clays which yielded plants (Woolwich Beds IV) lay between mottled clays and shell beds and were regarded by Davis as the equivalent of the Lignite Beds of Kentish localities. A few carbonaceous fruits or seeds only were found among much broken and indeterminable vegetable debris, but our ignorance of this flora makes them of great importance. They were readily washed from the loose-textured unconsolidated matrix. There were six recognizable families and genera (see p. 21). Some scraps of cuticle would perhaps repay the attention of a specialist in this line of research.

The few other recent and hitherto unrecorded additions to the Woolwich flora include a winged fruit, preserved as an impression in a block of argillaceous sandstone obtained by Davis from the Sewage Farm at Beddington, Surrey, and identified as *Abelia palaeocenica* (p. 83), and a leguminous seed so far not generically identified, from the Woolwich Beds of Bognor. The latter was found by E. M. Venables in a temporary sewer trench, and is the only known Woolwich plant from the Hampshire Basin apart from the (supposed *Platanus*) leaves at Newhaven.

There are two unidentified leaves preserved in the Winchester City Museum from the Reading Beds of Colden Common. One at least appears to be *Cinnamomum*.

A very few specimens, derivatives from underlying Reading Beds, have been found in the Pleistocene Arctic Beds of the Lea Valley. Among them are *Natsiatum eocenicum*, an anacardiaceous fruit, and an apocynaceous seed. The plants were extracted from a 'raft' of Tertiary material found in Rikof's Pit, Broxbourne, by the late S. Hazzledine Warren. The 'raft' contained nothing but Tertiary remains. There is also a solitary seed of *Myrtospermum* from the Arctic Beds of Ponder's End, and according to Wrigley the underlying beds at this locality are London Clay. But the preservation of the seed is more akin to that of the Reading Beds than

to that of typical London Clay. Perhaps, therefore, it was derived from Reading Beds higher up the valley near Broxbourne and carried into the Arctic Beds which were being deposited lower down at the Ponder's End site. At any rate the genus occurs at Tooting.

Woolwich and Reading Bed Flora

Below is a list of Woolwich and Reading Bed plants which can be regarded as satisfactorily determined. The present-day distribution of families is indicated in column 2, as follows: T, exclusively tropical; CT, chiefly tropical; TE, extra tropical; B, both tropical and extra tropical.

Family	Genus and Species	L=leaves F=fruits S=seeds	Occurrence	
			W= Woolwich Beds R= Reading Beds	
Schizaeaceae .	CT <i>Lygodium prestwichi</i> (Gard. & Ett.)	L	W	Croydon, Counter Hill, Lewisham, Woolwich, Newington
„	<i>Anemia subcretacea</i> (Saporta)	L	R	Reading
Taxodineae .	TE <i>Sequoia couttsiae</i> Heer	S	R	Hedge Lane, Lea Valley (derivative in Arctic Beds)
Cupressineae .	TE * <i>Cupressistrobus gardneri</i> n.sp.	L	R	Reading
„	<i>Libocedrus adpressa</i> Gardner	L	W	Bromley
Abietineae .	B <i>Pinus</i> sp.	L	R	Reading
Cyperaceae .	B <i>Caricoidea obovata</i> n. sp.	F	W	Tooting
Nymphaeaceae .	B ? <i>Palaeonymphaea</i> sp.	S	W	Lewisham
Betulaceae .	TE <i>Carpinus davisii</i> n.sp.	F	W	Tooting
Lauraceae .	CT <i>Laurocarpum</i> spp.	F	WR	Tooting, Dulwich, Reading
Hamamelidaceae	B <i>Liquidambar palaeocenica</i> n.sp.	F	R	Reading
„ (?)	Genus?	L	R	Reading
Leguminosae .	B <i>Leguminosites gardneri</i> n.sp.	F	R	Reading
„	<i>Leguminosites</i> sp.	F	R	Reading
„	Genus?	S	W	Bognor
Rutaceae .	B <i>Phellodendron costatum</i> Chandler	S	R	Reading
Anacardiaceae .	CT Genus? (<i>Rhus</i> or <i>Pistacia</i> ?)	F	R	Broxbourne (derivative in Arctic Beds)
Icacinaceae .	T <i>Natsiatum eocenicum</i> Chandler	F	WR	Broxbourne (derivative in Arctic Beds); Tooting
Vitaceae .	B * <i>Vitis pygmaea</i> ?	S	W	Tooting
Flacourtiaceae .	T ? <i>Oncoba variabilis</i> (Bowerb.)	F	R	Reading
Myrtaceae .	B * <i>Myrtospermum variabile</i> n.sp.	S	W	Tooting
„	<i>Myrtospermum warreni</i> n.sp.	S	R?	Ponder's End (derivative in Arctic Beds on London Clay)
„	Genus?	S	W	Tooting
Haloragidaceae .	B <i>Haloragis</i> sp.	L	R	Reading
Apocynaceae .	B *? <i>Apocynospermum lakense</i> n.sp.	S	R	Broxbourne (derivative in Arctic Beds)
Caprifoliaceae .	B <i>Abelia palaeocenica</i> n.sp.	F	W	Beddington
„	<i>Sambucus</i> sp.	S	R	Reading
Family? .	<i>Jenkinsella apocynoides</i> R. & Ch.	F	WR	Dulwich, Reading
„	<i>Carpolithus gardneri</i> n.sp.	F	R	Reading
„	<i>Carpolithus</i> spp.	F	WR	Reading, Tooting, Dulwich
		S		Broxbourne (derivative in Arctic Beds)

Species marked with an asterisk* are based on better preserved or more abundant material from newer beds. They are already described, but the descriptions are not yet published and will appear in a later catalogue.

Altogether there are nineteen families recognized and twenty-two named genera. Of these latter, five, *Caricoidea*, *Laurocarpum*, *Leguminosites*, *Myrtospermum* and *Apocynospermum* are form-genera; one, *Jenkinsella*, is a fossil genus as yet of unknown affinity, leaving sixteen which are identical with, or closely related to, living genera. Although numerically the evidence is so slight, the distribution in latitude and altitude of the families at the present time certainly suggests at least a sub-tropical climate, as may be seen by an examination of the above Table in which two families are shown to be exclusively tropical and three are chiefly tropical. It will appear subsequently that these families also occur in later warm beds of the Hampshire Basin. Further the Icacinaceae and Flacourtiaceae are highly characteristic of the warm London Clay and Lower Bagshot.

After the Upper Eocene, Icacinaceae virtually disappear in these latitudes, while the Flacourtiaceae have not so far been recognized later than the Highcliff (Cliff End) Beds near Mudeford.

Although the Cupressineae and Betulaceae are for the most part extra-tropical they are represented by the same genera in the warm floras of Dorset and Hampshire.

As to the genera: *Anemia*, *Lygodium*, *Oncoba* and *Jenkinsella* have already been mentioned (p. 16) as indicating a warm, perhaps subtropical climate. The form-genus *Myrtospermum* (represented especially by *M. variabile*), and the species *Sequoia couttsiae* are of widespread occurrence in the Eocene beds of the Hampshire Basin from the Lower Bagshot Beds upwards and are associated with warm or tropical floras, while *M. variabile* occurs in the London Clay of Nursling. *Sequoia* and *Myrtospermum* occur also in the Oligocene Bovey Tracey lignite, where somewhat cooler conditions appear to have prevailed. If the Nymphaeaceae indeed be represented by *Palaeonymphaea*, there is further indication of warm conditions, for this genus (not yet described) is based on seeds from the Bournemouth Freshwater Beds of Sandbanks and also occurs in the Lower Bagshot. *Natsiatum*, like the whole Icacinaceae family, is tropical. *Carpinus* is today extra-tropical but occurs in Tertiary times at several horizons characterized by warm floras in the Hampshire Basin. It also occurs at Bovey. *Libocedrus*, although extra-tropical, nevertheless indicates a greater degree of warmth than that of present-day Britain. It was recorded by Reid & Chandler in the Bembridge Beds (1926: 58). *Liquidambar* also suggests a greater degree of warmth, the genus extending into the tropics. *Pinus*, *Vitis* and *Abelia* give little information; they may be either tropical or extra-tropical, but pines predominate on the whole in cooler regions, although, as noted, a species occurs in the tropical London Clay.

The climatic evidence afforded by animals from the Woolwich and Reading Beds may be briefly summarized. Prestwich, the great student of London Clay and Lower London Tertiaries, stated (1854: 136) with regard to the Woolwich and Reading Beds that there is 'a preponderance of forms such as, on the whole, we might expect to meet with at present in more moderate climates than the one in which the more tropical-seeming vegetation and animals of the London Clay could have flourished'; but, he added, 'the data are too limited to arrive at any very satisfactory or definite result'.

According to more recent work by Morley Davies (1930) the Palaeocene fauna shows an admixture of boreal forms (such as *Cyprina*, *Aporrhais*, *Astarte*, *Natica*) with warm Tethyan forms (such as *Nautilus*, *Chama*, *Cucullaea*).

White's and Leriche's researches show that the fish-remains have tropical and subtropical affinities:

Muir-Wood (1939: 149) also produces evidence of warm water from the brachiopod, *Discinisca*, which is known from the Woolwich Beds of Tooting, Beckenham and Sundridge in the London Basin, and from Clapham, near Worthing, in the Hampshire Basin, also from the London Clay (Alum Bay and Lower Swanwick, near Southampton), and the Lutetian (Lower Bracklesham) of Bracklesham. Muir-Wood states that 'by analogy with recent species of the genus we have a sure indication of tropical or sub-tropical shallow-water conditions for the deposits in which they occur. All the Recent species of *Discinisca* are marine forms and, with one exception, live at a depth of from 0-20 fathoms off the shores of Japan, China, India, Chile, Peru, etc.'. Wrigley (1949) also supported a warm climate.

On the whole, therefore, palaeozoological and the somewhat scanty palaeobotanical evidence suggest warm and probably tropical conditions in the Palaeocene during the deposition of the Woolwich and Reading Beds.

The Woolwich and Reading Beds are comparable in age with part of the Sparnacian of the Paris Basin, a stage regarded by Wrigley (1949: 44, 45) as the lagunar phase of the marine Thanetian and of the marine London Clay (in part). These Sparnacian deposits also yield plants, notably in the Lignites of Soissonais and the Plastic Clays of Arcueil and Vanves (Seine) and Silly-la-Poterie (Aisne). Again the different mode of preservation and the fact that the French plants are represented by leaves makes comparison with the Woolwich and Reading Beds flora very difficult. Noteworthy is the occurrence of *Posidonia*, *Sabalites*, *Ficus*, *Laurus*, *Cinnamomum*, *Dombeyopsis*, *Aralia*, *Sapotacites*, plants indicating a warm climate.

As similar difficulties arise also in the comparison of the Ypresian floras on the opposite sides of the Channel it may be sufficient to point out here, while discussing the French deposits, that the Ypresian Grès de Belleu (Aisne) shows some families or genera in common with the London Clay, notably a fan-palm of *Sabal* type, *Juglans*, *Anona*, *Magnolia*, five genera of Lauraceae, including *Cinnamomum*, *Apeibopsis* (possibly *Oncoba*?). Among other genera recorded in the French Ypresian are *Carpinus*, *Quercus*, *Populus*, *Ficus*, *Sterculia*, *Acer* and *Acacia*.

II. Ypresian

1. BASEMENT BEDS (OLDHAVEN AND BLACKHEATH BEDS) AND THEIR DISTRIBUTION

The Oldhaven Series includes large beds of rolled shingle (Blackheath Beds) representing ancient shoal deposits, and finer and coarser sands with estuarine and sometimes with marine shells. The beds clearly afford evidence of that encroachment of salt water over a subsiding area which ushered in the London Clay sea. The deposits, as already stated, occur only in the eastern part of the London Basin, chiefly in West Kent, East Surrey and South Essex. According to Gardner (1883: 205) they may have been laid down between high and low water-marks by surf. Naturally, under such conditions, plants from the adjacent land tend to be fragmentary and much battered, and are frequently unrecognizable. Moreover, in the sandy beds, the coarseness of the matrix does not permit the preservation of impressions showing very fine details of cell-structure.

(a) OLDAHVEN BEDS (s. str.)

Such limited up-to-date knowledge of the Oldhaven Beds flora as exists depends entirely on a fortunate recent discovery by J. E. Cooper of several slabs of coarse-grained calcareous sandstone covered with plant-remains at Bishopstone, Herne Bay. Although Mr. Cooper has searched the neighbourhood for further productive material none has been found. The blocks showed an abundance of woody fragments and a few poor fruit and seed impressions lying on the bedding plane. The matrix could not be disintegrated by washing, so the blocks were broken up, and a few shrunken and cracked embedded fruits and seeds were revealed. They were in many cases so broken and decayed as to be unrecognizable. The coarseness of the matrix produced obscure impressions difficult to determine.

A few carbonaceous specimens enclosed a calcite cast of locule or seed; in rare instances the cast was partially pyritized.

In spite of the difficulties due to poor preservation, eleven families have so far been recognized, and ten named genera of which only five are living. Although the flora is so scanty, it suggests tropical conditions, witness the presence of Icacinaceae, of *Tinospora excavata* (a characteristic London Clay species), and other Menispermaceae; also of Lauraceae and Vitaceae. The following list includes all the Oldhaven plants so far determined:

LIST OF THE OLDAHVEN PLANTS

B=Both temperate and tropical families. CT=Chiefly tropical. T=Exclusively tropical.

Potamogetonaceae	B	<i>Limnocarpus cooperi</i> n. sp.
"	"	" sp.
"		<i>Limnocarpus? magnus</i> n. sp.
Menispermaceae	CT	
Cocculinae		<i>Canticocculus cooperi</i> n. gen. & sp.
"		Genus?
"		<i>Menispermicarpum serratum</i> n. sp.
Tinosporeae		<i>Tinospora excavata</i> Reid & Chandler
Lauraceae	CT	<i>Laurocarpum</i> sp. (<i>Cinnamomum?</i>)
"		" spp.
Rutaceae (Zanthoxyleae)	B	<i>Zanthoxylon</i> sp.
Euphorbiaceae	B	Genus?
Icacinaceae	T	<i>Natsiatum eocenicum</i> Chandler
Rhamnaceae	B	Genus?
Vitaceae	B	<i>Vitis</i> spp.
Myrtaceae	B	<i>Myrtospermum cooperi</i> n. sp.
"		" <i>variabile</i> Chandler
"		" sp.
Epacridaceae	B	Genus?
Symplocaceae	B	? <i>Symplocos</i> sp.

The occurrence of turtle bones (Gardner, 1883: 207) also suggests a warm climate. The absence of specifically temperate or extra-tropical families or genera may be noted.

In another brief discussion of the Oldhaven flora, Gardner (1879: 2) makes the following statement, on precisely what evidence is not clear. It has 'quite another character' (than that of the Woolwich and Reading Beds) the small amount of material collected seeming 'to indicate a relation to the Eocene floras of Sézanne. The same types, and the same luxuriant preponderance of serrate dicotyledonous leaves, are characteristic of both'. The Sézanne flora is

later in date than the Gelinden, and is usually regarded as more tropical in character. It represents a luxuriant flora watered by the spray from a cascade, and is rich in ferns, Lauraceae, Juglandaceae, Magnoliaceae, 'Alders', 'Willows' and *Viburnum*. 'Figs', Meliaceae and *Symplocos*, etc. are also said to occur. Saporta (1879: 217–220) suggested that it represents an admixture of plants characteristic of the southern part of the temperate zone with those characteristic of warmer climates.

(b) BLACKHEATH BEDS

The records of Blackheath plants are of no scientific value, although Whitaker (1872: 247, 582) mentions remains from several localities, notably from Widmore Kiln, Bromley, where two well-marked types of leaf occurred, referred by Carruthers to *Ficus* and *Cinnamomum* (see Gardner, 1879: 10, 11); also carbonized wood, said to be coniferous. The leaves were usually adherent to a stem, but no figures or descriptions have been traced and the specimens appear to have vanished.

A full account of the Widmore Kiln section is given by Whitaker (1889: 221–223). The section is no longer exposed. One plant only is as yet fully described. It occurs in a shelly conglomerate found at Chislehurst in 1883 by Sir Sidney Cockerell, the block being labelled 'Basement Bed of the London Clay'. Fish-remains collected at the same time caused further enquiry, and Dr E. I. White therefore re-examined the block. He found that the shells and matrix indicated Blackheath Beds (ex. lit. W. N. Edwards, 24 Dec. 1930). The consistent rounding of the pebbles indicates formation beneath the sea (not subaerial formation on a coastal beach) the pebbles drifting in submarine shoals at some distance from the land (cf. Stamp, 1921: 70). It was a fortunate chance that in such a coarse matrix a plant should be preserved at all. It has been identified as an endocarp of *Natsiatum* (family Icacinaceae) and is probably referable to *N. eocenicum* Chandler.

Further discussion of the Oldhaven and Blackheath Beds will be found on pp. 12, 23.

2. LONDON CLAY

(a) REFERENCES TO OLDER WORK OVERLOOKED IN 1933

This section is a supplement to a monograph published by Reid & Chandler in 1933. Details were there given of early research on the London Clay Flora. A few references were, however, overlooked and are recorded now.

(i) An earlier record of fossils in the London Clay than any previously traced occurs in the famous diary of John Evelyn under the date 23 July, 1668. It runs as follows:

'At the Royal Society were presented divers *glossa petras* and other natural curiosities found in digging to build the Fort at Sheerensse; they were just the same as they bring from Malta, pretending them to be Viper's teeth, whereas in truth they are of a shark, as we found by comparing them with one in our Repository.'

Although there is specific mention of animal fossils only, it is probable that among the 'other natural curiosities' some fruits and seeds would have been included.

(ii) By the kindness of the late A. G. Davis and A. Wrigley, my attention was called to a pamphlet which gives full details of the original discovery of *Petrophiloides*. The paper published by Richardson (1841) appeared under the unpromising title: 'Observations on the

locality of *Hyracotherium*'. It describes the cliff section in the lower 100 feet of the London Clay at Studd Hill between Herne Bay and Tankerton, Kent. Here, besides a mass of vegetable débris and 'bushels' of fruits and seeds, about 500 cones of *Petrophiloides* were found. Further details of the discovery are given on p. 136.

(iii) Davis (1936) has drawn attention to a note by Shrubsole (1878) recording the occurrence of fruits *in situ* in the cliff at Sheppey, and in a well-section at Sheerness. Details are given on p. 38.

(iv) A further manuscript record of London Clay plants, comprising eleven sheets of mounted drawings of fruits and seeds, was found by the late C. Davies Sherborn in 1939, while sorting an old collection of loose drawings and photographs in the Museum.

Unlike Crow's manuscript described by Reid & Chandler (1933: 5), its exact date and authorship are not known. The late W. N. Edwards reported that 'the paper, ink and handwriting are early nineteenth century, or late eighteenth century, and certainly not later than about 1835'. None of the writing on the drawings corresponds with Ettingshausen's; it includes original descriptions in Latin, and red ink notes (probably of later date) written in the English language in German script. Edwards suggested that the notes may have been by König, who, although of German origin, was on the Museum staff from 1807 to 1851.

Many of the drawings are of readily recognizable species. The following have been identified:

(1) Lauraceae berry, (5) *Cantitilia*?, with 'spots' not fibres, probably an artist's 'interpretation', (6) *Sapotocarpum latum*?, (7) *Cupanoides grandis*, (8) Tuber or gall, (9) *Dunstania multilocularis*, showing valves and secreting cavities, (12) *Anonaspermum commune*, seed-casts, (13) *Acacinicarya*?, (16) *Wetherellia variabilis*, a fruit abraded so as to show the locules, (18) *Tamesicarpum polyspermum*, (20) *Lagenoidea bilocularis*, (21) *Ochrosoidea sheppeyensis*, (22) *Cupressinites curtus*, (24) *Acacinicarya platycarpa*?, (26) *Tamesicarpum polyspermum*?, (28) *Oncoba variabilis*, (29) *Hightea elliptica*?, (33) *Sphinxia ovalis*?, a fruit abraded so as to expose hollows left by fallen seeds, (33) *Sphaeriodes ventricosa*?, (34) *Wetherellia variabilis*, a coccus, (36) *Lagenoidea trilocularis*, (40) *Hightea* sp.?, (43) *Lagenoidea trilocularis*, (44) *Magnolia gigantea*?, (46) *Wetherellia variabilis*, (49) *Lagenoidea trilocularis*, (50) *Anonaspermum punctatum*, (54) *Beckettia bilocularis*, (55) *Cupanoides*?, (56) *Protoravensara sheppeyensis*, (60) *Cupanoides* sp., (70) *Toona sulcata*?, (72) *Protoravensara sheppeyensis*, (74) Gall, tuber or bored wood, (76) *Langtonia bisulcata*?, (77) *Lobaticarpum variabile*, (78) *Minsterocarpum alatum*?, (79) *Oncoba variabilis*, (83) *Palaeorhodomyrtus subangulata*, (85) *Hightea turgida*?, (87) *Cantitilia polysperma*, (90) *Acacinicarya* sp.?, (93) *Tinospora excavata*, (100, 102) *Dracontomelon subglobosum*, (103) Lauraceae berry (inverted) or cupule, (105) *Dunstania multilocularis*, (106) *Hightea elliptica*?, columella with seeds.

(v) The following extracts from Charles König's personal diary, kindly supplied by the late W. N. Edwards, relate to Francis Crowe's London Clay fruits:

- ' 1821. Jan. 17. Crowe offered the whole of his duplicates of fruits, more than a bushel.
 Jan. 21. Went to Greenwish to look at Crowe's collection of fruits.
 Jan. 25. Called on Sir Humphrey Davy [a Trustee] resp. Crowe's Coll. . . . etc.
 Feb. 8. Crowe sent in his drawings.
 Feb. 10. Meeting of Comm. Ld Spencer in the chair. Genl Meeting, the Archbp in the chair. . . . Mr. Crow, comm. appointed for Thursday.

Feb. 15. Mr. Crow's fossil fruit Committee. Exchange approved of.

Feb. 19. Mr. Crow's letter, dissatisfied with the bargain.

Feb. 22. Answered Crow's letter of 19th in which I told him that I would lay his samples before the Trustees.

May 5. Letter from Mr. Crow.

May 12. [An entry "Ansd. Crow's letter" is crossed out.]

1822. Jan. 21. Letter from Mr. Dick resp. the objects given to Crowe for his fossil fruits.' Mr. Edwards himself appended the following comment:

'The above in an old document which I unearthed recently, suggests that part of Crowe's collection came here. Probably the specimens either decayed or got mixed with the later Bowerbank material, but at least it explains why we have Crowe's MS. catalogue.'

(b) RECENT WORK ON PHYTOGEOGRAPHICAL RELATIONSHIP AND CLIMATE

(i) Since 1933 there have been certain contributions to palaeontological and botanical knowledge which have a bearing on the London Clay flora and its investigation. First and foremost among these is Richards' important work on the Tropical Rain Forest (1952) giving many new data about rainfall, temperatures and other conditions necessary for plant-life in this botanical 'formation-type'. Richards discusses the factors which limit the growth of these forests, summarizing at the same time many recent researches which bear upon the subject. He stresses the dominating features of the climate, namely, high and even temperatures at all times of the year, and heavy rainfall spread over the greater part of the year with no prolonged seasonal drought. The high average relative humidity of the Rain-forest environment is emphasized. Thus the mean annual relative humidity of Singapore is given as 51%. Again, observations in a large clearing in a Rain-forest of Borneo show that in ten days in October at the beginning of the rainy season, the mean minimum humidity was 61% representing a saturation deficient (evaporating power of the air) of about 12 mm. at the temperatures prevailing at the middle of the day. This is contrasted with conditions in a temperate climate where 'at 15° C (the temperature of an average day) it would be equivalent to a relative humidity of 6%'.

Richards' evidence supports the main deductions already made by Reid & Chandler (1933) as to the tropical character of the London Clay flora and the conditions which must have been necessary for its growth. He accepted their general conclusions but commented (in a letter to W. N. Edwards, 1955) that in his opinion 70° F, the mean temperature suggested by Reid & Chandler for the London Clay vegetation, 'is certainly a lower limit and is probably too low'. He added that a good round figure would be more like 77°-79° F (25°-26° C).

'In a climatological sense the Tropical zone is defined,' Richards states, 'not by limits of latitude, but by the isotherm of 20° C mean annual temperature.' Further, the north and south climatic boundaries of the tropical Rain-forest formation are also determined, in most places, by precipitation, in contrast with the altitudinal boundaries where temperature is the primary limiting factor.

Another interesting comment (p. 135) is that 'the tropics are not natural climatic boundaries', but the uneven distribution of tropical Rain-forest formation-type 'ultimately depends on the uneven distribution of land and sea'

One further significant remark (p. 149) may be quoted: 'The presence of a large mass of

forest in itself modifies the climate to some extent, so that the climate of a potential Rain-forest area is not necessarily the same as that of the same area if it were in fact forest-covered.'

A great reduction in the extent of tropical forest has undoubtedly taken place since older Tertiary times. Moreover, at the present-day tropical Rain-forest forms perhaps only half of the world's forest area (Richards, p. 404, quoting Heske). The inference is that the reduction in area may in itself have assisted in modifying the climate. The subject, although as yet little understood, may have future significance for the palaeobotanist.

The picture Richards draws of tropical Rain-forest vegetation, and more especially of the Indo-Malayan and south-east Asian forests, recalls in a striking manner the London Clay flora. Four features in common may be noted.

1. *The richness in genera and species* (see pp. 39-48). In the London Clay some 140 genera have been named up to date apart from the numerous remains which have had to be referred to *Carpolithus*. Of these 140 many are form-genera such as *Anonaspermum*, *Bursericarpum*, *Euphorbiospermum*, *Icacinicarya*, *Laurocarpum*, *Sapindospermum*, *Sapotocarpum* to quote only some of the most striking. These form-genera probably represent many more distinct genera which have not yet been separated and identified. There are at least 500 species, not all named, including *Carpolithus* of which there are at least 80 distinct kinds. Moreover, the flora is by no means exhausted yet and much material still awaits study.

For a fossil flora these numbers are large. But as only a proportion of the plants actually present in life are likely to be represented in the fossil state, a very rich and varied flora is undoubtedly indicated by these numbers.

2. *The high proportion of woody plants both trees and shrubs* (cf. Reid & Chandler, 1933: 53). The large number of Palms (about 17) and Anonaceae (at least 14) is significant even when they have not been generically identified. These two groups are stated to form abundant constituents of the shrub layer in the Indo-Malayan forests.

The recent discovery of three kinds of Rhizophoraceae strengthens the case for a tropical Rain-forest. The apparent absence of mangroves, Leguminosae and Dipterocarpaceae was commented upon by Reid & Chandler. The new record of mangroves suggests that the absence (or in the case of the Leguminosae the virtual absence) of these other two typical families may be due to some characteristic of their fruits and seeds which perhaps militates against their preservation as carbonaceous or pyritized entities. It may be expected that given a deposit with a mode of preservation more favourable to them, they might occur. In this connexion the leguminous pod preserved as an impression at Assington (Bowerbank, 1840, pl. 17, fig. 42) may be noted. Note also the impressions of leguminous pods in the Reading Beds (p. 72, Pl. 7, figs. 1-8). The finding of the seeds of Rhizophoraceae has been one of the fortunate consequences of pyritization. Only replacement of the living tissues cell by cell by pyrites would have made likely the preservation of such organs destitute of any hard integument. As impressions they might have been preserved but they would probably have been less readily recognizable and difficult to prove.

3. *The fair abundance of large woody climbers* probably represented by some or most of the Menispermaceae (with at least 18 species), Icacinaceae (at least 25 species) and Vitaceae (at least 25 species). Possibly also by some of the Anonaceae and Sapindaceae. Such climbers are chiefly found in well-lit places in the tropical Rain-forest, for example along river banks.

4. *The poverty of the herbaceous element in the flora constituting the ground vegetation.* According to Richards this element forms an insignificant proportion of the total number of species of trees and shrubs in any tropical Rain-forest, even in Indo-Malaya where it is most richly represented at the present day. Two species can now definitely be assigned to this stratum of the forest, *Selaginella* (a typical Rain-forest herb) and the purely tropical fern *Anemia*. It must be remembered that adequate representation of this minor element may be hampered by the fact that in moist ground reproduction of herbaceous plants tends to be vegetative at the present time, and may have been so in former times also. In such a case fruits and seeds would be even rarer than the plants themselves. In addition to the herbaceous land plants there are traces of an aquatic vegetation, *Protobarclaya*, *Posidonia*?

The apparent absence of the largely epiphytic family, Orchidaceae, which forms such a conspicuous feature in the tropical Rain-forest of today is not surprising having regard to the smallness of the wind-borne seeds. Possibly search for pollen among the finer sediments and residues may eventually demonstrate the presence of this family.

(ii) In 1936 Edwards worked out from Reid & Chandler's plant lists (1933) that 76% of the leaves of related living forms had entire margins (leaving 24% with toothed margins). He pointed out, quoting Endo (1934), that whereas in tropical Rain-forests leaves or leaflets with entire margins predominate a definite increase occurs in the percentage of dicotyledonous leaves with toothed margins in passing from tropical to cooler northern forests. Thus, in south Japan entire margined leaves constitute 56% of the flora, in Hokkaido only 13%, while in northern Japan again only about 8%.

He thus emphasized the value of the physiognomy of a fossil flora as an index of its environmental conditions over and beyond the information to be derived from its taxonomic affinities. This point has lately been stressed by Richards (1952: 154, footnote).

(iii) There has been further information and discussion about floras of the Poltavian type of which the London Clay flora is such a rich example. Recent papers by Chandler (1954), Chesters (1955) and Edwards (1955) necessitate some modification of statements made by Reid & Chandler (1933) where direct migration of the London Clay flora from Indo-Malaya itself along the northern shores of the Tethys was explicitly stated (pp. 61, 62, 88). In view now of the fuller knowledge of tropical antecedent floras in the Cretaceous and Palaeocene, it is no longer necessary to explain how a tropical London Clay flora could have succeeded an older one then believed to be of much cooler type. For a somewhat fuller discussion of this subject see p. 11.

(iv) Some remarks made during the discussion of a paper read at the Linnean Society by Dr. M. A. H. Tinckner (1943: 167-184) on recent work in germination, confirm the view that moisture must have been a controlling factor on the growth of the tropical London Clay vegetation scarcely less important than temperature (Reid & Chandler, 1933: 74-80). During the discussion G. W. Robinson pointed out that tropical plants raised from seed in a botanical garden require 'high humidity and temperature', while C. P. Raffill, in an account of difficulties experienced at Kew in germinating seeds of exotic plants, made the following illuminating remarks:

'Those which come from Malaya, South America, Eastern Australia, East and West Africa and Ceylon, are generally troublesome, and this often because they die when dried.'

'Of dying when dry *Magnolia* is a good illustration, seed from China and from the Himalaya giving no result if despatched quite dry, but some return if sent moist. The seeds of the related *Michelia* are short-lived. Like *Magnolia*, seed of *Nothofagus* dies if dried.'

For the palaeobotanist concerned with past climatic conditions as they may be inferred from contemporary plant-life, this is a most important statement. *Magnolia* is one of the very abundant London Clay genera, with at least fifteen species and innumerable individuals. Evidently without extremely moist conditions this plant would never have thriven and propagated itself in these latitudes as it obviously did in past ages.

(v) The discovery of *Nipa burtini* in the Eocene of the Tatra mountains, south of Cracow (Kuzniar, 1910: 65, recorded but not figured), and near the village of Dudar in Hungary (Rásky, 1948: 130) constitutes another link in a strong chain of evidence. Whatever the precise age of these beds with *Nipa* may be, they provide two more localities for *Nipa* along the margins of the Tethys or in its neighbourhood. The connexion between the Tethyan boundaries and the known distribution of fossil *Nipa* is clearly brought out by Edwards in a map published in 1936 (p. 28, fig. 9).

As regards the Cracow *Nipa*, Edwards reported that he had himself seen two large specimens which were comparable in size with the largest Brussels fruits. They were associated with variously named entire-margined dicotyledonous leaves considered by him to be indeterminate but clearly of tropical Rain-forest type.

Watson (1928: 92) points out that *Nipa* is at its best along banks of tidal rivers where the water is almost if not quite fresh at low tide. Retardation of growth is recorded in *Nipa* plantations following flooding by salt water.

(vi) Scott (1954) in a paper dealing with fossil fruits and seeds from the Eocene Clarno formation of Oregon, U.S.A., gives data of great phytogeographical significance including records of four London Clay genera, two being actual London Clay species, *Laurocarpum proteum* and *Palaeophytocrene foveolata*. Of especial significance is the occurrence of the Phytocreneae and Mastixioideae (sections respectively of the Icacinaceae and Cornaceae) now confined to the tropics and subtropics of the Old World. Further evidence is waited with interest.

(vii) Of comparable significance is the discovery in the Palaeocene of Brazil of the palaeotropical genus *Nipa* based on indisputable evidence (Dolianiti, 1955).

(viii) The finding of the holothurian *Trochostoma* at Sheppey (Davis, 1936a: 340), a genus said to be the most abundant in the Indo-Pacific seas, affords a zoological link with the tropics of the Far East and is of especial interest in view of the connexion of the plants with that area. Likewise, the discovery at Rose Green, near Bognor, of a lamellibranch (*Enigmonia bognorensis*, Wrigley, 1936: 23) closely related to the Recent *E. aenigmatica* (Sowerby). The living species now subsists on the roots, branches and leaves of mangroves and *Nipa* on the shores of Borneo, Malaya, India and north Australia. The horizon which yielded *Enigmonia* at Bognor corresponds with that on the foreshore in which *Nipa* occurs. Another example is recorded from the London Clay at Highgate where again *Nipa* has been found (Prestwich, 1854a: 415; Wrigley, 1936: 25). Here also, as Wrigley points out, is confirmation of the tropical character of the London Clay based on fauna. Here, too, is another zoological link with the Far East and the Indian and Pacific oceans.

(ix) An investigation of the fish-remains in the London Clay (Davis, 1937: 77-79) confirms

Reid & Chandler's suggestion (1933: 20) that the conditions at that time were comparable with those beyond the mouth of the Ambernoh River (New Guinea) as described by Moseley (1892).

(c) GEOLOGY (RECENT CONTRIBUTIONS)

(i) FAUNAL DIVISIONS IN THE LONDON BASIN

Wrigley (1924: 252) re-affirmed a fact which had originally been pointed out by Wetherell (1836: 462) and Prestwich (1854a: 401-419), viz., that there seems to have been a gradual introduction of new species during the deposition of the London Clay, and an emigration or extinction of older species. Hence, Wrigley postulated that with increased knowledge it might be possible to trace *faunal* divisions throughout the London Basin. He gave a preliminary sketch of five such divisions which he had recognized in certain localities in the London district, and made it clear that these divisions could not merely represent a succession of facies faunas, for no considerable change of facies could be discovered during the lower four, and only in the fifth and highest did the typical clay facies give place to sandy top beds.

Wrigley (1940: 230-245) further discussed zonal divisions. Ignoring widely distributed organisms which occur throughout the formation, and using his former faunal lists, together with records of newly-discovered species, he was able to review his five original divisions, indicating their general lithological features, and the characteristic groups of animals in each. He pointed out that no individual species or genus among the London Clay animal remains can, in the present state of knowledge, be safely regarded as confined to one horizon or division, nor is there any group of organisms showing a series of evolutionary changes corresponding to successive stages. He considered that in the London district successive divisions can be recognized by groups of index fossils and mentioned localities where the divisions had been traced, but wisely insisted that they could not be regarded as generally established without fuller information about the successive faunas in other districts as yet little known.

The following is a summary of his conclusions:

The first division above the Basement Beds is palaeontologically insignificant. Its fauna is not yet known and no plants have so far been recorded from division 1 proper, except diatoms and two fruits at Bawdsey, Suffolk (pp. 221, 288).

The second division, which includes the Herne Bay, Swale Cliff and Studd Hill areas in Kent, the Clacton-Frinton cliff section in Essex, Hendon, Cockfosters Tube-section, Beddington Lane, Clapham and Clapham South, is not known to extend south and west beyond the outskirts of London. It is characterized by the occurrence together of *Balanocrinus subbasaltiformis* (Mill.) and *Thyasira angulata* J. Sowerby, and occurs at about 100 feet above the base of the London Clay. It is a stiffish clay with rather flat septaria. This division has yielded plants in abundance at Herne Bay and Swale Cliff, and there are rarer recorded occurrences of fruits in the Clacton-Frinton cliff section (p. 37), at Beddington Lane (*Nipa*, Wrigley, 1924: 254) and Clapham (*Nipa*, *Hightea*, cf. Davis, 1928: 351). A number of plants were also obtained at this last locality by D. J. Jenkins from a dump at the south of Clapham Common derived from the deep air-raid shelter made in 1941-42 at Clapham South station (see Wrigley, 1945: 214-218). Among them were *Nipa burtini* (Brongniart), *Wetherellia variabilis* Bowerbank, *Palaeophytocrene foveolata* Reid & Chandler, *Icacinicarya reticulata* Chandler, Anacardiaceae (Spondieae)

genus?, *Mastixia parva* Reid & Chandler, *Lanfrancia subglobosa* Reid & Chandler, *Dunstanian multilocularis* Reid & Chandler, *Carpolithus* sp.? and teredo-bored wood.

The occurrence of *Palaeophytocrene foveolata* and *Iceacinicarya reticulata* is of special interest. The former was recorded previously only from division 5 at Sheppey, the latter from division 2 at Herne Bay. Both have recently been found at Bognor.

The third division, a stiff grey clay, occupies most of the central thickness of the London Clay. A list of ten animal index fossils is given. They occur at about 200 feet above the base and an extensive fauna has been recognized. The division appears in the suburbs of London on the north, south and west, as far as Potter's Bar, Worcester Park and Staines. The flora is little known but *Nipa* certainly occurs at Worcester Park, Surrey and at Whitton, near Twickenham, Middlesex (Wrigley, 1924: 246, 254; 1940: 234, 235), also at Primrose Hill and Haverstock Hill. The *Hightea* species recorded at New Malden (horizon a) may belong to this division (cf. Wrigley, 1924: 247-248, 254) but the record is a little ambiguous.

The fourth division is comparatively insignificant from a palaeobotanical standpoint in the London district. It is a stiff clay with normal septaria; at about 300 to 350 feet above the base a characteristic fauna occurs. *Wetherellia* and *Nipa* are both found in this division at New Malden (Wrigley, 1924: 247, 254). Four animal index fossils are given together with about six species common to this division and to division 5 above. It is known on the southern and western sides of London as far as New Malden (Surrey) and Ashford (Middlesex), and extends westwards to Bracknell (Berkshire). *Cyprina planata* J. de C. Sowerby is a highly characteristic fossil.

With the *fifth division* comes a change of sedimentation throughout the London area. The uppermost 50 feet of London Clay become sandy and laminated, and more fossiliferous, but the fauna, as Wrigley points out, is not just a facies repetition of that in the sandy Basement Beds. Four index species are given, among them one highly characteristic form *Modiola elegans* J. Sowerby. The division is seen at the top of the London Clay at Rayleigh (Essex), in London at Highgate Archway, and in the surrounding country at Tolworth, Claygate, etc.; it extends to Bracknell and Wokingham. From the palaeobotanical standpoint the fifth division is of great importance for besides a small florule in the *Modiola* Beds at Bracknell (see p. 38) it is at this horizon that the rich flora of Sheppey occurs. It must be noted, however, that at Sheppey the sandy facies of the London area is represented by stiff clay, and in consequence, the marine faunas of divisions 3 and 4 persist as a facies fauna (Wrigley, 1940: 242; Davis, 1936a: 337). A single fruit of *Lagenoidea trilocularis* is recorded from Brentwood (Reid & Chandler, 1933: 495). *Nipa* occurs at Shoeburyness.

The changes in the fauna which can be traced in the London Clay are therefore to a very limited extent influenced by changes of facies, but this is not the whole explanation. It is probable that if changes had occurred in the flora during the deposition of the London Clay they would have taken place less rapidly and be less marked than changes in the fauna in so far as they depend almost entirely on climate and ecological conditions and to a less extent on facies. Although taking the succession as a whole, the flora is less well known than the fauna, it seems probable that little or no significant changes occurred with the passage of time so far as can be shown by the fruits and seeds.

(ii) RELATIONSHIP OF THE NOW SEPARATED BASINS OF LONDON AND HAMPSHIRE

Turning now to the development of the London Clay in the Hampshire Basin, it has often been observed that it is sandier than in the London Basin, and as might be expected, many

local species occur in the fauna mingled with forms typical of the clay facies in the London area (Wrigley, 1940: 242). Great difficulty is experienced in correlating sections at no great distance from one another within the Hampshire Basin, as at Alum Bay, Whitecliff Bay, Portsmouth and Bognor, even when a whole succession of beds can be traced in one locality. This difficulty, Wrigley suggests, may be due in part to the greater variety of facies in the shallower deposits of Hampshire and Sussex as contrasted with the considerable degree of uniformity of the deeper water development around London. Division 5 of the London Basin, whose sandier beds indicate a shallowing of the sea, seems to have a different aspect from the top of the series in Hampshire and the Isle of Wight. It also seems probable that 100 feet of sandy sediment in the southern basin is equivalent to a much less thickness of clay sediment in the London Basin, yet in the Isle of Wight only about 320 feet of London Clay occur, while in the London district there are some 400 feet. Hence the difficulty of any exact correlation between one basin and another (Wrigley, 1940: 243). In order to account for the facts summarized above, Wrigley postulates that the London Clay sea advanced from the north-east in a sinking area, and extended with silting up and renewed depressions (indicated by widespread pebble-beds south of Aldershot which extend over Hampshire and the Isle of Wight) towards the south and west with overlap in those directions. Its deposits thicken to the east, while to the west and north there is evidence of shallowing both in the thinning and the character of the sediment, also in the character of the fauna. If this interpretation of the evidence is correct, he points out, the lower London Clay of the Isle of Wight may be contemporaneous with the middle of the formation near London. The distribution of certain gastropods supports this view, for they are found in abundance near the base of the London Clay in Alum Bay, but are absent in the London area below divisions 3 and 4.

In a letter dated 25 February, 1945, Wrigley tentatively suggests that the equivalents of divisions 1 and 2 of the London area are absent in the Hampshire Basin, the division 3 level being the lowest represented, while very probably, therefore, the Bognor Rock is coeval with division 4. Two plants only, *Icecinicarya bognorensis* and *Vitis bognorensis* (Reid & Chandler, 1933: 355, 382), are as yet known from the Bognor Rock. E. M. Venables kindly informs me that most of the rich flora which he has discovered comes from beds which he names the 'Beetle Bed' and 'Upper Fish Tooth Bed'. These occur above the Bognor Rock and form part of a series which Venables calls the 'Sheppey Beds'.

In this connexion the occurrence at Bognor of *Cyprina planata* throughout the beds exposed in the foreshore is perhaps worthy of mention (Venables, 1929: 41-51). It is abundant below the Bognor Rock, rare in the rock itself, common in the overlying clays. In the Basingstoke district, according to Wrigley, it is confined to beds somewhat above the middle of the formation with a similar range throughout the Hampshire Basin. In the London Basin large mature examples characterize division 4, and the species is recorded occasionally from division 3. Another lamellibranch worthy of special mention is *Modiola elegans*, common in the Bognor Soft Rock and the overlying Bognor Rock, and at no other horizon at Bognor. It is given as one of the index fossils of division 5 in the London Basin where it is apparently restricted to this division.

The presence of these species may in part be due to certain special conditions but the fact remains that they both characterize beds above the middle of the formation in the London Basin. Wrigley stresses that his suggestions in regard to the relationship of the beds in the two basins must not at present be regarded as finally established. He further points out that

correlation must depend on the same *succession* of forms, not on isolated species, particularly as the sequence of beds in Hampshire and the Isle of Wight is not the same as that around London. Nevertheless, so far as their occurrence has at present been traced, the higher divisions of the London Clay certainly appear to extend further west than the lower.

It may ultimately prove that the plants of the Hampshire London Clay will have some contribution to make towards the correlation of deposits in the London and Hampshire Basins, but at present the evidence is quite inconclusive, although the Bognor flora may perhaps be more comparable with that of Sheppey (division 5) than with that of the lower beds (division 2) of Herne Bay.

(iii) RELATIONSHIP OF THE 'BASEMENT BEDS' TO THE LONDON CLAY PROPER WITH SPECIAL REFERENCE TO OLDHAVEN AND BLACKHEATH BEDS

A further result of the hypothesis outlined above of a London Clay sea advancing gradually from the north-east in a sinking area is its bearing on the age of various 'Basement Beds' from different localities, viz., that they must be of different ages marking successive stages of transgression. They cannot represent a single stage in the formation of the London Clay. Wrigley & Davis (1937: 220, pl. 18) put forward this suggestion, illustrating it by a diagram. It was further discussed by Wrigley (1940: 243, 244). Their suggestion, they considered, was supported by the amount of overlap seen in the London Clay in the whole united London-Hampshire Basin. The oldest Basement Beds of the series are really the Oldhaven and then the Blackheath Beds in the eastern part of the area. The precise age of some of the beds named 'Basement Beds' is still a question for further study for not all authorities agree with this view that they are of different ages.

The Oldhaven and Blackheath Beds have a notable element of peculiar animal species repeated as a facies fauna in the 'Basement Beds' wherever they are fossiliferous (Wrigley, 1940: 244, footnote). Wrigley states that there is no record of a fossiliferous London Clay Basement Bed immediately above the Oldhaven and Blackheath Beds, but fossiliferous Basement Beds are found overlying 'continental deposits' of the Reading type, and the Basement Bed facies seems to have been confined to situations where the sea was advancing across a sinking coast-line (1940: 244). The above statement is a reasonable explanation of the sequence of events and if accepted it would be illogical to group the plants from the various localities together and to treat them as a single 'Basement Bed Flora'. Each florule must be regarded temporarily as an independent entity in the absence of definite evidence from plants, animals or stratigraphy. Each must be related more closely to the flora of the London Clay division which immediately overlies it than of necessity to that of other Basement Beds if these belong to earlier or later stages of transgression. There is great need for fuller investigation of the age of the 'Basement Beds' of different localities and the character of the associated plant-remains of which at present so few are known, before Wrigley's theory can be regarded as established or disproved.

Until such investigations have been carried out, the floras which introduce the London Clay in the earlier periods or stages will be described in a section by themselves (see pp. 92-114) in the order of age suggested by Wrigley, i.e. the Oldhaven first, next the Blackheath, then that of Harefield and N. Harrow. The various florules or plants of unknown position in the series will be included in the main part of the systematic work, the locality being recorded.

(d) DISCOVERY OF NEW PLANT LOCALITIES, OF FRESH MATERIAL FROM OLD LOCALITIES, AND THE FINDING OF THE SHEPPEY PLANTS *IN SITU*

The publication of the London Clay Flora in 1933 gave an immense impetus to the collection of plants from the deposit, as the result of which many additions to fruits and seeds then known have been made. These are described or catalogued in the present work.

Nevertheless, further intensive collecting is essential, especially in areas which have yielded few plants, before the character of the flora as a whole, and the range of variation at different horizons in the formation, can be fully ascertained. The new material hereafter described is due in the main to the painstaking search by the following: the late A. G. Davis, J. E. Cooper, D. Curry, G. F. Elliott, D. J. Jenkins, H. E. Taylor, H. A. Toombs, the late Mr. and Mrs. J. G. Turner, E. M. Venables, Miss H. P. Wilkinson, F. M. Wonnacott and the late A. Wrigley. A number of new localities for plants have been found, and many additional specimens have been collected from plant-localities already known.

(i) THE HAMPSHIRE BASIN

(a) *Bognor Lower and Upper 'Fish Tooth Beds' and 'Beetle Bed'*

Outstanding in importance among the newer records is the Bognor plant-bed found by E. M. Venables on the shore at Bognor opposite to the village of Aldwick. Up to 1933 the Hampshire Basin flora was almost unknown, the only plants recorded being a *Nipa* from Portsmouth (Meyer, 1871: 77), an undetermined leaf-fragment from Verwood (C. Reid, 1902: 18), a leaf-fragment and two named fruiting organs, *Vitis bognorensis* (seed), from the Bognor Soft Rock, and *Icacinicarya bognorensis* (endocarp), from the Bognor Rock (Reid & Chandler, 1933: 21, 355, 382). The coast section of London Clay was partially described by Venables (1929: 41-51) but this was some years before he discovered his plant-beds. The section, exposed between tide-marks, was then divided into Lower, Middle and Upper Clays, separated by harder calcareous and glauconitic sandstone bands known respectively as the Bognor Rock and the Barn Rock. The soft rock which yielded the specimen described in 1933 occurs immediately below the Bognor Rock. The plant-bed discovered in 1934 occurs *in situ* in clays above the Bognor Rock. It is referred to by Venables as the 'Upper Fish Tooth Bed'. Most of the specimens hitherto collected are from this horizon. Recently, however, plants have been obtained from other beds: the 'Lower Fish Tooth Bed', above the Bognor Rock, but lower than the 'Upper Fish Tooth Bed', and the 'Beetle Bed'. The 'Lower Fish Tooth Bed' is apparently the lowest horizon of the plant-bearing group of strata.

I am indebted to Mr. Venables for the above particulars which he proposed to describe more fully in a forthcoming paper.

As the result of Mr. Venables' persistent efforts, in which he has sometimes been assisted by other workers, notably by Mrs. Venables, the late Mr. J. G. Turner and Mr. H. E. Taylor, a rich flora has now come to light.

The preservation of the fruits and seeds is apparently similar to that of the specimens found *in situ* at Warden by Davis (1936a: 341, footnote), viz., carbonaceous entities with casts in pyrites and films of pyrites, between successive coats or layers, pyrites also occupying the cavities of cells. Often the carbonaceous outer integuments have been destroyed leaving internal casts only.

A noticeable feature of the flora commented upon independently by Venables in the field, and by the author in the laboratory, is that the Bognor species are represented by a few individuals only or by solitary specimens. The poverty of individuals is in marked contrast with the abundance of specimens of many Sheppey and Herne Bay species. It is probably explained by the mode of collecting the fossils at Bognor. There has been no concentration by tidal action on the foreshore as in the other two localities where each pyrites patch with its rich yield of fruits and seeds must represent the concentrated waste of many tons of cliff, possibly also of a wide land surface.

Such a mode of concentration may also explain the far greater variety of plants represented in the London Clay than for example in the freshwater sediments of the Lower Bagshot and Bournemouth Freshwater Beds. In these latter deposits fruits and seeds often occur in limited lenticular patches which may, in large measure, represent an accumulation derived from a few plants growing in the immediate vicinity. Such patches may therefore be very rich numerically in organs of a few species as when, for example, an overhanging *Mastixia*-like tree, *Rubus*, *Vitis*, or *Ehretia*, have dropped fruits into a quiet pool. But a dense growth of *Rubus*, *Mastixia*, etc., may have served virtually to exclude many other plants which, although an important constituent of the flora at no distance from the site, may not so readily be represented in the plant lenticle.

(b) *Verwood, Dorset*

A *Nipa* has been found here by F. C. Stinton in a septarian band near the base of the London Clay. The most westerly record of the genus yet known in the London Clay.

(c) *Nursling, Southampton*

Very recently D. Curry found a plant bed in a temporary exposure near Southampton (see Appendix, p. 325). The value of this tiny flora is out of all proportion to its size in that a quarter of the species are common to the London Clay and Lower Bagshot. Here at last is definite evidence of a continuity and similarity hitherto largely obscured by the very different modes of preservation, deposition and extraction of the fossils from the two horizons.

It may now confidently be expected that future research will reveal other species common to the London Clay and succeeding tropical deposits. Some may have been overlooked owing to the different appearance of pyritized and carbonized specimens or to the difficulty of collecting really small specimens from débris in the foreshore at Sheppey and Herne Bay.

(ii) THE LONDON BASIN

(a) *Basement Beds*

A sparse ill-preserved flora was found by H. A. Toombs in the Basement Beds at Harefield, Middlesex (Reid & Chandler, 1933: 22, and the present work, pp. 111-114), and at N. Harrow. It includes *Jenkinsella apocynoides*. The only other earlier record of a Basement Bed plant was *Durania stonei* at Watford Heath.

(b) *Herne Bay and other division 2 localities*

From division 2 of the London Clay at Herne Bay much additional material has been collected. Almost all of the specimens recorded in 1933 came from the shore to the east of the town. Only *Petrophiloides* and *Wetherellia* were known at that time from the western part of the shore between Herne Bay and Swale Cliff. The work of Messrs. Jenkins, Davis, Cooper and

Miss Wilkinson has now shown that fruits and seeds may occur as abundantly to the west as they do to the east. *Nipa*, although much scarcer than at Sheppey, is found along both parts of the coast. It was formerly thought to be absent from Herne Bay.

In 1939, Davis extended the known range of London Clay fruits and seeds by the discovery on the Essex coast, between Clacton-on-Sea and Walton-on-Naze, of determinable plant-remains, again in beds referable to division 2. The exact position of the plants has been described by Davis & Elliott (1951: 329-338). They were found in pyrites patches at Holland-on-Sea, Clacton (Fiddle Dock), Frinton Cliffs between Frinton and Walton-on-Naze, and Frinton. Although specimens are few, the above records are of considerable importance as an earnest of what may yet be collected by persistent effort at this northern end of the London Clay outcrop.

Perhaps the most important recent discovery is that of Rhizophoraceae both at Herne Bay and Sheppey (divisions 2 and 5 respectively).

(c) *Location of fossils at Sheppey and elsewhere*

Much new plant material from Sheppey, including material found *in situ*, has been added to the collections. Outstanding among recent additions to knowledge of the plant-bearing strata of the London Basin is a paper by Davis (1936a: 328-345) describing the occurrence of the fossils, both plant and animal, actually in the cliffs at Sheppey. In 1933 Reid & Chandler noted that the plants had never been found *in situ*; they summarized possible theories of their origin, giving reasons in support of the view that they came from the cliff-section (pp. 24, 25). The various collections described at that time were obtained almost entirely from the pyrites patches on the beaches, only in the case of *Petrophiloides* was there definite evidence of derivation from a fallen mass of cliff (Reid & Chandler, 1933: 25), and these fruits were not from Sheppey, but from the lower beds (division 2) near Herne Bay.

The admission by Reid & Chandler of failure to locate the plants *in situ*, stimulated Davis to re-survey the Sheppey cliff-section with the definite object of discovering once and for all the place of origin of the fossils known for so long in the detritus on the beach. This survey showed that they are mainly derived from the slipped beds which form the Sheppey undercliffs, the beds being exposed to marine denudation on the seaward face so that the fossils they contain are washed out and concentrated in the well-known patches on the shore. In spite of careful complete traverses of the cliffs, Davis found no collecting-stations in the clay actually in their original position higher up; but in the huge masses (sometimes half an acre in extent) which have fallen, owing to the instability resulting from the local seaward dip, fossils occur from high water-mark level to 30 feet above. The structure of the cliff-section is shown by reference to Davis (1936a: 329, fig. 57). No evidence was found of any horizontal variation of the fauna between Minster and Warden. Davis interpreted the complete sequence of London Clay beds in the cliff-section as follows:

At the top

- (d) Stiff brown clay with few fossils. Slipped and degraded, masking much of the beds below. Thickness up to 50 feet.
- (c) Stiff grey and brown clays with the fauna and flora of Sheppey in the lower part. Not seen *in situ*, but exposed in the seaward face of the undercliff where they slide over and obscure bed (b) below. Thickness 60 feet.

- (b) Stiff blue clays with few fossils, only seen in the gaps which cut into the cliffs. Thickness 50 feet.
- (a) Foreshore. Barren clays, blue or lead-coloured.

Four type sections were described which had yielded fossils (Davis, 1936a: 333).

As regards the occurrence of plants, *Nipa* fruits were found *in situ* at six points (see p. 134, and Davis, 1936a: 341). Their distribution appears to have been sporadic and showed no signs of lenticular or other accumulation. One specimen had been found at Minster by D. J. Jenkins in 1934 (Davis, 1936a: 341; Edwards, 1936: 29). Davis also drew attention to a much earlier record, previously overlooked, of a fruit (kind not specified) *in situ* at the base of the cliffs (Shrubsole, 1878: 357, footnote), and in the same work (p. 356) there is also a mention of *Leguminosites* Bowerbank *in situ* in the clay of the new Town Well at Sheerness.

The location of the smaller fruits and seeds at Sheppey proved more difficult, at first only four rather poor specimens were recorded from as many parts of the cliff-section. But ultimately persistent and exhaustive effort was rewarded by the discovery of a quantity of the smaller fruits in slipped bed c. at Warden Point (Davis, 1936a: 341, footnote). These specimens were either carbonaceous, or covered by a carbonaceous coat when fresh from the matrix. On exposure, the integument decayed and flaked away almost immediately, leaving bright pyrites internal casts. Similar casts, but usually abraded and discoloured by oxidation, constitute the bulk of the fossils found in the beach detritus.

Reference to the Sheppey plants so far found *in situ* will be found in the catalogue. From all localities, excluding Nursling, at least fifty specimens have now been found *in situ*. At Nursling all were *in situ*.

It may be noted that the *Nipa* fruits from Shoeburyness (division 5) were probably found *in situ* (Reid & Chandler, 1933: 131). They were collected by Colonel Peile who extracted them from the foreshore where they were associated with a double course of septaria. The discovery was made by a junior Officer after a severe storm, who reported it to Colonel Peile supposing that he had found the remains of a 'buried Viking ship complete with a litter of iron spear-heads'. These details were kindly supplied by the late Messrs. Davies and Wrigley who obtained them direct from Colonel Peile.

Bracknell, Berkshire (division 5 of Wrigley)

A small florule was discovered by Davis in the Down Mill Company's Brickpit at Bracknell, Berkshire, the relationship to beds *in situ* being established indubitably. An account of the section and mode of occurrence of the plants was published by Davis (1936). He there refers to earlier sections in the locality described by Wrigley (1922: 79 and 1923: 66). Two horizons are clearly distinguishable in this neighbourhood, although not always visible simultaneously. The lower beds (division 4 of Wrigley) are characterized by *Cyprina planata*. They have so far yielded no identifiable plants, but teredo-bored wood is common. The upper beds (Wrigley's division 5) are among the highest of the London Clay and show the typical sandy character of the succeeding Claygate Beds. They are characterized by *Modiola elegans*, and have yielded five species of plants.

Two specimens of *Nipa* were found in concretions belonging to the *Modiola* Beds on a waste heap. The other species came from a single shelly concretion rich in mollusca and with scanty remains of drift-wood.

(d) Other miscellaneous records (not all new)

In this group a few isolated specimens of plants have been placed. They include wood from Faversham in Lower or Middle London Clay (Seward, 1919: 194, fig. 718c) and plants from Assington, Suffolk, previously described by Reid & Chandler (1933: 250, 330, 380, 511, 527). A solitary fruit of *Beilschmiedia oviformis* was found at Kenton and a fruit of *Jenkinsella* at Stanmore, Middlesex (Reid & Chandler, 1933: 483).

The Suffolk plants are peculiar in their preservation, and until further evidence is forthcoming little can be said about them. The following statement must, however, be made regarding the Bawdsey specimens. In 1940 when the Natural History Museum suffered damage by bombs, certain specimens from Warden Point at Sheppey, Bawdsey and the Essex coast localities, had to be sorted from a débris of mingled wood and glass, their labels having been detached and in some cases destroyed. Fortunately there were lists and correspondence relating to these specimens giving the numbers from each locality, and incorporating a few descriptive notes on individual specimens by means of which it was possible to recognize them. All of the Essex specimens could be picked out with certainty by their preserved labels or the notes. The Suffolk specimens could be distinguished with the highest degree of probability by the distinctive preservation, quite different from that of the Essex, Sheppey and Herne Bay fruits and seeds.

Although no record exists to this effect, it is likely that some of the Warden specimens salvaged were collected *in situ*, as suggested by the perfect preservation of external carbonaceous coats.

As the manuscript of this catalogue was about to go to press, two or three pyritized fruits were received for identification from the Geological-Palaeontological Institute and Museum, Kiel. The specimens are from the London Clay of Fehmarn Island in the Kiel area of Germany. A *Wetherellia* has been recognized, perhaps of a new species, and there is also a fruit referable to the Mastixioideae, and probably to *Mastixia parva* (Chandler, 1958). This is the most northerly record up to date of the tropical London Clay flora lying as it does between 54° and 55° North latitude. It may be hoped that further finds will have been made before additional work on the London Clay is ready for publication.

(e) LIST OF THE LONDON CLAY PLANTS

Species previously recorded by Reid & Chandler (1933) are marked with an asterisk *. Two asterisks** denote that the species is again described or recorded in the present work.

The localities where the plants were found are indicated in the Table by the following letters: ASS, Assington. B, Bognor. BAW, Bawdsey. BR, Bracknell. CL, Clacton. CLAP, Clapham. E, Essex. F, Faversham. FR, Frinton. HARE, Harefield. HB, Herne Bay. K, Kenton. NH, North Harrow. N, Nursling. S, Sheppey. STAN, Stanmore. WAT, Watford.

Family	Genus and Species	Locality
Selaginellaceae	? <i>Selaginella</i> sp.	B
Schizaeaceae	<i>Anemia poolensis</i> Chandler	N
Filicales (Family?)	Genus?	HB S
Araucarineae	** <i>Araucarites</i> sp.	B S
	? <i>Araucarites</i> sp. (cone)	B
Abietineae	**? <i>Pinus macrocephalus</i> (L. & H.)	HB S

Family	Genus and Species	Locality
Cupressineae	** <i>Pinus bowerbanki</i> (Carr.) * <i>Cupressinites curtus</i> Bowerb. <i>Cupressinites oviformis</i> n. sp.	S S S
Podocarpaceae? Taxaceae	* <i>Cupressinoxylon holdenae</i> Sew. * <i>Podocarpus? argillaelondinensis</i> Gardner * <i>Cephalotaxus bowerbanki</i> R. & C.	F S S
Potamogetonaceae Palmae	*Genus? ? <i>Posidonia parisiensis</i> (Brongn.) * <i>Oncosperma? anglica</i> R. & C. * <i>Caryotispermum cantiense</i> R. & C. * <i>Sabal grandisperma</i> R. & C.	S HB S S
	** <i>Sabal</i> sp. (<i>S. grandisperma?</i>) * <i>Serenoa eocenica</i> R. & C. * <i>Serenoa</i> sp.	B HB S S S
	* <i>Livistona? minima</i> R. & C. <i>Palmospermum bracknellense</i> n. sp. <i>Palmospermum cooperi</i> n. sp. <i>Palmospermum davisii</i> n. sp.	S S S S BR
	* <i>Palmospermum elegans</i> n. sp. ** <i>Palmospermum excavatum</i> R. & C. * <i>Palmospermum jenkinsi</i> R. & C. ? <i>Palmospermum jenkinsi</i> R. & C.	B HB S HB S HB S
	* <i>Palmospermum minimum</i> R. & C. <i>Palmospermum minutum</i> n. sp. <i>Palmospermum ornatum</i> n. sp. <i>Palmospermum ovale</i> n. sp.	S B HB HB S
	* <i>Palmospermum parvum</i> R. & C. <i>Palmospermum pulchrum</i> n. sp. <i>Palmospermum subglobulare</i> n. sp.	S S S
	* <i>Palmospermum</i> sp. 6 * <i>Palmospermum?</i> sp. 7 ** <i>Palmospermum?</i> sp. 7?	HB S HB S
	<i>Palmospermum</i> spp. ? <i>Palmospermum</i> sp. <i>Carpolithus</i> (<i>Palmospermum</i> sp.?)	B HB HB B
Nipaceae	** <i>Nipa burtini</i> (Brongn.)	B HB S BR CL etc.
Nipaceae or Palmae	Genus?	B
Myricaceae	<i>Myrica boveyana</i> (Heer)	N
Juglandaceae	** <i>Petrophiloides richardsoni</i> Bowerb.	B HB S E
	<i>Juglandicarya bognorensis</i> n. sp.	B
	* <i>Juglandicarya cantia</i> R. & C. <i>Juglandicarya cooperi</i> n. sp.	S HB
	* <i>Juglandicarya crassa</i> (Bowerb.)	S
	** <i>Juglandicarya depressa</i> R. & C. * <i>Juglandicarya lubbocki</i> R. & C.	B HB S S
	? <i>Juglandicarya lubbocki</i> R. & C. <i>Juglandicarya</i> sp. (<i>J. lubbocki?</i>)	HB HB
	<i>Juglandicarya minuta</i> n. sp. <i>Pterocaryopsis bognorensis</i> n. gen. & sp.	HB S B
Moraceae	? <i>Morus</i> sp.	S
	Genus?	HB
Urticaceae	* <i>Urticarpum scutellum</i> R. & C.	S

Family	Genus and Species	Locality
Olacaceae	** <i>Erythropalum europaeum</i> R. & C.	S
	<i>Erythropalum jenkinsi</i> n. sp.	HB
	* <i>Erythropalum(?) striatum</i> R. & C.	S
	<i>Erythropalum turbinatum</i> n. sp.	S
	* <i>Olax depressa</i> R. & C.	S
Olacaceae?	*Genus?	S
Nymphaeaceae	* <i>Protobarclaya eocenica</i> R. & C.	S
Trochodendraceae	* <i>Trochodendron(?) pauciseminum</i> R. & C.	S
Menispermaceae	* <i>Bowerbankella tiliacoroidea</i> R. & C.	S
	** <i>Tinomiscoidea scaphiformis</i> R. & C.	S
	<i>Tinomisium taylori</i> n. sp.	B
	* <i>Microtinomisium foveolatum</i> R. & C.	S
	** <i>Tinospora excavata</i> R. & C.	B HB S N
	* <i>Tinospora rugosa</i> R. & C.	HB
	<i>Tinospora wilkinsoni</i> n. sp.	HB
	<i>Calycocarpum(?) jenkinsi</i> n. sp.	HB
	* <i>Eohypserpa parsonsi</i> R. & C.	S
	<i>Frintonia ornata</i> n. gen. & sp.	FR
	<i>Davisicarpum gibbosum</i> n. gen. & sp.	S
	<i>Wardenia davisii</i> n. gen. & sp.	S
	<i>Palaeosinomenium venablesi</i> n. gen. & sp.	B
	<i>Palaeosinomenium pulchrum</i> n. sp.	N
	<i>Palaeococculus lakensis</i> n. gen. & sp.	N
	<i>Diploclisia bognoensis</i> n. sp.	B
	<i>Menispermicarpum rariforme</i> n. sp.	N
	<i>Menispermicarpum venablesi</i> n. sp.	B
	<i>Menispermicarpum</i> sp.	N
Magnoliaceae	** <i>Magnolia angusta</i> R. & C.	B HB S
	*? <i>Magnolia angusta</i> R. & C.	HARE
	** <i>Magnolia crassa</i> R. & C.	B HB S
	<i>Magnolia davisii</i> n. sp.	S
	* <i>Magnolia enormis</i> (Bowerb.)	S
	? <i>Magnolia enormis</i> (Bowerb.)	S
	<i>Magnolia gigantea</i> n. sp.	S
	<i>Magnolia lata</i> n. sp.	B
	** <i>Magnolia lobata</i> (Bowerb.)	B S
	* <i>Magnolia longissima</i> (Bowerb.)	S
	<i>Magnolia oblonga</i> n. sp.	B HB S
	<i>Magnolia pygmaea</i> n. sp.	S
	<i>Magnolia rugosa</i> n. sp.	B HB S
	** <i>Magnolia subcircularis</i> R. & C.	B HB S
	** <i>Magnolia subquadrangularis</i> (Bowerb.)	B S
	** <i>Magnolia subtriangularis</i> R. & C.	S
	<i>Magnolia symmetrica</i> n. sp.	B S
	* <i>Magnolia</i> sp.	S
Anonaceae	** <i>Anonaspermum anoniforme</i> R. & C.	S
	* <i>Anonaspermum cerebellatum</i> R. & C.	S
	** <i>Anonaspermum commune</i> R. & C.	S
	** <i>Anonaspermum complanatum</i> R. & C.	S
	<i>Anonaspermum complicatum</i> n. sp.	S
	* <i>Anonaspermum corrugatum</i> R. & C.	S
	** <i>Anonaspermum minimum</i> R. & C.	B
	* <i>Anonaspermum obscurum</i> R. & C.	S

Family	Genus and Species	Locality
Lauraceae	** <i>Anonaspermum ovale</i> R. & C.	B S
	** <i>Anonaspermum pulchrum</i> R. & C.	S
	* <i>Anonaspermum punctatum</i> R. & C.	S
	* <i>Anonaspermum rotundatum</i> R. & C.	S
	** <i>Anonaspermum rugosum</i> R. & C.	S
	* <i>Anonaspermum subcompressum</i> R. & C.	S
	<i>Anonaspermum</i> spp.	B S
	* <i>Endiandra crassa</i> R. & C.	S
	** <i>Cinnamomum globulare</i> R. & C.	B HB S
	** <i>Cinnamomum grande</i> R. & C.	B HB S
	<i>Cinnamomum oblongum</i> n. sp.	B HB S FR
	<i>Cinnamomum ovoideum</i> n. sp.	B HB
	** <i>Litsaea pyriformis</i> R. & C.	B HB S
	<i>Beilschmiedia bognorensis</i> n. sp.	B
	* <i>Beilschmiedia bowerbanki</i> R. & C.	S
	* <i>Beilschmiedia</i> ? <i>crassicutata</i> R. & C.	S
	* <i>Beilschmiedia eocenica</i> R. & C.	S
	* <i>Beilschmiedia</i> ? (<i>Endiandra</i> ?) <i>fibrosa</i> R. & C.	S
	* <i>Beilschmiedia gigantea</i> R. & C.	S
	** <i>Beilschmiedia oviformis</i> (Bowerb.)	HB S K
	** <i>Beilschmiedia pyriformis</i> R. & C.	HB S
	** <i>Protoravensara sheppeyensis</i> R. & C.	B HB S
	* <i>Crowella globosa</i> (Bowerb.)	S
	* <i>Laurocalyx bowerbanki</i> R. & C.	S
	* <i>Laurocalyx dubius</i> R. & C.	S
	* <i>Laurocalyx fibrotorulosus</i> R. & C.	S
	** <i>Laurocalyx globularis</i> R. & C.	HB S
	* <i>Laurocalyx magnus</i> R. & C.	S
	* <i>Laurocarpum crassum</i> R. & C.	S
	<i>Laurocarpum cupuliferum</i> n. sp.	HB
	<i>Laurocarpum davisii</i> n. sp.	S
	<i>Laurocarpum inornatum</i> n. sp.	HB
	** <i>Laurocarpum minimum</i> R. & C.	B HB S HARE
	? <i>Laurocarpum minimum</i> R. & C.	S
	** <i>Laurocarpum minutissimum</i> R. & C.	B HB S
	** <i>Laurocarpum ovoideum</i> R. & C.	HB S FR
	** <i>Laurocarpum paradoxum</i> R. & C.	B HB S
	* <i>Laurocarpum proteum</i> R. & C.	S
	? <i>Laurocarpum proteum</i> R. & C.	HB
	* <i>Laurocarpum pyrocarpum</i> R. & C.	S
	** <i>Laurocarpum sheppeyense</i> R. & C.	HB S
	* <i>Laurocarpum</i> sp. 9	S
	* <i>Laurocarpum</i> sp. 10	S
	* <i>Laurocarpum</i> sp. 11	S
	* <i>Laurocarpum</i> sp. 12	S
* <i>Laurocarpum</i> sp. 13	S	
* <i>Laurocarpum</i> sp. 14	S	
* <i>Laurocarpum</i> sp. 15	S	
** <i>Laurocarpum</i> sp. 16	B HB S	
* <i>Laurocarpum</i> sp. 17	S	
** <i>Laurocarpum</i> sp. 18	HB	
* <i>Laurocarpum</i> sp. 19	S	
* <i>Laurocarpum</i> sp. 20	S HARE	

Family	Genus and Species	Locality
	* ? <i>Laurocarpum</i> sp. 21	S
	* ? <i>Laurocarpum</i> sp. 22	S
	<i>Laurocarpum</i> sp.	S
	<i>Laurocarpum</i> sp.	HB
	<i>Laurocarpum</i> sp.	HB
	<i>Laurocarpum</i> sp.	HB
	<i>Laurocarpum</i> sp.	S
	<i>Laurocarpum</i> sp.	S
	<i>Laurocarpum</i> (? <i>Endiandra</i>) sp.	S
	* Genus? sp. 1	S
	* Genus? sp. 2	HB
Hamamelidaceae	* <i>Protoaltingia europaea</i> R. & C.	S
	<i>Corylopsis venablesi</i> n. sp.	B
	<i>Corylopsis</i> (?) <i>bognorensis</i> n. sp.	B
	<i>Corylopsis</i> (?) <i>latisperma</i> n. sp.	B
	* Genus?	S
	Genus?	B
Leguminosae	* <i>Mimosites browniana</i> Bowerb.	ASS
Leguminosae?	** <i>Leguminocarpon nervosum</i> (R. & C.)	S
	Genus?	HB
	Genus?	S
Linaceae	* <i>Decaplatyspermum bowerbanki</i> R. & C.	S
Rutaceae	* <i>Canticarya gracilis</i> R. & C.	S
	* <i>Canticarya ovalis</i> R. & C.	S
	** <i>Canticarya sheppeyensis</i> R. & C.	HB S
	** <i>Canticarya ventricosa</i> R. & C.	HB S
	<i>Canticarya</i> sp.	B
	* <i>Shrubsolia jenkinsi</i> R. & C.	HB
	* <i>Eozanthoxylon glandulosum</i> R. & C.	S
	* <i>Clausenispermum dubium</i> R. & C.	S
	<i>Caxtonia elongata</i> n. sp.	S
	** <i>Caxtonia glandulosa</i> R. & C.	B S
	* <i>Caxtonia rutacaeformis</i> R. & C.	S
	<i>Rutaspermum minimum</i> n. sp.	B
	<i>Rutaspermum bognorense</i> n. sp.	B
	<i>Citrispermum sheppeyense</i> n. gen. & sp.	HB S
Burseraceae	* <i>Tricarpellites communis</i> Bowerb.	HB S
	** <i>Protocommiphora europaea</i> R. & C.	B S
	<i>Bursericarpum aldwickense</i> n. sp.	B
	* <i>Bursericarpum angulatum</i> R. & C.	S
	<i>Bursericarpum bognorense</i> n. sp.	B
	<i>Bursericarpum clausentium</i> n. sp.	N
	<i>Bursericarpum ovale</i> n. sp.	B
	<i>Bursericarpum venablesi</i> n. sp.	B
	<i>Palaeobursera bognorensis</i> n. gen. & sp.	B
Meliaceae	** <i>Toona sulcata</i> (Bowerb.)	B S
	* <i>Melicarya variabilis</i> R. & C.	S
Meliaceae?	* Genus?	S
Euphorbiaceae	<i>Euphorbiotheca minima</i> n. sp.	HB
	* <i>Euphorbiotheca minor</i> R. & C.	S
	* <i>Euphorbiotheca obovata</i> R. & C.	S
	* <i>Euphorbiotheca obscura</i> R. & C.	S
	* <i>Euphorbiotheca sheppeyensis</i> R. & C.	S

Family	Genus and Species	Locality
	* <i>Euphorbiotheca(?) pentalocularis</i> R. & C.	S
	** <i>Euphorbiospermum ambiguum</i> R. & C.	S
	<i>Euphorbiospermum bognoyense</i> n. sp.	B
	<i>Euphorbiospermum cooperi</i> n. sp.	HB
	* <i>Euphorbiospermum crassitestum</i> R. & C.	S
	** <i>Euphorbiospermum eocenicum</i> R. & C.	B HB S
	* <i>Euphorbiospermum latum</i> R. & C.	S
	** <i>Euphorbiospermum obliquum</i> R. & C.	S
	* <i>Euphorbiospermum obtusum</i> R. & C.	S
	<i>Euphorbiospermum subglobulare</i> n. sp.	B
	** <i>Euphorbiospermum subovoideum</i> R. & C.	S
	* <i>Euphorbiospermum subquadratum</i> R. & C.	S
	* <i>Euphorbiospermum truncatum</i> R. & C.	S
	<i>Euphorbiospermum venablesi</i> n. sp.	B
	<i>Euphorbiospermum</i> sp.	S
	? <i>Euphorbiospermum</i> sp.	S
	*Genus?	HARE
Euphorbiaceae?	** <i>Wetherellia variabilis</i> Bowerb.	B HB S CLAP
	** <i>Lagenoidea bilocularis</i> R. & C.	HB S
	** <i>Lagenoidea trilocularis</i> R. & C.	S E
	? <i>Lagenoidea</i> sp.	B
Anacardiaceae	** <i>Dracontomelon minimum</i> R. & C.	B S
	** <i>Dracontomelon subglobosum</i> R. & C.	B HB S
	** <i>Pseudosclerocarya lentiformis</i> R. & C.	HB S
	** <i>Pseudosclerocarya subalata</i> R. & C.	S
	** <i>Choerospondias sheppeyensis</i> (R. & C.)	HB S
	* <i>Spondicarya trilocularis</i> R. & C.	S
	** <i>Odina (Lansea) europaea</i> R. & C.	B S
	** <i>Odina (Lansea) jenkinsi</i> R. & C.	B HB S CLAP
	* <i>Odina (Lansea)? subreniformis</i> R. & C.	S
	? <i>Odina (Lansea)</i> sp.	HB
	<i>Spondiaecarpon operculatum</i> n. sp.	B
	* <i>Xylocarya trilocularis</i> R. & C.	S
	*Genus? (Spondieae)	S
	Genus?	B
	Genus?	HB S
Anacardiaceae?	** <i>Lobaticarpum variabile</i> R. & C.	B HB S
	*Genus?	HB
Celastraceae	* <i>Cathispermum pulchrum</i> R. & C.	S
	* <i>Canticarpum celastroides</i> R. & C.	S
Icacinaceae	** <i>Iodes corniculata</i> R. & C.	S
	<i>Iodes davisii</i> n. sp.	BAW
	* <i>Iodes eocenicum</i> R. & C.	S
	** <i>Iodes multireticulata</i> R. & C.	B HB S HARE
	<i>Iodes</i> sp. (<i>I. multireticulata</i> ?)	B
	* <i>Iodes</i> sp.	ASS
	? <i>Iodes</i> sp.	HB
	** <i>Sphaeriodes ventricosa</i> (Bowerb.)	S
	** <i>Palaeophytocrene ambigua</i> R. & C.	S CLAP
	** <i>Palaeophytocrene foveolata</i> R. & C.	B HB S
	* <i>Palaeophytocrene foveolata</i> var. <i>minima</i> R. & C.	S
	** <i>Stizocarya communis</i> R. & C.	S

Family	Genus and Species	Locality
	* <i>Stizocarya oviformis</i> R. & C.	S
	** <i>Faboidea crassicutis</i> Bowerb.	HB S
	<i>Icacinicarya amygdaloidea</i> n. sp.	HB
	* <i>Icacinicarya bognorensis</i> R. & C.	B
	<i>Icacinicarya echinata</i> n. sp.	S
	* <i>Icacinicarya (Iodes?) elegans</i> (Bowerb.)	S
	<i>Icacinicarya emarginata</i> n. sp.	S
	<i>Icacinicarya forbesi</i> n. sp.	S
	** <i>Icacinicarya foveolata</i> R. & C.	HB S
	<i>Icacinicarya glabra</i> n. sp.	S
	* <i>Icacinicarya jenkinsi</i> R. & C.	HB
	** <i>Icacinicarya minima</i> R. & C.	B S
	? <i>Icacinicarya minima</i> R. & C.	B HB
	<i>Icacinicarya mucronata</i> n. sp.	B
	** <i>Icacinicarya nodulifera</i> R. & C.	HB S
	<i>Icacinicarya</i> sp. (<i>I. nodulifera</i> ?)	S
	* <i>Icacinicarya ovalis</i> R. & C.	S
	<i>Icacinicarya</i> sp. (<i>I. ovalis</i> ?)	S
	** <i>Icacinicarya ovoidea</i> R. & C.	HB S
	** <i>Icacinicarya platycarpa</i> R. & C.	B HB S
	<i>Icacinicarya reticulata</i> n. sp.	B HB CLAP
	* <i>Icacinicarya rotundata</i> R. & C.	S
	* <i>Icacinicarya</i> sp. 11 (= <i>I. forbesi</i> ?)	S
	* <i>Icacinicarya</i> sp. 12	S
	<i>Icacinicarya</i> spp.	B S
	*Genus?	S
	Undetermined	S
	*Various	S
Sapindaceae	<i>Palaeallophyllus minimus</i> n. sp.	HB S
	* <i>Palaeallophyllus ovoideus</i> R. & C.	S
	** <i>Palaeallophyllus rotundatus</i> R. & C.	HB S
	** <i>Palaeaelectryon spirale</i> R. & C.	S
	** <i>Cupanoides grandis</i> Bowerb.	HB S
	** <i>Cupanoides tumidus</i> Bowerb.	HB S
	<i>Sapindospermum cooperi</i> n. sp.	HB
	<i>Sapindospermum davisii</i> n. sp.	S
	* <i>Sapindospermum grande</i> R. & C.	S
	** <i>Sapindospermum jenkinsi</i> R. & C.	B HB
	* <i>Sapindospermum ovoideum</i> R. & C.	HB
	<i>Sapindospermum revolutum</i> n. sp.	HB
	* <i>Sapindospermum(?) subovatum</i> (Bowerb.)	S
	<i>Sapindospermum</i> spp.	HB S
	*Genus?	S
Sabiaceae	** <i>Meliosma cantiensis</i> R. & C.	B HB S HARE
	** <i>Meliosma jenkinsi</i> R. & C.	B HB S HARE FR
	** <i>Meliosma sheppeyensis</i> R. & C.	B S
Sabiaceae?	<i>Bognoria venablesi</i> n. gen. & sp.	B
Vitaceae	<i>Vitis bilobata</i> n. sp.	S
	* <i>Vitis bognorensis</i> R. & C.	B
	<i>Vitis bracknellensis</i> n. sp.	B S BRACK
	<i>Vitis elegans</i> n. sp.	B S
	** <i>Vitis longisulcata</i> (R. & C.)	B S
	<i>Vitis magnisperma</i> n. sp.	S

Family	Genus and Species	Locality
	* <i>Vitis minuta</i> R. & C.	ASS
	<i>Vitis obovoidea</i> n. sp.	B N
	<i>Vitis platyformis</i> n. sp.	S
	<i>Vitis pygmaea</i> n. sp.	N
	<i>Vitis rectisulcata</i> n. sp.	B S
	** <i>Vitis semenlabruscoides</i> R. & C.	B S
	** <i>Vitis subglobosa</i> R. & C.	B HB S
	<i>Vitis venablesi</i> n. sp.	B
	<i>Vitis</i> spp.	B N
	<i>Parthenocissus jenkinsi</i> n. sp.	S
	** <i>Parthenocissus monasteriensis</i> (R. & C.)	B S
	* <i>Ampelopsis crenulata</i> R. & C.	S
	** <i>Ampelopsis monasteriensis</i> Kirchh. (<i>A. rotundata</i>)	B S
	<i>Ampelopsis turneri</i> n. sp.	S
	<i>Tetrastigma corrugata</i> n. sp.	B
	<i>Tetrastigma davisii</i> n. sp.	S
	<i>Tetrastigma(?) elliotii</i> n. sp.	S
	* <i>Tetrastigma globosa</i> R. & C.	S
	<i>Tetrastigma sheppeyensis</i> n. sp.	S
	** <i>Palaeovitis paradoxa</i> R. & C.	HB S
Elaeocarpaceae	* <i>Echinocarpus priscus</i> R. & C.	HB S
	* <i>Echinocarpus sheppeyensis</i> R. & C.	S
Tiliaceae	<i>Cantitilia lobata</i> n. sp.	S
	** <i>Cantitilia polysperma</i> R. & C.	HB S
Sterculiaceae	** <i>Sphinxia ovalis</i> R. & C.	HB S
Dilleniaceae	* <i>Tetracera(?) cantiensis</i> R. & C.	S
	<i>Tetracera croftii</i> n. sp.	HB
	** <i>Tetracera eocenica</i> R. & C.	B HB S
	* <i>Tetracera(?) sheppeyensis</i> R. & C.	S
	<i>Hibbertia bognoensis</i> n. sp.	B
	Genus?	S
Dilleniaceae?	Genus?	S
Ternstroemiaceae?	*Genus?	S
Flacourtiaceae	** <i>Oncoba variabilis</i> (Bowerb.)	B HB S
	** <i>Saxifragispermum spinosissimum</i> R. & C.	HB S
	* <i>Oncobella polysperma</i> R. & C.	S
Haloragidaceae	* <i>Haloragicya quadrilocularis</i> R. & C.	S
Lythraceae	* <i>Minsterocarpum alatum</i> R. & C.	S
	* <i>Pachyspermum quinqueloculare</i> R. & C.	S
Lythraceae?	** <i>Tamesicarpum polyspermum</i> R. & C.	B HB S
	*? <i>Tamesicarpum polyspermum</i> R. & C.	S
	** <i>Cranmeria trilocularis</i> R. & C.	S
Rhizophoraceae	<i>Palaeobruquiera elongata</i> n. gen. & sp.	HB
	<i>Palaeobruquiera lata</i> n. sp.	HB
	Genus?	S
Nyssaceae	** <i>Nyssa bilocularis</i> (R. & C.)	HB S
	<i>Nyssa cooperi</i> n. sp.	HB
	<i>Nyssa</i> spp.	B HB S
	** <i>Palaeonyssa multilocularis</i> R. & C.	B HB S
	* <i>Palaeonyssa</i> sp.	B S
Nyssaceae or Cornaceae	*Genus? sp. 1	S
	*Genus? sp. 2	S

Family	Genus and Species	Locality
Alangiaceae Myrtaceae	<i>Alangium jenkinsi</i> n. sp. <i>Myrtospermum variabile</i> n. sp. <i>Myrtospermum</i> spp.	HB N N
Myrtaceae?	* <i>Palaeorhodomyrtus subangulata</i> (Bowerb.) ** <i>Hightea elliptica</i> Bowerb. ** <i>Hightea turgida</i> Bowerb.	S B HB S HB S
Onagraceae Mastixioideae	<i>Aldwickia venablesi</i> n. gen. & sp. ** <i>Palaeocharidium cellulare</i> R. & C. ** <i>Mastixia cantiensis</i> R. & C. * <i>Mastixia grandis</i> R. & C. ** <i>Mastixia parva</i> R. & C. ? <i>Mastixia</i> sp.	B HB S B HB S B HB S S B HB S CLAP
Cornoideae	** <i>Langtonia bisulcata</i> R. & C. ** <i>Beckettia mastixioides</i> R. & C. ** <i>Lanfrancia subglobosa</i> R. & C. <i>Portnallia bognorensis</i> n. gen. & sp. <i>Portnallia sheppeyensis</i> n. sp. *Genus?	HB S B HB S B HB S CLAP B HB S HB S S
Epacridaceae Myrsinaceae Sapotaceae	** <i>Dunstaniania ettingshauseni</i> (Gardner) ** <i>Dunstaniania multilocularis</i> R. & C. ** <i>Leucopogon quadrilocularis</i> R. & C. * <i>Ardisia</i> (?) <i>eocenica</i> R. & C. * <i>Sapotocarpum dubium</i> R. & C. * <i>Sapotocarpum latum</i> R. & C. * <i>Sapotocarpum rotundatum</i> R. & C. * <i>Sapotispermum sheppeyense</i> R. & C. * <i>Sapotispermum</i> sp. 2	HB S B HB S CLAP B HB S S S S S S S S
Symplocaceae	* <i>Symplocos curvata</i> R. & C. * <i>Symplocos quadrilocularis</i> R. & C. ** <i>Symplocos trilocularis</i> R. & C. <i>Symplocos</i> sp. <i>Symplocos</i> (?) <i>bognorensis</i> n. sp.	S S S S S S S
Apocynaceae	** <i>Durania stonei</i> (R. & C.) * <i>Ochrosoidea sheppeyensis</i> R. & C. * <i>Ochrosella ovalis</i> R. & C.	B HB S S S
Boraginaceae	<i>Ehretia clausentia</i> n. sp. ** <i>Ehretia ehretioides</i> (R. & C.)	N HARE
Solanaceae Cucurbitaceae	* <i>Cantisolanum daturoides</i> R. & C. <i>Cucurbitospermum cooperi</i> n. sp. <i>Cucurbitospermum equiaelaterale</i> n. sp. <i>Cucurbitospermum sheppeyense</i> n. sp. <i>Cucurbitospermum triangulare</i> n. sp.	S HB B B S B
Family?	** <i>Jenkinsella apocynoides</i> R. & C. ** <i>Lagenella alata</i> R. & C. ** <i>Neuroraphe obovatum</i> R. & C. ** <i>Polycarpella caespitosa</i> R. & C. ** <i>Leyrida bilocularis</i> R. & C.	HB HARE FR NH STAN B HB S HB S HB S B HB S
Incertae sedis	* <i>Leyrida subglobularis</i> R. & C. * <i>Carpolithus bignoniformis</i> R. & C. * <i>Carpolithus bowerbanki</i> R. & C. * <i>Carpolithus crassus</i> (Bowerb.)	S S S

Family	Genus and Species	Locality
	* <i>Carpolithus curtus</i> (Bowerb.)	S
	* <i>Carpolithus ebenaceoides</i> R. & C.	S
	** <i>Carpolithus gracilis</i> (Bowerb.)	B HB S
	* <i>Carpolithus lentiformis</i> (Bowerb.)	S
	* <i>Carpolithus lignosus</i> R. & C.	S
	* <i>Carpolithus monasteriensis</i> R. & C.	S
	* <i>Carpolithus olacaceoides</i> R. & C.	S
	** <i>Carpolithus pusillus</i> var. <i>elongatus</i> nov.	B S
	** <i>Carpolithus pusillus</i> var. <i>latus</i> nov.	B S
	<i>Carpolithus pusillus</i> var. <i>ornatus</i> nov.	B S
	* <i>Carpolithus quadripartitus</i> R. & C.	S
	* <i>Carpolithus ranunculoides</i> R. & C.	ASS
	** <i>Carpolithus scalariformis</i> R. & C.	S
	* <i>Carpolithus semencorrugatus</i> R. & C.	S
	* <i>Carpolithus subfusiformis</i> (Bowerb.)	HB S
	* <i>Carpolithus tessellatus</i> (Bowerb.)	S
	** <i>Carpolithus thunbergioides</i> R. & C.	HB S
	and about 60 unnamed species.	

(f) *Analysis of Plant List*

The plant list shows at least 420 distinct plants apart from unnamed *Carpolithus* of which there are about 60 species, making a total of nearly 500 species in all. Some of these plants are of unknown affinity, others have been placed in their approximate botanical positions, while 140 are named genera.

An analysis of the list shows that (excluding unnamed *Carpolithus*) 326 plants have been found at Sheppey, 135 at Herne Bay, 125 at Bognor. Forty-five kinds occur at all three localities, 40 are common to Herne Bay and Sheppey, 31 to Bognor and Sheppey and 6 only to Herne Bay and Bognor. Herne Bay has 43 species not yet recorded from the other two localities, Bognor has 43 and Sheppey 210.

Undoubtedly the large numbers from Sheppey may be due in part to the intensive collecting which has taken place there from Bowerbank's day right down to the present time. At Bognor, owing to the mode of occurrence, the flora is to an unusual extent represented by *small* fruits and seeds. Such are not so readily found in the pyrites patches on the shore from which the bulk of the Sheppey and Herne Bay specimens were obtained.

So far as present evidence goes, therefore, there appear to be no grounds for regarding the floras of the three localities as truly distinct.

The finding of *Jenkinsella* and *Durania* in older beds only so far, and especially of *Jenkinsella* (found at several localities as well as in Palaeocene beds) may perhaps be of some chronological significance, but apart from this there appears to be no evidence of zoning to be derived from the plants.

Nine new families have been added to the plant list, viz., Selaginellaceae (chiefly tropical), Schizaeaceae (essentially world-wide tropical), Filicales (genus and family unknown), Potamogetonaceae?, Moraceae (chiefly tropical and subtropical with a few temperate forms), Myricaceae (northern hemisphere and Andes, especially subtropical), Rhizophoraceae (tropical, chiefly Old World), Alangiaceae (tropical, Old World), Cucurbitaceae (wide-ranging, but most abundant in tropics).

Twenty-nine additional genera are recorded, many being form-genera or extinct, so that they give little information about phytogeographical connexions. Examples are *Aldwickia* (Myrtaceae?), *Bognoria* (Sabiaceae?), *Cucurbitospermum* (Cucurbitaceae), *Davisicarpum*, *Frintonia*, *Menispermicarpum*, *Palaeococculus*, *Palaeosinomenium*, *Wardenia* (Menispermaceae belonging either to the Cocculeae or Tinosporeae, largely tropical sections of the family). *Leguminocarpon* (Leguminosae) and *Pterocaryopsis* (extinct Juglandaceae) likewise give no information; but the genera *Portnallia* (Mastixioideae) and *Palaeobursera* (Burseraceae) belong to essentially tropical families, the Mastixioideae being purely Indo-Malayan. *Durania* (Symplocaceae?) is an extinct genus based on material from the German Brown Coal by Kirchheimer, where it is associated with the *Mastixia* flora.

Of living genera, or those closely related to the living: *Anemia* is now obviously a relict genus as demonstrated by its curious discontinuous distribution today in the West Indies, South and Central America as far north as the Sierra Nevada and Florida, with two or three species only surviving in the Old World—one in Madagascar, one in Tropical Africa and India and one in Natal.

The record of *Calycocarpum*? must be treated as doubtful. The living genus occurs in Atlantic North America.

Parthenocissus ranges in North America from Mexico to Canada and also occurs in Asia (Himalayas, Farther India, China and Japan).

Palaeobrugiera has its modern counterpart in *Bruguiera* (Africa, Madagascar and tropical Asia).

Diploclisia still survives in Eastern Asia (western and central China, India, Burma, Ceylon, Malay Peninsula and Islands).

Ehretia is tropical, chiefly in the Old World.

Selaginella is chiefly tropical and especially prevalent in damp places, a typical Rain-forest herb but with a few temperate species.

Morus is today north temperate but belongs to a family with a very different range as stated above.

Nyssa, characteristic of temperate east North America to Florida and East Asia, also has extensions into the Asiatic tropics.

Myrica ranges widely throughout the northern hemisphere and in the Andes. It is especially subtropical.

Corylopsis is native to Japan and China but belongs to a family with extensions into the tropics.

Pinus (now definitely identified in the London Clay) is usually regarded today as an essentially temperate genus. It forms woods, however, behind mangrove swamps in Florida and is a mountain plant in the north tropics.

To the climbers and lianas previously recorded can now be added *Cucurbitospermum*, many new Vitaceae (now totalling 25 in all) and Icacinaceae (now at least 36), and probably all of the Menispermaceae (18).

The rich abundance of Lauraceae is a striking feature. There are over 50 species, although not all can be named. *Magnolia* has at least 15 species. Palmae 17 species, Euphorbiaceae at least 19 species and Anonaceae 14. There are 9 representatives of the tropical family Burseraceae.

Thus the new evidence taken as a whole supports the deductions published in 1933 as to the dominant phytogeographical relationship of the London Clay flora with the tropical Rain-forests of south-east Asia. It also adds a few new links with America (for example *Anemia*, *Calycocarpum?*, *Parthenocissus*, *Nyssa* itself) and with Africa (*Alangium*, *Ehretia*, *Myrica*, *Palaeobrugiera*, *Selaginella*).

SYSTEMATIC DESCRIPTION

FLORA OF THE THANET BEDS

(see p. 16 of Introduction)

Pteridophyta

Order *FILICALES*

Family OSMUNDACEAE

Genus OSMUNDITES Unger, 1854 : 143

Osmundites dowkeri Carruthers

Plate 1, figs. 1, 2

- 1870 *Osmundites dowkeri* Carruthers, p. 349, pl. 24, figs. 1-3; pl. 25, figs. 1, 3, 4.
1872 *Osmundites dowkeri* Carr.: Carruthers, p. 52, pl. 2, figs. 8, 9.
1882 *Osmundites dowkeri* Carr.: Gardner & Ettingshausen, pp. 22, 50, 53.
1903 *Osmundites dowkeri* Carr.: Seward & Ford, p. 254.
1907 *Osmundites dowkeri* Carr.: Kidston & Gwynne-Vaughan, p. 768, pl. 4, fig. 21.
1910 *Osmundites dowkeri* Carr.: Seward, p. 339.

DESCRIPTION. A silicified stem fragment, presumed to come from the Thanet Beds, was found on the shore at Herne Bay by George Dowker and examined and described by Carruthers. Details of cell-structure, even to starch grains, were beautifully preserved. The specimen was compared with corresponding portions of the stem of *Osmunda regalis*, and in Carruthers' opinion it certainly belonged to the family Osmundaceae and probably to the genus *Osmunda* although he preferred to describe it as *Osmundites* on the grounds that the Recent genus had been established on characters which are not present, and which consequently cannot be recognized, in the fossil.

Seward & Ford (1903) confirm that this is an osmundaceous fern but do not attempt to determine the closer relationship.

Recently Mr. D. J. Jenkins found on the shore at Hampton, Swale Cliff, a somewhat smaller piece of stem. It is silicified and shows the same characters as the specimen described and figured by Carruthers, including the details of cell-structure and crescentic vascular

bundles (Pl. 1, figs. 1, 2). The length of this fragment is about 50 mm.; the diameter 35 by 45 mm.

On the evidence at present available it is not possible to distinguish with certainty between *Osmunda* and *Todea*. For the present, therefore, the specimens are left in Carruthers' genus *Osmundites*. *Osmunda* is a fern of wide distribution both in temperate and tropical regions. *Todea* is restricted to S. Africa and Australia. In view of the present distribution and of the fact that *Osmunda* is not uncommon in the fossil record of Britain and Western Europe it appears highly probable that the fern is really an *Osmunda*.

- V.29629 Holotype, figured Carruthers (1870, pl. 24, figs. 1-3, pl. 25, figs. 1, 3, 4; 1872, pl. 2, figs. 8, 9). A silicified stem fragment in two pieces, from which transverse sections have been cut showing the position of the axis, petioles and roots. Thanet Sands: Herne Bay, Kent. (The section figured by Kidston & Gwynne-Vaughan in 1907 is in the *Kidston Coll.*, Glasgow University, No. K.1248.)
- V.29630 Figured Pl. 1, figs. 1, 2. A small silicified stem fragment with persistent leaf-bases, from which a transverse section has been cut. *D. J. Jenkins Coll.* Thanet Sands: Shore at Hampton, Swale Cliff, Herne Bay, Kent.

Gymnospermae

Order CONIFERALES

Family ABIETINEAE

Genus PINUS (Tourn). L.

Pinus macrocephalus (Lindley & Hutton) Gardner

Plate 1, figs. 3-11; Pls. 2, 3; Pl. 12, fig. 25

- 1834 *Zamia macrocephala* Lindley & Hutton, p. 117, pl. 125.
 1836 *Zamiostrobus macrocephalus* (L. & H.) Endlicher, p. 72.
 1837 *Zamia ovata* Lindley & Hutton, p. 189, pl. 226A.
 1841 *Zamites macrocephalus* (L. & H.) Morris, p. 116.
 1841 *Zamites ovata* (L. & H.) Morris, p. 116.
 1842 *Zamiostrobus henslowi* Miquel, p. 75.
 1845 *Zamia macrocephala* L. & H.: Corda, p. 84.
 1861 *Zamiostrobus ovatus* (L. & H.) Miquel, p. 29.
 1861 *Zamiostrobus macrocephalus* (L. & H.): Miquel, p. 29.
 1866 *Pinites macrocephalus* (L. & H.) Carruthers, p. 536, pl. 20, figs. 1, 2; pl. 21, figs. 5, 6.
 1866 *Pinites ovatus* (L. & H.) Carruthers, p. 540, pl. 20, figs. 3, 4.
 1867 *Pinites macrocephalus* (L. & H.): Carruthers, p. 8, pl. 58, figs. 1, 2; pl. 59, figs. 5, 6.
 1867 *Pinites ovatus* (L. & H.): Carruthers, p. 11, pl. 58, figs. 3, 4.
 1884 *Pinus macrocephalus* (L. & H.) Gardner, p. 63, pl. 14, figs. 1, 2, 6, 7.
 1884 *Pinus ovata* (L. & H.) Gardner, p. 65, pl. 14, figs. 4, 5.
 1916 *Pityostrobus macrocephalus* (L. & H.) Dutt, p. 529, pl. 15, text-figs. 1, 2.
 1919 *Pityostrobus macrocephalus* (L. & H.): Seward, p. 389, text-figs. 783, 784.

The species has been described in much detail by Carruthers, Gardner and Dutt. Descriptions have been based hitherto on silicified material from which thin sections could be cut. These

yielded to Dutt most valuable and in some cases peculiar anatomical details by means of which he demonstrated beyond doubt that the supposed two species, *Pinus macrocephalus* and *P. ovatus*, founded on differences of external appearance, are really one.

He united them under the name *Pityostrobus macrocephalus* and diagnosed the aggregate species in the following terms: 'Cones ovoid-cylindrical, apex obtuse. Length 15 cm. or less. Breadth 5 cm. Axis very slender, surrounded by a conspicuous ring of resin-canals. Scales leave axis almost horizontally and then ascend sharply beyond the seeds, which are borne in pairs in hollows on the upper surface near the base. Apophyses thick, flat, quadrangular or irregularly hexagonal. Basal scales with large apophyses. Short bract-scale. Ovules two on each scale, 1 cm. long by 0.6 cm. in breadth. Stone layer corrugated. Seeds usually barren.'

Dutt placed on record that the xylem cylinder of the axis was weakly developed with neither resin canals nor resin parenchyma. But resin 'spools' were present in ordinary tracheids. Detailed ovule structure was described from the sections and winged pollen grains, germinated and ungerminated, were shown collected at the tip of the nucellus. Two ovules showing embryos of normal *Pinus* type were discovered although the majority were barren and not fully mature.

There is but little to add to Dutt's fine account of the species, but material recently discovered gives one or two additional facts. Thus a small ovoid cone about 8 cm. long and 3.8 cm. broad from Bishopstone (V.29633) shows that the basal scales can sometimes be smaller than those of the body although in other respects the specimen is identical with *P. macrocephalus* having the same large smooth apophyses which meet in a valvate manner. In this specimen (an external cast with a few carbonaceous scales preserved) the surface of the apophyses shows a smooth epidermal layer of flat or convex rounded cells about 0.025 to 0.05 mm. in diameter. There was no umbo or ridge and the outline of the apophyses was usually hexagonal, sometimes quadrangular or pentagonal.

An exceptionally valuable specimen was found recently *in situ* in the Thanet Sands. It was purely carbonaceous and the scales soon fell apart so that the surface features of scales and seeds were seen as they rarely are in the silicified cones and sections hitherto available. Indeed, the cone when first seen appeared as fresh and easy to study as a Recent Pine-cone. On drying considerable shrinkage took place. The cone (very slightly incomplete) was 9.5 cm. long. The perfect length (estimated from the curvature) must have been about 10.5 or 11 cm. Breadth, 4 × 3 cm. The axis about 5 mm. in diameter. After maceration of fragments with nitric acid the xylem could be seen clearly both in longitudinal and transverse fractures. The primary tracheids are short, broad, dark in colour and spirally thickened. The secondary tracheids are more slender, light brown and with one line of bordered pits on each tracheid. The phloem is finer still, several cells thick. The cortex is of irregular shaped cells and is dark in colour. Within it is a ring of resin ducts, with maximum transverse diameter of 0.06 mm. The tracheids with bordered pits are about 0.01 mm. broad. The scales are as described by earlier writers. The specimen was perfect on one surface which lay in a hard concretion of glauconitic sand, the exposed half having been partially destroyed by wave action. Fortunately this revealed a natural longitudinal section which at first appeared as shown in Pl. 3, fig. 1. After drying and cleaning the cone some of the scales on this broken side flaked away thereby exposing the cone-axis and the origin of the scales and seeds (Pl. 3, fig. 3). On the perfect side 25 scales could be seen some of which are in part visible on both surfaces. Probably the total

number of scales was about 40. The apophyses are smooth and slightly convex. Again there is no trace of any ridge or umbo in this specimen but where complete the surface is covered by a layer of rounded much inflated cells about 0.03 mm. in diameter. On slightly abraded scales large scattered circular scars are also visible (Pl. 2, figs. 2, 5). They are the ends of resin ducts exposed by wear and tear. A series of small canals also fringe the edge of the abraded apophyses. In this carbonaceous specimen as in those described by earlier writers the basal scales are the largest (Pl. 2, fig. 1) but the extreme base is incomplete. The height of the lowest apophysis was 26 mm.; in scales higher up it was 24, 23 and 20 mm. respectively, and near the apex a scale was 14 mm. high. Corresponding breadths were 20, 20, 20, 15 and 12 mm. The breadth of the smooth flat sutures where adjacent scales meet one another was 4, 3.5, 5, 4 and 3 mm. respectively in four scales, but sometimes at the lowest point of a scale about 5 mm. Maximum thickness through the apophysis, 10 mm. A barren basal scale with the apophysis arising from the whole surface is seen in Pl. 2, figs. 2, 3.

Fertile scales above have a longer and more ascending body (cf. the basal scales with those at the middle in Pl. 3, fig. 3). The whole length is about 5 cm., the apophysis 20 mm. high, 14 mm. broad. The scale body is about 11 mm. broad. Length of seed and wing about 32 mm. and of the wing alone 23 mm.

The paired seeds at the base of the scale are well shown in Pl. 2, fig. 14. As noted by Dutt each seed lies in a pocket sunk in the upper surface of the scale while the overlying scale has a basal pocket on its under surface which fits over the curved surface of the seed on the scale below (Pl. 2, figs. 7, 8, 15, 16). Hence each scale has two pairs of pockets, one at the extreme base on the lower surface, and one slightly further from the axis on the upper surface as seen on detached scales (cf. Pl. 2, figs. 7, 8, 15, 16).

The seeds are somewhat compressed sub-obovoid, sometimes with a conspicuous gently convex facet on the lower surface at the end away from the cone axis (Pl. 3, figs. 4, 6f, 8), more or less pointed at the micropylar end (towards the cone axis), angled at the margin, usually more convex on the lower than on the upper surface which may be flat or even very slightly concave (Pl. 3, fig. 6). They split marginally, the gape beginning at the pointed micropyle (Pl. 3, figs. 6, 7). The surface is rugose with tubercles or elongate sinuous rugosities (Pl. 3, figs. 2, 6-8, 10). The rugosities are more longitudinally aligned (giving a longitudinally striate surface) on the upper side of the seed where the seed-body is covered by a wing (Pl. 2, fig. 14; Pl. 3, fig. 6). The marginal splitting was noticed by Dutt in silicified material but was thought to be accidental and the result of pressure. The carbonaceous specimen shows that the split follows natural planes of weakness indicated by finished marginal sutures, 0.6 mm. wide, which display narrow longitudinally aligned cells. They are obviously connected with germination. The cells of the surface of the seed, like the rugosities, are longitudinally aligned giving a striate effect. They are about 0.03 mm. broad. After the wing has been removed somewhat more rounded cells are sometimes displayed on the upper surface of the seed. The wing is formed of narrow and elongate cells longitudinally aligned on the whole, but in places sinuous in alignment and coarse (0.025 mm. broad). Some of the cells have irregular outlines with protuberances and projections here and there. Near the wing margin there are narrow, parallel-sided, longitudinally aligned cells with finely digitate walls. The lining of the testa is of elongate cells with bevelled or pointed ends which dovetail into one another. They may be 0.02 to 0.025 mm. broad and have conspicuously raised walls. Towards the lateral margins

the cells become sinuous in arrangement. Near the micropyle they converge and become smaller and shorter, especially in the micropylar canal itself.

The seeds vary in shape according to the degree of development. Abortive or immature seeds may be of irregular shape and only about 4 mm. long. Well-developed seeds are much larger. Typical dimensions are (1) Length, 8 mm.; breadth, 5.5 mm.; thickness, 3.5 mm. (2) Length, 7 mm.; breadth, 5.5 mm.; thickness, 4.5 mm. The dorsal facet of this seed (as described) measures 5 by 5 mm. (3) Length (abortive or immature?), 4.5 mm.; breadth, 3.3 mm.; thickness, 2.5 mm. (4) Length (abortive?), 6.5 mm.; breadth, 3 mm.; thickness, 2 mm. It will be observed that the largest seeds measured are somewhat smaller than Dutt's, a difference accounted for by shrinkage of the carbonaceous material.

This carbonaceous cone was so fragile that on contracting and drying the scales all too readily fell apart and the seeds were shed. The beginning of this process is seen on Pl. 2, fig. 1, where the basal scales are loose.

The apical part of a silicified cone (V. 32224) was recently found at Herne Bay by Mr. D. J. Jenkins. The specimen had been broken transversely just above the middle, the fractured surface showing eight seeds with rugose testa and cavities filled with chalcedony. About thirty-six scales are preserved, the apex being unusually well displayed. A small abortive terminal scale is flanked by two opposite pairs of scales, beyond which larger, presumably fertile, scales can be seen. One scale of the terminal pairs above described has a damaged surface, the damage being continued as a large crack which obscures the arrangement at first sight (Pl. 12, fig. 25).

Resin cavities are exposed on the surfaces of the scales chiefly around their lower margins. The maximum thickness of scale seen is 7 mm. Length of fragment about 36 mm.; maximum diameter, 57 by 48 mm.

Dutt adopted the generic name *Pityostrobus* for these cones, a name coined by Nathorst for Abietinean cones which cannot safely be referred to any one Recent genus. Nevertheless Dutt states that in this case the characters point clearly to affinity with *Pinus* itself. His only reason for the reference to *Pityostrobus* was that nothing is known of the vegetative characters of the tree on which the cone was borne.

To the writer it appears unreasonable not to use the name *Pinus*. The species is clearly defined and an abundance of anatomical detail is available. There appears to be no justification for using a name which obscures the true affinities and the species is described here as *Pinus macrocephalus* (Lindley & Hutton).

Seward (1919) used the name *Pityostrobus (Pinites) macrocephalus*. He also united *P. macrocephalus* and *P. ovatus* but his work was obviously drafted before Dutt had completed his researches and he adds nothing new.

The genus *Pinus* is cosmopolitan, but in tropical latitudes it is confined to mountains.

- V.11000 Holotype, figured Lindley & Hutton (1834, pl. 125), Gardner (1884, pl. 14, fig. 7) and Seward (1919, text-fig. 783). A silicified cone showing internal and external structure. *G. Dowker Coll.* Thanet Sands: Found in a pond near Deal, Kent.
- V.11003 Figured Lindley & Hutton (1837, pl. 226A), Carruthers (1866, pl. 20, figs. 3, 4; 1867, pl. 58, figs. 3, 4), Gardner (1884, pl. 14, figs. 4, 5) and Dutt (1916, pl. 15, figs. 4, 10). Holotype of *Zamia ovata* L. & H. A well-preserved imperfect cone without apex, later sectioned. *Cowderoy Coll.* Thanet Sands: ? East Kent.
- V.11001 Figured Carruthers (1866, pl. 21, figs. 5, 6; 1867, pl. 59, figs. 5, 6), Gardner (1884, pl. 14, figs. 1, 2), Dutt (1916, pl. 15, figs. 2, 3, 7, 8, 13, 14) and Seward (1919, text-fig. 784). A complete silicified cone

- sectioned parallel to the axis with six thin sections showing the internal structure. *Cowderoy Coll.* Thanet Sands: ? East Kent.
- V.7105 Figured Carruthers (1866, pl. 20, fig. 1; 1867, pl. 58, fig. 1). A more or less complete cone about $5\frac{1}{2}$ inches long and $2\frac{1}{4}$ inches across. *G. Dowker Coll.* Found *in situ* in a bed near the junction of the Woolwich and Reading Beds in a pit just above the Infirmary of the Canterbury Barracks.
- 46653 Figured Carruthers (1866, pl. 20, fig. 2; 1867, pl. 58, fig. 2) and Gardner (1884, pl. 14, fig. 6). Fragment (about $2\frac{1}{4}$ inches long) of the upper part of a silicified cone. *J. S. Bowerbank Coll.* Thanet Sands: ? East Kent.
- V.29633 Figured Pl. 1, figs. 3-9. Cast of an imperfect cone with about nine carbonaceous scales preserved, some represented only by their thickened apophyses. *J. E. Cooper Coll.* Thanet Sands: Bishopstone, Herne Bay, Kent.
- V.32225 Figured Pl. 1, figs. 10, 11. Basal end of a typical silicified cone which has been broken off transversely. *H. P. Wilkinson Coll.* Thanet Sands: Shore between Bishopstone Glen and Reculvers, Herne Bay, Kent.
- V.29631 Figured Pl. 2; Pl. 3, figs. 1-11. A well-preserved carbonaceous half-cone and the sandy mould in which it was found. The specimen has now partially fallen to pieces and a number of scales and seeds showing structural detail have been separately figured. *D. J. Jenkins Coll.* Thanet Sands: About 40 yards from cliff face between Bishopstone Glen and the Headland, Herne Bay, Kent. *In situ.*
- V.29632 Figured Pl. 3, fig. 12. Fragment of the middle part of a large silicified cone. *D. J. Jenkins Coll.* Shingle edge at low tide, East side of Pebble Bed opposite where Reading Beds are first seen in cliff, Herne Bay, Kent.
- V.32224 Figured Pl. 12, fig. 25. Apical part of a silicified cone broken transversely just above the middle and showing eight seeds. *D. J. Jenkins Coll.* Thanet Sands: Shore, nr. Bishopstone Glen, Herne Bay, Kent.
- V.652 An abraded cone about $5\frac{1}{2}$ inches long and $2\frac{1}{4}$ inches across. *J. R. Gregory Coll.* Thanet Sands?: Locality unknown.
- V.11002 Silicified cone fragment about $4\frac{1}{2}$ inches long and $2\frac{1}{4}$ inches across; the apex is worn and the basal part is missing. *Wetherell Coll.* Presumed to come from Thanet Sands. Locality unknown.

Pinus prestwichii Gardner

Plate 4, figs. 1-7

1854 *Abies* sp. Prestwich, p. 156, pl. 3, fig. 3.

1884 *Pinus prestwichii* Gardner, p. 65, pl. 13, fig. 3.

DIAGNOSIS (Amended). Cone cylindrical to elongate-ovoid, tapering gradually to the sharply pointed apex, more suddenly to the somewhat truncate base. Length about 80 to 110 mm.; diameter about 21 to 24 mm. Scales arising from the axis at acute angles then bending sharply upwards. Apophyses with marked mucro and transverse ridge. Basal scales smaller and narrower than those above. Largest seed-body seen about 7 or 8 mm. long (slightly imperfect); 3.5 mm. broad. Length of an abortive seed plus its wing, 23 mm.

HOLOTYPE. V.2455.

NEOTYPE. V.32110.

DESCRIPTION. *Cone*: Elongate-ovoid to cylindrical, tapering gradually to a sharply pointed apex and more suddenly to a somewhat truncate base. Basal scales distinctly smaller and narrower than those above. Apophyses convex, sub-hexagonal or pentagonal, usually with the upper margins rounded so as to obscure two angles, and with lower margin three-sided, the middle of the three being very narrow. Surface of apophyses with conspicuous median transverse ridge and marked prominent umbo (Pl. 4, fig. 7) which is scarcely, if at all, recurved; shining with fine striations due to fine cells diverging from the umbo and transverse ridge. On the umbo itself these cells are coarser than elsewhere on the apophyses, with smooth angular walls. Elsewhere the cells appear finely sinuous walled. There are numerous

minute pits scattered among the cells over the surface each surrounded by a ring of small round cells. Probably these are secreting cavities exposed by slight abrasion.

Largest apophysis seen 14 mm. broad, 9 mm. high; others were 13 by 10 mm.; 14 by 8 mm.; 14 by 8 mm. The scales arise at an acute angle from the axis which is about 2 mm. in diameter; they continue in the same direction for about 5 mm., then bend sharply upwards (Pl. 4, fig. 5). Upper surface of scales longitudinally striate but at their tips beyond the edges of the seed-wings they are formed of more or less rectangular inflated cells which are broader than long and aligned in more or less regular longitudinal rows. These cell-walls are slightly sinuous. The seeds, which are borne in pairs, lie in hollows on the upper surface of the scales and a pair of hollows on the lower surface of the scales at their base fit over the seeds immediately below (Pl. 4, fig. 2).

Length of cone 80 to 110 mm. approx.; diameter about 21 to 24 mm.

The seeds have long wings (Pl. 4, figs. 2, 4). Seed-body sub-ovoid, surface fairly smooth but with coarse cells, on the whole longitudinally aligned. Wing formed of longitudinally elongate and aligned parallel-sided cells somewhat sinuously arranged near the tip and diverging outwards along the external margin. The individual cells are obliquely truncate or with bevelled ends, and are about 0.028 to 0.038 mm. broad. They diverge from the seed-body immediately around its margin and show a contorted arrangement. There is a tough brown inner integument.

Length of seed and wing, 23 mm. Length of seed-body, 7 or 8 mm.; breadth, 3 to 3.5 mm. All are probably immature and the smaller ones abortive.

REMARKS. The holotype is an impression in an ironstone concretion. Gardner recorded that it was ninety-four millimetres in length. There was originally a lignitic core. It appears that owing to the cementing of the external surfaces of the apophyses to the pyritous matrix, the outer layers were torn from the cone-scales and remained adherent to the impression. Hence the true surface was not visible on it. Instead the scales, as preserved, appeared longitudinally and coarsely striate, the striae either parallel or slightly divergent below. This surface, representing the subcutaneous tissue of the cone, led Gardner to compare it with the *Strobilus* type of Pine which it in no way resembles when the true external surface of the scales is seen. Another unusual feature of the specimen is the occurrence of *incised* partings between the scales of the mould instead of ridges. But where the adherent cone-surface has flaked away from the cast normal raised partings between the scales are present.

Since the holotype was described five more specimens, some in a better state of preservation, have been discovered. The size and shape of the scales make it clear that these cones belong to the same species as V.2455. V.26422 is a carbonaceous cone. It shows the complete length, but throughout, the apophyses have been worn away so that only the broken bodies of the scales are preserved. V.26423 is a fragment only of a carbonaceous cone with a few apophyses preserved.

Three carbonaceous cones are embedded in sandy ferruginous concretions. Two occurred in the same block but have now been separated. One of these two broke in transit and could be lifted out of its mould. The broken basal part shows the axis in longitudinal section and the mode of origin of the scales as described above. By the removal of one or two loose scales seeds were exposed with wings in part as impressions on the scales, in part as the actual carbonaceous substance. The second cone of this pair has beautifully preserved apophyses (Pl. 4, figs. 6, 7) but its base is concealed by closely adherent pyrites.

The third carbonaceous cone, V.24390, shows no evidence of seed impressions on the exposed lower surfaces of its lowest preserved scales, hence it may be supposed that it was immature.

The cones are absolutely distinct from those of *Pinus macrocephalus* from which they differ in size, form and apophyses.

- V.2455 Holotype, figured Prestwich (1854, pl. 3, fig. 3); Gardner (1884, pl. 13, fig. 3). Cone preserved as an impression in an ironstone concretion. *J. Prestwich Coll.* Thanet Sands: Immediately E. of Bishopstone Ravine, nr. Reculver Cliffs, Herne Bay, Kent.
- V.32109 Figured Pl. 4, figs. 6, 7. A carbonaceous cone about 80 mm. long, 24 mm. broad, originally in the same concretion as V.32110 below. It shows well-preserved apophyses.
- V.32110 Neotype, figured Pl. 4, figs. 1-5. A carbonaceous cone about 90 mm. long (slightly imperfect) lying in a ferruginous concretion. Broken so as to display the longitudinal section in part (Pl. 4, fig. 5). One or two loose scales were removed thereby showing seeds, or their impressions on overlying scales (Pl. 4, figs. 2, 3). Both the above *D. J. Jenkins Coll.* Thanet Sands: Herne Bay side of Bishopstone Glen where *Cyprina morrisoni* occurs in the basal Thanetian.
- V.24390 A more or less complete but much worn and sand encrusted carbonaceous cone preserved in an ironstone concretion. *J. E. Cooper Coll.* Thanet Sands: Bishopstone, Herne Bay, Kent.
- V.26422 Carbonaceous cone with apophyses abraded.
- V.26423 Fragment of a carbonaceous cone.
Both the above *P. O. Barnett Coll.* (Corbula Beds): Bishopstone, Herne Bay, Kent. [Some authorities would prefer to place these in the Woolwich Series.]

FLORA OF THE WOOLWICH AND READING BEDS

(see p. 18 of Introduction)

NOTE

The flora of the Woolwich and Reading Beds is regarded as one in view of the fact that the beds are contemporaneous or more or less so.

The poor condition of some of the Woolwich and Reading specimens would have made it almost impossible to identify them but for the fortunate fact that they were already known from better preserved material at higher horizons. This material, although studied earlier, will be described later on account of the chronological arrangement adopted in the catalogues.

Any reference to such specimens indicates a forthcoming description in a later volume.

Pteridophyta

Order *FILICALES*

Family SCHIZAEACEAE

Genus LYGODIUM Swartz

Lygodium prestwichi (Gard. & Ett.) Gardner

1955 *Lygodium prestwichii* (Gard. & Ett.): Chandler, p. 307, pl. 36, figs. 66-69.

The species was described by Chandler (1955) and the previous references to it listed. It is unnecessary to repeat the details. It is distinguished from *Lygodium kaulfussi* Heer by the toothed margins of the barren pinnules.

- V.24862** Neotype, figured Chandler (1955, pl. 36, figs. 66-68). Leaf impression and counterpart showing toothed margins, nervation and surfaces of the leaf.
- V.24859** Figured Chandler (1955, pl. 36, fig. 69). Impression of lower surface of another pinnule, margin largely incomplete, teeth obscurely shown on the right at the base. Part of a second specimen is preserved on the same block.
- V.29860** Two small pinnule fragments, one near the base with a few rather obscure teeth.
- V.24861** A fragment of pinnule with teeth (upper surface). All the above *H. C. Berdinner Coll.* Woolwich Beds: Newington, Kent.

Genus ANEMIA Swartz

Anemia subcretacea (Sap.) Gardner & Ettingshausen

1955 *Anemia subcretacea* (Sap.): Chandler, p. 293.

The species has been discussed and the literature listed by Chandler (1955). Barren foliage from the Reading Beds was figured by Gardner (1886a: 400, 402, pl. 1) who thought it was specifically identical with material from Bournemouth.

Knowlton (1922) included Gardner's Bournemouth specimens in *Anemia elongata* (Newberry) from the uppermost Cretaceous of Colorado. The foliage also resembles *A. fremonti* Knowlton from the Upper Cretaceous of south-western Wyoming (Andrews & Pearsall, 1941, pl. 5). But typical ridged *Anemia* spores were found associated with *A. fremonti*, whereas, if *A. subcretacea* is the barren foliage of *A. poolensis* Chandler, as the writer believes, its spores are smooth and quite distinct (Chandler, 1955: 294) despite similarity of foliage. It therefore seems inadvisable on the evidence of barren material only to unite fronds from such widely separated localities as Europe and the United States at least without the most careful scrutiny of actual material. While it is quite possible that the species may have been world-wide under former conditions, fuller evidence is needed before this can be established.

- V.15272** Figured Gardner (1886a, pl. 1). Two specimens (counterparts). *J. S. Gardner Coll.* Reading Beds: Katesgrove Pit, Reading, Berkshire.

Gymnospermae
Order *CONIFERALES*
Family *TAXODINEAE*
Genus *SEQUOIA* Endlicher
Sequoia couttsiae Heer

Plate 4, figs. 8, 9

1862 *Sequoia couttsiae* Heer: Heer, p. 372, pl. 18, figs. 1-7.

1862a *Sequoia couttsiae* Heer: Heer, p. 1051, pl. 59; pl. 60, figs. 1-46; pl. 61.

A single slightly imperfect seed found in the sub-Arctic Beds of Hedge Lane, Lea Valley (Pit CE lowest bed of Hazzledine Warren) is obviously derivative and probably comes from the Reading Beds. It shows the seed-body and lateral wings. The extreme apex is broken and one side also, the base is somewhat folded and distorted but the hilar scar can certainly be distinguished (*sc* in Pl. 4, fig. 9). The striate surface with pits between the striae is typical of the seeds of *Sequoia couttsiae*. The striae diverge obliquely downwards from the body over the wings but the cells and pits have also a longitudinal alignment. On the body itself cells, pits and striae are longitudinally aligned. A comparison of the form and cell-structure in seeds from Bovey Tracey and Colwell Bay shows that the seed is indistinguishable from *S. couttsiae*, so that in spite of the imperfect preservation of this solitary specimen, there can be little doubt about its identity.

Length (slightly imperfect), 2.75 mm.; breadth, 2 mm. Typical Bovey seeds measure 4.5 × 3 mm.; 4 × 3 mm.; 4 × 2.5 mm.; 3 × 2.5 mm.; 3 × 3 mm.; 4.25 × 3 mm.

REMARKS. The occurrence of this seed is of great interest, for if correctly determined, it takes the genus and species further back into the Tertiary than any previous record. The next oldest locality for the species is the Lower Bagshot of Studland (material yet to be described in a forthcoming catalogue).

V.29634 Figured Pl. 4, figs. 8, 9. A single seed (broken while manipulating it for photography). *H. Warren Coll.* Derivation in the sub-Arctic Beds, Hedge Lane, Lea Valley (Pit CE lowest bed of Hazzledine Warren — of Reid, E. M., 1949). Presumed to come from the Reading Beds.

Family *ABIETINEAE*
Genus *PINUS* (Tourn.) L.

Pinus sp.

1886 'Pine-needles' Gardner, p. 92, pl. 24.

1886a 'Pine-leaf' Gardner, p. 400.

A 'pine-leaf of two needles' is recorded from the Reading Beds of Katesgrove Pit, Reading. Gardner (1886a) states that they are 'about the size and substance of those of *P. maritima*'.

Elsewhere (1886: 92) he described them as 'Fragments of Pine-needles, which afford no sufficient material for specific description'. They are figured on a block with *Taxodium europaeum* (= *Cupressistrobus gardneri* n. gen. & sp.) and other plants. Gardner could hardly have been mistaken in this genus which is therefore included in the list of Woolwich and Reading plants.

V.15274 Figured Gardner (1886, pl. 24). Pine-needles (fragments) on a block with other plants. *J. S. Gardner Coll.* Reading Beds: Katesgrove Pit, Reading, Berkshire.

Family CUPRESSINEAE

Genus LIBOCEDRUS Endlicher

Libocedrus adpressa Gardner

1883 *Libocedrus adpressa* Gardner, p. 25, pl. 2, figs. 17-20.

1919 *Libocedrus adpressa* Gard.: Seward, p. 308.

This species was described from foliage which was formerly somewhat locally distributed in the Woolwich Beds of Bromley. Gardner states that it appeared to be identical with the living *L. decurrens* of the Sierra Nevada except for its somewhat broader foliage.

The genus occurs in temperate and warm temperate habitats. There seems no reason to doubt Gardner's determination of this genus, although it is only fair to state that Seward considered the specimens valueless as evidence of *Libocedrus*.

V.520a-d Figured Gardner (1883, pl. 2, figs. 17-20). Four specimens with impressions of foliage. *J. S. Gardner Coll.* Woolwich Beds: Bromley, Kent.

V.40196 Two specimens from the same locality.

Genus CUPRESSISTROBUS nov.

DIAGNOSIS. A conifer referable to the Cupressineae as evidenced by cuticle structure and cone-scales, but distinguished from *Cupressus* by the non-papillate cuticle and laterally expanded barren shoots.

TYPE SPECIES. *Cupressistrobus gardneri* n. sp.

Cupressistrobus gardneri n. sp.

1862 *Cupressites taxiformis* Unger: De la Harpe, p. 111, pl. 5, fig. 2.

1883 *Cupressus taxiformis* (Unger) Gardner, p. 26, pl. 1; pl. 5, figs. 13, 14; pl. 7, fig. 8; pl. 9, figs. 28, 29.

1883 *Taxodium europaeum* Brongn.: Gardner, p. 30, pl. 3, figs. 1-9; pl. 4, figs. 1-8.

1883 *Sequoia tournaïi* (Brongn.): Gardner, p. 40, pl. 5, figs. 1-12.

1886 *Taxodium europaeum* Brongn.: Gardner, p. 92, pl. 24.

1886a *Taxodium europaeum* Brongn.: Gardner, p. 400.

1923 *Taxodium europaeum* Brongn.: Bandulska, p. 260, pl. 20, fig. 34; pl. 21, fig. 33.

1923 *Sequoia tournaïi* (Brongn.): Bandulska, pp. 256, 257, 265, pl. 21, figs. 28-30.

DIAGNOSIS. That of the genus. Foliage polymorphic, both imbricate and distichous. Barren shoots with laterally expanded leaves give a superficial resemblance to *Taxus*. Cone-scale with very slender stalk.

HOLOTYPE. V.32108. Bournemouth Freshwater Beds: Between Branksome and Canford Chines, Bournemouth.

REMARKS. The full account of this species must await the publication of the catalogue dealing with the Bournemouth flora, for from this area, cones and foliage of both types yielding cuticle have been obtained. Cuticle preparations from Bournemouth now show that *Taxodium europaeum* and *Sequoia tournalii* of Gardner are really identical with the conifer which he described as *Cupressus taxiformis* and are related to the Cupressineae. For reasons to be explained fully in the later catalogue all are now referred to a distinct genus and species under the name *Cupressistrobus gardneri*. They are distinguished from *Cupressus* by the non-papillate cuticle and slender stalk of the cone-scale.

It was only after Gardner had described *Taxodium europaeum* from Bournemouth in detail (1883) that he recorded the same species from the Reading Beds of Reading, recognizing it also from the Woolwich Beds of Croydon (Park Hill cutting). The Reading material was, he states, magnificent, as is clearly evidenced by his figure (1886, pl. 24) which shows both imbricate and distichous foliage. He did not give a detailed description but referred to that of the Bournemouth material. Although superficial resemblances between one conifer and another may be misleading, it must be borne in mind that Gardner was a careful observer, with considerable knowledge of both living and fossil coniferous material and with a marked tendency to multiply species and genera rather than to unite those that differed in any respect.

There appears to be no adequate reason for doubting his record of the same conifer at both horizons in spite of the fact that neither cones nor cuticle are available from the Woolwich and Reading Beds. *Cupressistrobus gardneri* is widespread in the Eocene coast sections of the South of England. It occurs at intervals in the Freshwater Beds at Bournemouth, in the Bournemouth Marine Beds above and probably also at Alum Bay. The species is only one of several Palaeocene plants which are now known to have persisted in these latitudes in post Yprésian times.

V.15274 Figured Gardner (1886, pl. 24). A block with branched twigs and two kinds of foliage. On the same block are an imperfect leaf of Hamamelidaceae (?), *Pinus* leaves, a winged fruit (or flower), and a second species of dicotyledonous leaf with entire margin.

V.15275 A similar specimen but not quite so well preserved as V.15274.

V.15276-79 Four small specimens showing fragments of foliage.

All the above *f. S. Gardner Coll.* Reading Beds: Katesgrove Pit, Reading, Berkshire.

Angiospermae

MONOCOTYLEDONES

Family CYPERACEAE

Section CARICOIDEAE

Genus CARICOIDEA Chandler, 1957:86

Caricoidea obovata n. sp.

Plate 4, figs. 10-13

DIAGNOSIS. Elongate-obovate or obovoid utricles with several superficial longitudinal fibre strands, and longitudinally aligned surface cells. Endocarp much thicker than utricle.

Locule-lining of quadrangular cells aligned so as to produce both transverse and longitudinal striations. Length of utricle, 3 to 3.5 mm.; breadth, 1.3 to 2 mm.

HOLOTYPE. V.29635.

DESCRIPTION. *Fruit*: An elongate-obovate or obovoid utricle tapering gradually to a small truncate base with aperture, and having a more or less rounded apex with small mucro. Fruit somewhat flattened, partially as a result of growth in a spike, partially(?) as the result of fossilization. Surface showing several conspicuous longitudinal fibre strands or ribs which do not all extend throughout the length of the fruit. The utricle is sometimes angled along the more conspicuous ribs.

Surface cells oblong, longitudinally aligned, 0.014 mm. broad. Apex of utricle occupied by a mass of parenchymatous cells about 0.012 mm. in diameter. Endocarp seen in section only, wall thicker than that of utricle, highly vitrified, about 0.038 mm. thick. Locule-lining of rectangular cells 0.014 mm. broad, 0.013 mm. long, arranged in both longitudinal and transverse rows so as to produce conspicuous transverse striations and somewhat less conspicuous longitudinal striations.

Length of a perfect utricle, 3 mm.; breadth, 1.3 mm.

Length of a second utricle, 3.5 mm.; breadth, 2 mm.

REMARKS AND AFFINITIES. Two complete utricles, and four more or less imperfect specimens one of which shows the locule-lining with its cells. One of the perfect specimens broke transversely after photography showing the utricle and endocarp in section.

The structure indicates the family Cyperaceae, and the closed utricle suggests relationship with the section Caricoideae. The material is scanty and imperfect but is perhaps sufficiently distinctive to justify the bestowal of a specific name.

V.29635 Holotype, figured Pl. 4, fig. 10. A small perfect fruit.

V.29636 Figured Pl. 4, fig. 11. A somewhat flattened fruit, now fractured transversely.

V.29637 Figured Pl. 4, fig. 12. A fruit broken at the base, abraded at the apex so as to show the thick layer of parenchyma.

V.29638 Figured Pl. 4, fig. 13. A fruit broken at the base, showing superficially the longitudinal ribs, and internally the cell-structure of the locule-lining.

V.29639 An imperfect fruit which has broken transversely, and a second specimen broken in two but almost perfect.

All *A. G. Davis Coll.* Woolwich Beds, IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

DICOTYLEDONES

Family BETULACEAE

Genus CARPINUS Linnaeus

Carpinus davisii n. sp.

Plate 5, figs. 1-3

DIAGNOSIS. Fruit ovate. Ribs mostly, but not all, extending from base to apex. Length, 2.2 mm.; breadth, 1.7 mm.

HOLOTYPE. V.26940.

DESCRIPTION. *Fruit*: Bracteate, bract broken but represented by a short frill at the base (Pl. 5, figs. 1, 3). Bract of coarser texture than the surface of the fruit, its cells, irregularly arranged, measure 0.025 mm. in diameter, the bases of several large nerves form ridges on its surface. Rather broadly sub-ovate in outline, somewhat truncated by a large basal scar concealed by remains of the bract, flattened evidently in fossilization, ribbed and angled, most, but not all of the ribs, reaching from base to apex, more or less symmetrically placed, fibrous. On the side away from the bract there are one median and two sub-marginal ribs, on the side towards the bract five ribs, three reaching the top, two being shorter. The outer surface is formed of more or less equiaxial cells somewhat irregularly arranged from 0.025 to 0.04 mm. in diameter.

Length of fruit, 2.2 mm.; breadth, 1.7 mm.

REMARKS AND AFFINITIES. A small, perhaps abortive fruit with remains only of the bract. Cell-structure comparable with that of *Carpinus*. Size small for the genus (*C. laxiflora* 2.5 mm. long, 2 to 3 mm. broad). The fruit is distinctive on account of its small size, and has been named *Carpinus davisii*. It is much to be desired that more material should be found so that the range of variation of the species can be established.

V.29640 Holotype, figured Pl. 5, figs. 1-3. A fruit with remains of bract at the base only. *A. G. Davis Coll.* Woolwich Beds, IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Family NYMPHAEACEAE

Genus PALAEONYMPHAEA nov.

DIAGNOSIS. Seeds with embryotega, referable to Nymphaeaceae, having testa cells with slightly sinuous margins, usually irregular in size and arrangement with a tendency to be transversely aligned.

TYPE SPECIES. *Palaeonymphaea eocenica* n. sp. Bournemouth Freshwater Beds (V. 40449). To be described in a forthcoming catalogue.

?*Palaeonymphaea* sp.

- 1822 *Carpolithes ovulum* Brongniart in Cuvier & Brongniart, p. 366, pl. 11, fig. 6.
 1854 'Seed-vessel' Prestwich, p. 156, pl. 3, fig. 4 (figure too obscure to be of use).
 1855 *Carpolithes ovulum* Brongn.: Hooker, p. 562, pl. 16.
 1874 ?*Nymphaea arethusae* Brongn.: Schimper, p. 93.

Seeds found in the 'Planorbis bed' (Woolwich Series) at Counter Hill, Lewisham, were regarded as cryptogamous sporangia by Hooker (1855) who described and figured them as *Carpolithes ovulum* Brongniart. Schimper (1874) recognized Brongniart's species as Nymphaeaceae. This relationship is equally clear in the Counterhill seeds which show a typical germination plug (Hooker, 1855, pl. 16, figs. 2, 3, 13). They bear a general resemblance to *Brasenia ovula* (Brongn.) of the Upper Eocene and Oligocene (Chandler, 1925: 23, pl. 3, figs. 7a-d; Reid & Chandler, 1926: 99, pl. 6, figs. 15-18).

Nevertheless there is a difference between them and *B. ovula* if Hooker's figures are correct (1855, pl. 16). In *B. ovula* the seeds are very regularly ovoid or sub-globular, the cells of the testa are conspicuously digitate. In the Counterhill seeds the form is more

irregular, the testa cells are scarcely sinuous at all, but conspicuously rectangular and aligned in longitudinal and transverse rows. Actually they more closely resemble seeds to be described under the name *Palaeonymphaea eocenica* from the Freshwater Beds of Bournemouth both in form and cell-structure. But they are larger (length 7 mm. *Palaeonymphaea eocenica* length 2-3 mm.). A final decision as to generic identity cannot be reached in the absence of actual material from Counter Hill and the Paris Basin in a condition suitable for microscopic examination. The seeds are provisionally referred to the genus *Palaeonymphaea*.

Family LAURACEAE

Several species referable to the family Lauraceae occur in the Woolwich or Reading Beds. Material is very limited, however, and in view of this fact, and of the large size of the living family, it seems inadvisable to refer the berries to a living genus. At the same time it is probable that one or two at least may belong to *Cinnamomum*.

Genus LAUROCARPUM Reid & Chandler, 1933:225

Laurocarpum sp.

Plate 5, fig. 4

1861 'Seed-vessel', Rickman, p. 6.

An ellipsoid berry with leathery epicarp is typical of Lauraceae. The epicarp is shining, puckered, semi-translucent, formed of more or less equiaxial cells delimited in surface view by black walls which surround yellow semi-transparent cell-cavities. The cells are 0.018 mm. in diameter. Epicarp now puckered through shrinkage into unequal convexities irregular in size and shape. Basal scar preserved only on the external impression in the matrix, small, about 3 mm. in diameter, suggesting a swollen peduncle rather than a cupule, although this is not conclusive for the berry may have been attached only at the extreme base of a shallow cupule. Endocarp compact, columnar in section, 0.1 mm. thick. Length of berry without stalk, 13 mm.; breadth, 7.5 mm.

REMARKS AND AFFINITIES. One specimen only, represented by the remains of the berry now detached from its external impression. It is larger and more coarsely puckered than the ellipsoid berries from Tooting Woolwich Beds.

V.29641 Figured Pl. 5, fig. 4. A berry represented by an external impression and detached remains of the actual fruit. *C. Rickman Coll.* Woolwich Beds: Dulwich, Surrey.

Laurocarpum sp.

Plate 5, fig. 5

A sub-globular berry with the actual substance preserved and still lying in the matrix. The surface is shining and the texture somewhat leathery; a network of deep furrows divides it into small convex areas varying considerably in size and form. The areas are smaller than those of *Laurocarpum* sp. (Pl. 5, fig. 4). Cell-structure obscure owing to the medium used to preserve

the specimen; cells probably about 0.02 mm. in diameter. Traces of the endocarp are exposed within the berry, it is columnar in section.

Basal scar truncating the berry, large, 7 mm. in diameter, probably indicating a large swollen peduncle. Length of berry 7.5 mm.; breadth 9 mm.

This berry is more globular and somewhat larger than berries from Tooting next to be described.

V.15504 Figured Pl. 5, fig. 5. A berry. *f. S. Gardner Coll.* Woolwich Beds: Dulwich, Surrey.

Laurocarpum sp.

Plate 5, figs. 6, 7

Two oval (originally ovoid but now much compressed) Lauraceae berries, one broken at the base, the other perfect. Epicarp leathery, one cell thick, formed of equiaxial cells varying in size from about 0.009 to 0.016 mm. in diameter; these cells diverge from a small apical stylar scar. Surface shining, puckered owing to shrinkage, in places semi-translucent and yellow.

Endocarp columnar in section, about 0.05 mm. thick where seen in the smaller berry. In the larger berry the perfect base of the endocarp (*e*) projects beyond the perfect basal margin of the epicarp (Pl. 5, fig. 6). This suggests that the berry was borne on a small cupule such as may occur in *Cinnamomum*, *Litsea*, *Ocotea*, *Sassafras*, *Persea*, etc., or on a much swollen peduncle.

Length of perfect berry, 10 mm.; breadth (flattened), 7 mm.

Length (imperfect) of smaller berry, 7.75 mm.; breadth, 5 mm.

V.29642 Figured Pl. 5, fig. 6. A perfect berry showing the endocarp projecting below.

V.29643 Figured Pl. 5, fig. 7. A berry broken at the base, showing the endocarp in section.

V.29644-46 Three internal casts, one ovoid 9.5 × 5.75 mm., another ovoid 6.75 × 5.25 mm., the third sub-globular (crushed) 6 × 6.25 mm. are also Lauraceae berries which may belong to one or more species. The first shows a fragment of epicarp, and columnar endocarp 0.05 mm. thick and probably belongs to *Laurocarpum* sp. above. The other two show columnar endocarp about the same thickness. Characters seen are insufficient for exact determination.

All *A. G. Davis Coll.* Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Laurocarpum sp.

Plate 5, figs. 8-11

1854 Buds. Hooker in Prestwich, pp. 166, 170, pl. 4, figs. 24-26.

1941 Fruits of *Cercidiphyllum*: Seward & Edwards, p. 172.

There are four blocks of matrix from Reading with impressions which were referred by Hooker to buds of a dicotyledonous shrub or tree. In two blocks the supposed buds are detached and no twig is preserved, in the other two they are still attached to twigs. They are oval in outline, pointed at the apex. One twig is borne on a block the surface of which is a matted mass of leaf impressions. It also bears impressions of a much stouter twig apparently having a large stipule on one side (Pl. 6, fig. 8).

That the detached and attached objects belong to the same species is indicated not only by form and size but by two peculiar longitudinally aligned but slightly curved ridges on the

impressions which can be seen in specimens of both types. These of course represent depressions on the actual specimens separating broad low rounded ribs, as if the objects had been somewhat fluted longitudinally.

These impressions bear far more resemblance to Lauraceae berries than to leaf-buds and undoubted Lauraceae berries do exist in the Reading Beds. There is no trace of separate scales such as would almost certainly show if the impressions were those of buds. Moreover the organs are seated within much wrinkled, leathery(?) cupules typical of Lauraceae (Pl. 5, figs. 10, 11). The rugosities of the cupules are on the whole longitudinally oriented, but close to the free edges of the cupules they lie parallel with the margin, i.e. transverse to the length (Pl. 5, fig. 10).

The texture of the berry was also somewhat leathery and the surface had evidently become finely puckered through shrinkage, although the actual substance is not preserved, or if originally present it has now disappeared with the passage of years since the specimen was collected. A few newly-exposed patches of impressions show more or less equiaxial cells arranged in longitudinal rows. The cells have a diameter of about 0.011 to 0.014 mm. The base of the detached berries is concave or truncated by the large scar of attachment (Pl. 5, figs. 8, 9).

Three of the attached berries are borne on one twig, apparently alternately. This twig (figured by Hooker *in* Prestwich, 1854, pl. 4, fig. 26) now shows two small opposite scales or stipules at its lower end only recently exposed by removal of the matrix (Pl. 5, fig. 10 at *st*). Surface of twig more or less smooth. Length of berry above the cupule 13 to 15 mm.; breadth of berry 7 to 9 mm. Breadth of basal scar 4 to 6 mm. Length and breadth of cupule about 6.5 mm.

- V.15476 Figured Pl. 5, fig. 8. Also figured by Hooker *in* Prestwich (1854, pl. 4, fig. 25). Two detached berries showing limits of basal scar (*s*).
- V.15475 Figured Pl. 5, fig. 9. Also figured by Hooker *in* Prestwich (1854, pl. 4, fig. 24). A detached berry. It is not connected with the twig lying beside it. On the same block is a leaf figured by Hooker, pl. 4, fig. 29.
- V.3595 Figured Pl. 5, fig. 10. Also figured by Hooker *in* Prestwich (1854, pl. 4, fig. 26). The specimen has been slightly developed since Hooker's figure was made and now shows the pair of stipules or bracts (*st*) near its base. Three alternate berries in cupules are attached above.
- V.15463 Figured Pl. 5, fig. 11. A twig with two berries, one small. The surface of the large slab on which it lies is a matted mass of leaves which have no connection with the specimen. There is also an impression of a much stouter twig carrying what appears to be a stipule (see p. 72).
All the above *J. Prestwich Coll.* Reading Beds: Railway cutting, near Reading, Berkshire.

Family HAMAMELIDACEAE

Genus LIQUIDAMBAR Linnaeus

Liquidambar palaeocenica n. sp.

Plate 5, figs. 12-17; Pl. 6, figs. 1-3

DIAGNOSIS. Globular agglomerate fruiting heads about 22 mm. in diameter (including awns). Fruitlets with a pair(?) of thin long awns resembling those of *Liquidambar formosana* Hance rather than those of *L. styraciflua* L.

HOLOTYPE. V.15361.

DESCRIPTION. *Fruiting head*: Globular (now much compressed in fossilization), agglomerate, the surface divided obscurely into polygonal areoles (seen in one or two specimens

only, cf. Pl. 5, figs. 14, 17). Fruitlets presumably one to each areole. Diameter of heads (including awns) about 22 mm. (without awns) about 12 mm.

Fruitlets: (Seen obscurely), probably capsular and syncarpous the distal ends of the carpels produced into two(?) long, tapering, somewhat curved awns. Awns longitudinally striate with a conspicuous median ridge on one side (groove on the impression). Locules (as represented by an internal cast) compressed, angled at the margins, somewhat elongate-oval in outline (Pl. 5, figs. 12, 13). Inner layers of carpel wall of transversely aligned cells or fibres, outer layers (or surface of cup-like cavities which hold the fruits) longitudinally striate and fibrous. Seeds not clearly seen but possibly represented by convex bodies with impressions of convex cells about 0.025 mm. broad aligned more or less in longitudinal rows. Length of locule-cast (incomplete at apex) about 3 mm.; breadth, 1.25 mm. Thickness much less, but owing to the position in the head this could not be measured accurately, probably about 0.5 mm.

REMARKS AND AFFINITIES. Seven heads, one represented by counterparts. Three (one very imperfect) are on a single block of coarse matrix (with a fragment of a fourth also). Another is small and perhaps either immature or a male head, it shows no awns as in all other specimens but areoles can be seen (Pl. 5, fig. 17).

All are partly impressions and partly much compressed carbonaceous remains. The impressions of the awns are best seen on specimens in the finer matrix. The locule-cast and seeds? are preserved on a specimen in the coarser matrix only, where the awns are somewhat obscure although discernible.

These fruits have been alluded to as *Platanus* although they have never been figured or described. Thus Gardner (1886: 400) in discussing the plants found in the Katesgrove Pit, Reading, says that 'One leaf bed is almost wholly made up of leaves of *Platanus*, and a bed above is fairly sprinkled with fruits of the same'. It is unfortunate that with such an abundance of material, available for a limited time only, so few specimens appear to have survived or to have been collected. The superficial resemblance of the globular fruits to *Platanus* is obvious. But despite the poor preservation of detailed structure, a close examination does not support such an ascription for the reasons given below:

1. *The character of the agglomerate head in the fossil*

This is a single fused entity holding the fruits, not a closely crowded capitulum formed merely of distinct and separable fruits seated on a globular parenchymatous receptacle as in *Platanus*. There is no evidence of any bursting or falling apart despite the compressed condition in the fossil. In *Platanus*, on the other hand, on drying or compression the fruits are shed, the head breaking up into its component fruitlets, each with its basal ring of stiff hairs for dispersal. Only the globular placenta of parenchyma is left intact, sometimes with a coarse readily detachable network of nerves still adhering to its surface. Moreover in *Platanus* the fruits themselves are of small transverse diameter, very numerous, closely packed leaving no room for a network of ridges delimiting the alveolae such as is seen in Hamamelidaceae (*Altingia*, *Liquidambar*).

On these grounds alone, it is highly improbable that the fossils can be referred to *Platanus*.

2. *The character of the apex of the fruitlet in the fossil*

The triangular ends of the dehisced carpels taper into very long slightly curved awns quite unlike the styler end of *Platanus* on close examination. These awns may be almost equal in

length to the radius of the head out of which they arise, whereas in *Platanus* the recurved somewhat truncate style is only about one-third of the radius when straightened out.

3. *The form of the fruit and locule*

The bisymmetric locule-cast, somewhat sharply angled at the margins, elongate-oval in outline, broad and rounded at the base, resembles that seen in certain Hamamelidaceae, but

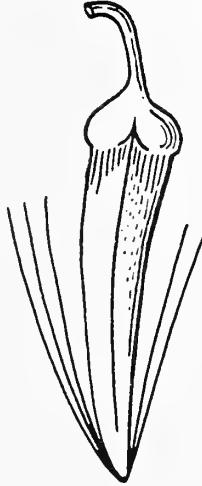


Fig. 1. *Platanus* fruitlet.
Diagrammatic and much magnified.

is quite unlike *Platanus*. In this genus the fruit is more or less symmetric, broadest at the apex beneath the style, but it then contracts suddenly and thereafter tapers gradually into the long attenuated obconical body of the fruit. A locule-cast would therefore be obconical, long and narrow, gradually tapering to a more or less pointed base (Text-fig. 1).

4. *The substance of the fruit*

In the fossil traces of transversely aligned fibres have been seen forming the inner layers of the carpel wall as in Hamamelidaceae. In *Platanus* the fibres throughout the wall are longitudinally aligned.

The evidence summarized above appears to separate the fossils very definitely from *Platanus* and to relate them to Hamamelidaceae. The fused agglomerated heads point to *Liquidambar* or *Altingia*, or some allied form. The globular heads, coupled with indications of splitting into *two* long curved awns, suggest relationship to *Liquidambar* rather than to *Altingia* but there may be a closer relationship to some wholly extinct genus. The fossil *Protoaltingia* is distinguished by its ovoid heads, and four-partite fruit apices devoid of awns.

The Reading Bed fossil is described under the name *Liquidambar palaeocenica* n. sp.

- V.15361** Holotype, figured Pl. 5, figs. 12, 13. Three specimens on one block and a fragment of a fourth. One, chosen as the holotype, is the only specimen which shows the locule-cast and it also shows the long awns although their preservation is poor. These are also seen in the second fruit. Also catalogued under *Phellodendron costatum*, p. 75.
- V.15360** Figured Pl. 5, figs. 14-16. A pair of counterparts showing the long tapering awns very clearly, the superficial areoles are obscurely seen on one side (fig. 14). Carbonaceous substance is much crushed.
- V.15357** Figured Pl. 6, figs. 1, 2. A fruit showing awns clearly, and the crushed areoles and fruitlets in section represented by carbonaceous remains.

- V.15358 Figured Pl. 6, fig. 3. A specimen showing the awns and a carbonaceous core which at first sight simulates the placenta of *Platanus*. Part of the peduncle may be preserved.
- V.15359 Figured Pl. 5, fig. 17. A small fruit, only about 10 mm. in diameter, which may be either a male head or an immature female head. The awns (if present at all) are obscure. The areoles can be distinguished. All the above *f. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Family HAMAMELIDACEAE?

Genus?

Plate 6, figs. 4-8; Text-fig. 2

- 1854 *Phyllites* Hooker in Prestwich, p. 163, pl. 4, figs. 1-3, 4?, 9, 9*, 10, 15, 16, 16*?.
- 1886 'Dicotyledonous leaf' Gardner, p. 92, pl. 24.
- 1941 *Cercidiphyllum richardsoni* (Heer): Seward & Edwards, p. 172.

Leaves with characters of form, nervation and margin, regarded by Brown as characteristic of *Cercidiphyllum* (1939: 485-499, pls. 51-56) are among the commonest in the Reading Beds at Reading.

Hooker (1854, pl. 4) figured about nine or ten leaves which appear to belong to one species. The originals are still extant. Gardner (1886, pl. 24) figured part of a large leaf with petiole (incomplete) preserved as an impression on a block with coniferous remains. Gardner's figure appears to be more accurate as regards the nervation than those of Hooker for he shows some looping of the nerves whereas Hooker illustrates them quite incorrectly (as shown by comparison of actual specimens) passing directly towards or into the marginal teeth.

The leaves vary in outline and size. They may be ovate to broadly ovate or palmate and tapering (Pl. 6, fig. 5) or three-lobed at the apex (cf. Hooker, 1854, pl. 4, figs. 9, 9*, especially fig. 9* where the presence of a toothed margin shows that the lobing is original and not due to irregular decay, cf. also Pl. 6, fig. 6). The base may be simple or cordate. The nervation in all types is palmate. The midrib is flanked by two, or sometimes three, pairs of primary basal nerves whose outer branches form loops as mentioned above and do not pass directly into the teeth at the margin (see Pl. 6, fig. 4 and Text-fig. 2A). The secondary nerves arise from the midrib at a point near the broadest part of the leaf, and form similar loops (Text-fig. 2A). The marginal teeth are frequently well developed although in some leaves, especially the larger, they appear to be almost absent, and parts of the margins of others do not appear to show them. When present they are gland-tipped and somewhat sigmoidal in outline (Pl. 6, fig. 5). They may be irregular in size. The crumpling of the leaf may indicate a thin texture of lamina, but is perhaps due to the contraction on drying of a more fleshy blade in which the somewhat obscure nerves lie concealed. The nerves are difficult to show in a photograph and indeed difficult to trace even in the impressions themselves. Length of Hooker's unlobed leaf about 7 cm.; breadth, 6.25 cm. Another similar leaf (Pl. 6, fig. 5) is 8.5 cm. long and 6.5 cm. broad. Length of a larger leaf (lobed but somewhat incomplete at the apex) 6.5 cm.; breadth of half this leaf from midrib to margin 5 cm. (estimated full breadth about 10 cm.). Breadth of half the incomplete leaf figured by Hooker (1854, pl. 4, fig. 2) about 6 cm. Length of small well characterized leaf (Hooker, 1854, pl. 4, fig. 15) about 4 cm.; breadth about 2.7 cm., and another (pl. 4, fig. 4), length 3 cm.; breadth, 1.7 cm.

The writer has little knowledge of leaves, but in view of their similarity to leaves ascribed to *Cercidiphyllum* and of their association at Reading with fruits of supposed *Cercidiphyllum* type (see discussion under *Carpolithus gardneri* p. 85) it seems worth while to call special attention to these specimens. The characters described above are, however, not only found in *Cercidiphyllum*, they also occur in the family Hamamelidaceae. There is comparable nervation

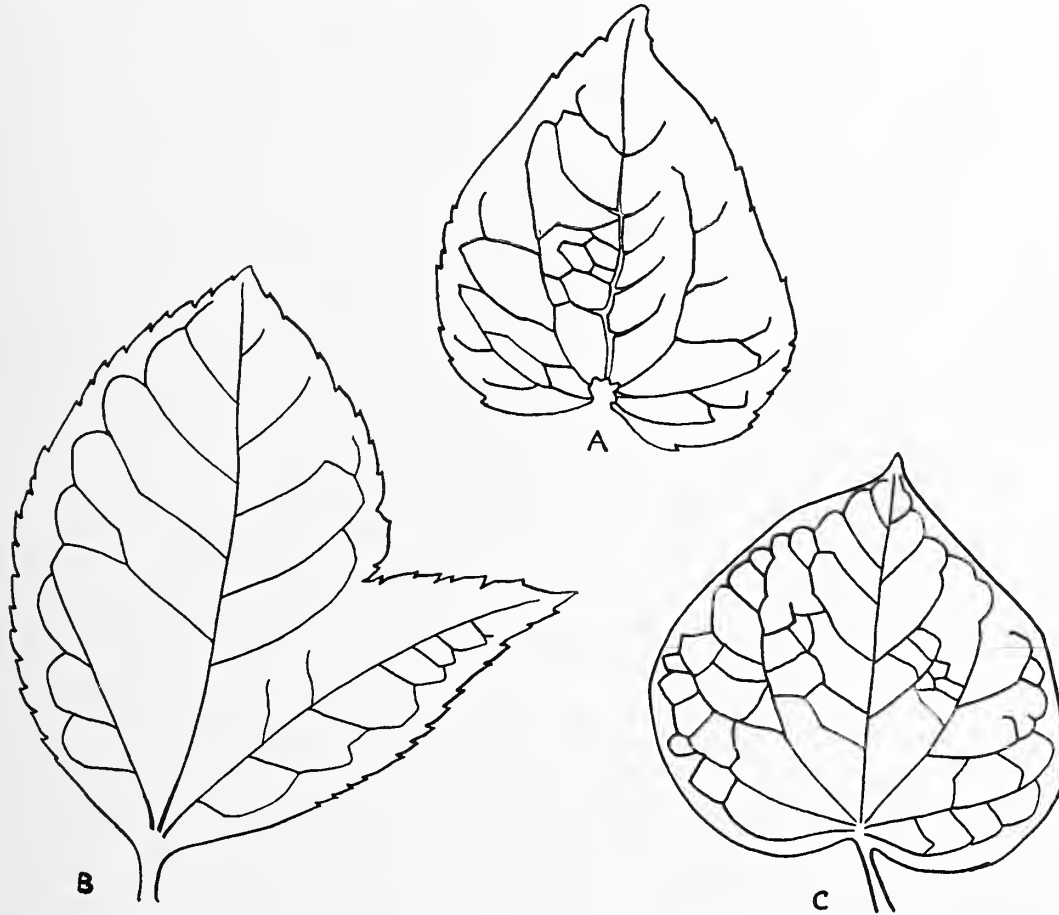


Fig. 2. A, Hamamelidaceae? Genus? Diagrammatic sketch of leaf shown in Pl. 6, fig. 4.
 B, Recent leaf of *Altingia chingi* Metcalf (Coll. Tsang, W. T. 21257, Kew Herb.).
 C, Recent leaf of *Disanthus*.

in *Bucklandia*, *Disanthus*, *Loropetalum* and *Altingia chingi* (Text-fig. 2B, C). Coriaceous and thin leaves both occur in the family, so also do toothed and entire margins. Usually the coriaceous texture and entire margins go together. The sigmoidal teeth are gland-tipped and are well seen in species of *Altingia*. In *Altingia* and *Bucklandia* the leaf outline may be ovate, or palmate and three-lobed, while in the former genus the margin can be toothed or entire in the same species.

The characters of the fossil are therefore present within the family Hamamelidaceae distributed among closely related genera. The matter deserves the attention of a leaf expert. It may be of interest in this connexion to notice that in Tertiary fruiting heads referred to this family, it has been necessary sometimes to give a distinct generic name since the characters

no longer occur in any one living genus. One such species is to be described in a forthcoming catalogue on the Dorset and Hampshire Tertiary floras. Already *Protoaltingia excelsa* has been described from the London Clay (Reid & Chandler, 1933: 247, pl. 9, figs. 1-5).

Winged seeds referred by Brown to *Cercidiphyllum*, occurring in association with the leaves so named by him ought to be compared carefully with winged seeds of Hamamelidaceae, such as *Altingia* and *Bucklandia*. But no such seeds have been seen so far in the Reading Beds.

The Reading Bed leaves are associated with the pods referred to above (*Carpolithus gardneri*, p. 85), also with Lauraceae twigs and berries (V.15463), and with fruiting heads of *Liquidambar*. Mass association in itself therefore has no great significance.

Attention may here be drawn to a broad twig on block V.15463 which bears what appears to be a large finely net-veined entire-margined stipule (Pl. 6, fig. 8). It is possible that the stipule embraces a small immature flowering head, more apparent in the photograph than at first sight in the actual specimen. It may, or may not, have a relationship to the matted mass of leaves with which it is associated. The point is worth recording in view of the presence of large persistent stipules in the living *Bucklandia* for example.

V.15463 Figured Pl. 6, figs. 4, 6, 8; Text-fig. 2A. Also figured Hooker (1854, pl. 4, fig. 1). Impressions of at least six leaves, two of which are figured, are seen matted together. The specimen figured by Hooker is complete except for the petiole, which is not preserved. The scar at its cordate base is due to a hard concretionary patch in the stone and does not, as he supposed, indicate that the leaf was sessile. A broad twig with stipule(?) on the same block (Pl. 6, fig. 8) perhaps belongs to the same species. A Lauraceae twig with berries (*Laurocarpum* sp.) also occurs (cf. Pl. 5, fig. 11, and p. 66).

V.15297 Figured Pl. 6, fig. 5. A leaf with well-preserved marginal teeth and acuminate tip. Unfortunately the looping of the nerves, apparent in the specimen, does not show in the photograph.

V.15336 Figured Pl. 6, fig. 7. Another smaller leaf with toothed margin well preserved.

Other specimens: V.789, V.3592, V.15274, V.15298-302, V.15327, V.15354, V.15465-67, V.15469-71. *J. Prestwich & J. S. Gardner Colls.* Reading Beds: Railway Cutting, nr Reading, Berkshire.

Family LEGUMINOSAE

Genus LEGUMINOSITES Bowerbank, 1840:140

Leguminosites gardneri n. sp.

Plate 7, figs. 1-5

DIAGNOSIS. Leguminous pods growing in a raceme. Stem winged. Pod flat, oboval, contracted below into a stalk which arises out of the persistent perianth, asymmetric with one margin longer than the other beyond which it projects ending in the style. Perianth segments free above with rounded lobes. Seeds solitary? Length of pod, 8 to 16 mm.; breadth, 7 to 12 mm.

HOLOTYPE. V.15340.

DESCRIPTION. *Fruiting head:* A raceme with fruits sometimes opposite (Pl. 7, fig. 4), sometimes alternate. Stem with thin wing-like flanges when well-preserved. Some less well-preserved impressions in which the epidermis has been abraded show circular scars perhaps marking the point of emergence of bundles passing into pods (Pl. 7, fig. 5).

Fruit: Calyx persistent formed of several rounded sepals which are free above, apparently united below; aestivation not clear (Pl. 7, figs. 1, 2).

Pod flattened, splitting marginally?, contracted below into a stalk-like base which arises

out of the calyx, oboval in outline, slightly asymmetric, one margin being somewhat longer than the other beyond which it projects terminating in the style (Pl. 7, figs. 2, 3). The longer margin is somewhat flanged and has a band of marginal fibres 1 to 1.5 mm. broad (Pl. 7, fig. 3). Over the surface fibres diverge obliquely from one margin to the opposite one (seen in V.15347).

Seeds not seen, but perhaps solitary in each pod, as there is no indication of seed outlines causing unevenness (turgidities or convexities) of the surface.

Length of large pod above calyx, 16 mm.; breadth, 12 mm.

Length of large pod including calyx, 18 mm.

Length of another pod without calyx, 18 mm.; breadth, 12 mm.

Length of a smaller pod about 8 mm.; breadth about 7 mm.

REMARKS. Ten specimens of this species are preserved, one represented by counterparts. Six are solitary pods, one shows a pair of opposite pods, one shows five pods in a row, evidently originally attached to a single peduncle from which they hung down (although the connexion is in two cases chipped away).

The form of the flattened fruit is rather distinctive, although without knowledge of the seeds it appears inadvisable to refer the specimens to a living genus, or even to a section of the family.

The most closely comparable pod seen during a search through this enormous family was *Ormosia* Jacks (Papilionatae-Sophoreae of Taubert), a genus growing in tropical Asia, Africa and America.

A Chinese species from Canton and Hainan (*O. semicastrata* Hance) had similar shortly stalked pods arising from a small perianth with free sepals above. As in the fossil the two margins of the pod were slightly unequal, the longer appearing partly to embrace the shorter owing to the projecting style. Although in some respects *Caesalpinia* resembles the fossil, it is not strictly comparable in that the lower margin of its pods has not the appearance of overlapping and embracing the upper. The fossils must provisionally, therefore, be left in the form-genus *Leguminosites* with the specific name *L. gardneri*.

- V.15340 Holotype, figured Pl. 7, figs. 1, 2. Four pods originally united to a stem on the right of them and a part of a fifth; part of another flanged stem is also seen.
- V.15348 Figured Pl. 7, fig. 3. A large pod with well-preserved rim. The calyx is broken away.
- V.15344 Figured Pl. 7, fig. 4. A pair of opposite pods hanging down from the axis.
- V.15341 Figured Pl. 7, fig. 5. A stem with two pods, represented by counterparts. The stem shows circular scars for the bundles very clearly on one counterpart (figured). On the other less of the stem is preserved but remains of the wing-like flange can be seen where it occurs.
- V.15342 Fragment of stem with remains of three separate pods.
- V.15343 A pod with remains of stem on the same block.
- V.15345 Another pod not so well preserved.
- V.15346 Another pod.
- V.15347 A pod without calyx.
- V.15349 Another pod with remains of calyx.
- All the above *ŷ. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Leguminosites sp.

Plate 7, figs. 6-8

Two specimens, one represented by counterparts, appear to be elongate, straight pods of a leguminous plant represented by impressions. Both are incomplete, the one at both ends, the

other at one end. In the latter specimen the pod tapers at the perfect end into a straight peduncle or style. There is a stout fibre band along each margin. In one specimen (V.15339) actual fibres are preserved lying in the impression. The pod was almost flat as indicated by the thinness of its internal cast, sections of which are exposed at each end. Cell structure not seen.

Length of V.15339 (incomplete at both ends), 65 mm.; maximum breadth, 12 mm.

Length preserved of V.15338 including stalk or style (10 mm.), 46 mm.; breadth, 10 mm.

The evidence is insufficient to permit of closer description and definition.

V.15339 Figured Pl. 7, fig. 6. A pod, incomplete at both ends.

V.15338 Figured Pl. 7, figs. 7, 8. A pod with stalk or stylar end, incomplete at the opposite end. Represented by counterparts.

Both *?*. *S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Family LEGUMINOSAE

Section CAESALPINOIDEAE

Genus?

Plate 7, fig. 9

Seed: Pointed-oval, one end more sharply pointed than the other, flat, rather thinner in the middle than at the rounded margins except at the pointed end where the margin is thinner and sharply angled. Hilum sub-terminal marginal at the more rounded end; the scar is asymmetric, one side being more convex than the other; one margin is continued as a groove close to and parallel with the margin of the seed which is here thickened and rounded; it may be associated with the raphe and dies out about 2 mm. from the end of the seed opposite the hilum. Surface smooth, hard, polished, formed of equiaxial cells, about 0.008 mm. in diameter and marked by fine slightly incised striations (probably not originally present) having a general transverse or radial alignment so as to lie at right angles to the margin. Wall about 0.9 mm. thick, compact, structure obscure, apparently formed of equiaxial cells about 0.03 mm. in diameter. Seed-cavity small (now compressed in fossilization). Length of seed, 8 mm.; breadth, 5.2 mm.; thickness, 1 mm.

REMARKS AND AFFINITIES. One perfect seed (now in two pieces). The shape and character so far as can be seen indicate relationship with Leguminosae, cf. the sections Caesalpinoideae or Mimosoideae. Although some of the Mimosoideae have seeds rather similar in size and shape, the absence in the fossil of a sharply delimited central area, and the character of its hilum and raphe exclude it from this sub-family. In the Caesalpinoideae similar flat seeds are found, e.g. *Gleditschia heterophylla*. But only in *Bauhinia* has a similar hilum and raphe been seen. A thickened margin like that of the fossil occurs in *Bauhinia* where it is due to thickening of the inner parenchymatous coat of the testa along the course of the raphe, but the outline of the fossil is more regular. It must be stated however that little living material is available in the Reid Collection (5 out of about 200 species), moreover, the degree of variation of the fossil species cannot be ascertained from one seed only. The tropical genus *Bauhinia* is recorded from Tertiary and later Cretaceous beds.

V.29647 Figured Pl. 7, fig. 9. A seed (now in two pieces). *E. M. Venables Coll.* Woolwich Beds: Sewer trench at junction of Chichester Road and Annandale Avenue, Bognor, Sussex.

Family RUTACEAE

Genus PHELLODENDRON Rupr.

Phellodendron costatum Chandler

Plate 7, figs. 10, 11

1925 *Phellodendron costatum* Chandler, p. 28, pl. 4, figs. 6a-c.

DESCRIPTION. *Seed*: Bisymmetric, sub-ovoid, somewhat constricted and curved near the apex so as to form a slight apical knob curved towards the ventral margin. Ventral margin less convex than the dorsal, flattened with a long median strap-shaped sunk hilar scar with raised margins (incomplete in upper half of seed). External surface ornamented with numerous acute very finely sinuous longitudinal ribs apparently terminating at the sub-apical constriction. They converge towards the opposite pole of the seed, indicating the position of the chalaza, and some near the ventral margin curve towards the hilar scar. The ribs have fine transverse striations due to the transverse alignment of equiaxial (or more or less equiaxial) cells about 0.016 mm. in diameter.

Length of seed about 3.5 mm.; transverse diameter (as exposed), 2 mm.

REMARKS AND AFFINITIES. One seed represented by an external cast. Fortunately the block of matrix split so as to expose the dorsal surface of the seed on one counterpart half, and part of the ventral surface with typical hilar scar on the other half. It would have been extremely difficult to interpret and identify this specimen but for the fortunate fact that the species had already been found both at Hordle and in the older (Lutetian?) beds of Sandbanks near Bournemouth, in both of which localities actual seeds (not casts) occurred. The Sandbanks seeds will be described in a later catalogue. The relationship to *Phellodendron* was discussed by the author in 1925 (p. 28).

V.15361 Figured Pl. 7, figs. 10, 11. A seed-cast represented by counterparts, one showing part of the ventral hilar scar, the other the apical constriction, longitudinal ribs, and the convergence of these ribs towards the basal chalaza. Also catalogued under *Liquidambar palaeocenica* Chandler. *J. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Family ANACARDIACEAE

Genus? (RHUS? or PISTACIA?)

Plate 7, figs. 12, 13

An oval fruit, highly carbonized, and compressed in fossilization, has a rather obscure network of flattened strands of fibres over the surface; several of the fibre strands lie longitudinally. On maceration with nitric acid an incrustation of a whitish substance or possibly loose scaly patches became apparent lying in the hollows of a slightly uneven or irregularly corrugated surface formed of regular equiaxial cells about 0.012 to 0.016 mm. in diameter. Wall, seen in section where broken near the apex, about 0.1 mm. thick, columnar. A conspicuous aperture 1.2 mm. in diameter as compressed can be seen asymmetrically placed at one end. It probably represents the attachment (*a*) in Pl. 7, figs. 12, 13.

Length of carpel, 6.25 mm.; breadth, 5.25 mm. (as crushed).

The structure of the coat, with the scaly incrustation and the character of the aperture, suggest relationship with Anacardiaceae, possibly with *Rhus* or *Pistacia*. The condition of the specimen is such that its internal structure cannot be investigated. The treatment with nitric acid while bringing out details of cell-structure and clearing the basal aperture caused the specimen to crack on drying so that it became very fragile. Hence it is not possible to establish the relationship conclusively on evidence from this one specimen alone, and it is doubtfully referred to *Rhus* or *Pistacia*.

V.29648 Figured Pl. 7, figs. 12, 13. A crushed endocarp, cracking as a result of maceration with nitric acid. The walls where cracked are black and shining and highly carbonized. *S. H. Warren Coll.* From a raft of Tertiary material in the late-glacial deposits of Rikof's Pit, Broxbourne, Hertfordshire (probably derived from Reading Beds).

Family ICACINACEAE

Genus NATSIATUM Buch.-Ham.

Natsiatum eocenicum Chandler

Plate 7, figs. 14-17

1925 *Natsiatum eocenicum* Chandler, p. 29, pl. 4, figs. 7a-d; text-fig. 11.

The species is represented by one perfect endocarp and a few fragments probably derived from the Reading Beds but found in a raft of Tertiary material in the late-glacial beds of Broxbourne. Also by an incomplete but unmistakable endocarp from the Woolwich Beds of Tooting Broadway. The following description is based on the perfect specimen.

DESCRIPTION. *Endocarp*: Bisymmetric, broadly ovate in outline, compressed, lateral margins sharp, one thicker and more rounded than the other. Style terminal, a transverse opening surrounded by a prominent thickening. Attachment basal. Funicle indicated by the thickening along one margin (Pl. 7, fig. 14). Placenta apical, adjacent to the hilar canal, indicated externally by a broad thickening which lies transverse to the margin on both surfaces of the endocarp. External surface ornamented with a network of prominent acute ridges separated by rather flat-bottomed depressions. One ridge runs more or less longitudinally over the middle of the flat surfaces from attachment to style. There is a marked marginal flange, about 0.5 mm. broad, most conspicuous near the base of the endocarp (Pl. 7, figs. 14, 15). The carpel wall is thin, hard and brittle, formed in part at least of finely digitate cells. Locule showing digitate cells, about 0.025 to 0.5 mm. in diameter where the surface is abraded. Elsewhere there are low rounded tubercles, separated from one another by their own breadth, about 0.016 mm. in diameter. The testa and seed have not been seen. Length of endocarp, 9.5 mm.; breadth, 7.25 mm.; thickness too reduced by compression to measure (flattening exaggerated in fossilization).

REMARKS. One of the fragments of derivative material shows very clearly the basal marginal flange. The endocarp from indubitable Woolwich Beds at Tooting is represented by the lower part of one valve and the middle part of the other. It also is much compressed but shows the smooth flat marginal area (Pl. 7, fig. 16) and the hollows and ridges of the surface.

Some of the surface depressions are partially subdivided by incomplete ridges (Pl. 7, figs. 16, 17). The funicular canal in the thickness of the wall is preserved but not the placenta since the upper part of the endocarp is missing. The broken wall shows two regions in section, an outer about 0.03 mm. thick, and an inner 0.1 mm. thick. Both are indurated and brittle, and have a vitreous lustre. The cells of the outer coat appear to be about 0.025 mm. in diameter. The locule surface is papillate, the smooth rounded papillae arising from cells with interlocking digitate margins. There are about 4 papillae in 0.05 sq. mm. The original length of the endocarp represented by this fragment must have been about 9 or 9.5 mm., and the breadth about 7 mm. (estimated from the curvature of the margin compared with the perfect Broxbourne specimen).

The relationship with Icacinaceae is unmistakable, and the section Iodeae is indicated by the form, ornamentation, and papillate locule-lining.

These specimens are indistinguishable from *Natsiatum eocenicum* first described from the Upper Eocene of Hordle, and recently recognized in the Lower Bagshot of Lake, Dorset. There is also some resemblance between *N. eocenicum* and *Iodes multireticulata* Reid & Chandler from the London Clay (1933: 325, pl. 15, figs. 1-11). But *N. eocenicum* is larger, less inflated, usually relatively broader, with an external network of sharper, thinner, more prominent ridges. It has a broader, flatter marginal flange in the lower part near the attachment (when well preserved). Usually the papillae of the locule-lining are finer and sometimes they are closer and less clearly separated from one another. The appearance of the papillae varies considerably with the degree of abrasion and state of preservation as is shown by the larger range of material available from later beds (yet to be described).

The living species *Natsiatum sinense* Oliver, which appears to be most nearly related to the fossil, is a large climber in the Chinese mountains. Other species, the fruits of which differ considerably in appearance, occur in Assam, Burma, the Himalayas and Indochina.

The occurrence of this fossil in beds both above and below the London Clay is interesting and suggests comparable conditions. The latest recorded occurrence of the species is in the Lower Headon.

V.29649 Figured Pl. 7, figs. 14, 15. An almost perfect endocarp.

V.29650 Fragments of an endocarp or endocarps.

The above *S. H. Warren Coll.* From a raft of Tertiary material in the late-glacial deposits of Broxbourne, Hertfordshire (probably derived from Reading Beds).

V.29651 Figured Pl. 7, figs. 16, 17. An imperfect endocarp. *A. G. Davis Coll.* Woolwich Beds IV: City and S. London Tube Extension, Tooting Broadway, Surrey.

Family VITACEAE

Genus VITIS (Tourn.) L.

Vitis pygmaea n. sp.

DIAGNOSIS. Seed obovoid with smooth contours, not channelled at the apex, stipitate at the base. Ventral face faceted with sharp raphe ridge, ventral infolds about half the length of the seed, slightly concave to the raphe ridge. Chalaza oval, above the middle of the dorsal face. Length of seed, 2.25 to 3.25 mm.; breadth, 0.5 to 2.25 mm.

HOLOTYPE. V.34675 from the Lower Bagshot Beds of Lake, to be described in a forthcoming volume of the catalogue.

Vitis pygmaea?

Plate 8, figs. 6, 7; Text-fig. 3

DESCRIPTION. *Seed*: Originally obovoid (distorted and much compressed in fossilization), pointed at the base (probably not quite complete), rounded, not channelled at the apex, faceted (probably unequally) on the ventral face but so much distorted that the original shape is obscured. Raphe ridge broad reaching almost to the apex. Ventral infolds deep, conspicuous, diverging from below upwards, concave towards the raphe ridge (Pl. 8, fig. 7; Text-fig. 3B).

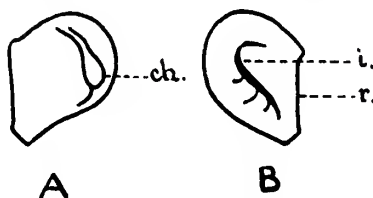


Fig. 3. *Vitis pygmaea?* A, Dorsilateral showing chalaza (*ch*); B, ventrolateral showing a ventral infold (*i*) and raphe ridge (*r*) on right.

Chalaza large, oval, convex, surrounded by a groove which is continued between the chalaza and the base (Pl. 8, fig. 6; Text-fig. 3A). Surface much decayed, slightly puckered radially around the chalaza and ventral infolds. Cells of surface about 0.05 mm. in diameter. Length of seed, 2.75 mm.; breadth (distorted), 2 mm.

REMARKS AND AFFINITIES. One seed. The relationship with *Vitis* is clear from the form and structure, but the seed is only about half the size of the smallest living seed seen.

The resemblance in form and size to *V. pygmaea* Chandler from the Lake and Sandbanks sections (Lower-Middle Bagshot) is very close and is discussed in a later catalogue. But the seed is less stipitate partly because the extreme base is broken. It therefore appears less slender. In view of the distortion which the only specimen has undergone, the reference to *V. pygmaea* is regarded as doubtful.

V.29652 Figured Pl. 8, figs. 6, 7; Text-fig. 3 (diagrammatic). A distorted seed. *A. G. Davis Coll.* Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Family FLACOURTIACEAE

Genus ONCOBA Forsk.

? *Oncoba variabilis* (Bowerb.) Reid & Chandler

Plate 8, figs. 1-5

1840 *Cucumites variabilis* Bowerbank, p. 91, pl. 13.

1933 *Oncoba variabilis* (Bowerb.) Reid & Chandler, p. 406, pl. 21, figs. 9-18.

DESCRIPTION. *Fruit*: Globular or ovoid, contracted at the apex into a narrow pointed elongate mucro (style), seated at the base on a somewhat swollen peduncle from which it is

separated by a narrow constriction probably indicating an inferior perianth. Pericarp formed of longitudinal valves which meet edge to edge, their limits marked by small longitudinal ridges. Four such valves are seen on the exposed surface of one specimen (Pl. 8, fig. 1) so that probably in the whole fruit there would have been eight. Surface almost smooth but with fine corrugations due apparently to a network of fibres immediately within the epicarp such as occurs in the living *Oncoba spinosa* Forsk. Its presence in the fossil may have been emphasized by the shrinking of the pericarp on drying causing it to cling more closely. Several longitudinal fibres can be seen in each valve arising from the base and diverging upwards for a short distance (about 4 mm.) when they become merged in the general fine network covering the surface. The external surface of the peduncle shows a series of fine transverse corrugations.

Placental mass occupying the whole interior, somewhat lobed longitudinally, the lobes separated by narrow longitudinal furrows in which lie fibre strands connected with the parietal placentas. Surface of mass finely striate transversely. Seeds not seen *in situ*.

Length of fruit (slightly imperfect at apex and without style), 20 mm.; breadth, 22 mm.; breadth of stalk where broadest just below fruit, 6 mm.

Length of a second fruit with style, 30 mm. and without style about 24 mm. Length of placental mass in this specimen, 25 mm.; breadth of mass about 19 mm.; breadth of peduncle, 6 mm.

Seed: An obovoid seed represented by an external cast (now broken) and an internal cast (incomplete on one side) may be a small detached seed of *Oncoba variabilis*. The length of the internal cast is 2 mm., breadth, 1 mm. The cells diverge from the two extremities as if from an organ at each end. At the broad end a distorted, originally oval, scar (maximum diameter 0.45 mm.) appears to represent the chalaza—the cells upon its surface converge towards a central point upon it. Four integuments or layers of cells can be seen.

On the external cast are the remains of coarse equiaxial cells (convex on the actual seed) about 0.016 mm. in diameter, also a longitudinally striate coat, cells about 0.012 mm. broad.

On the internal cast is the remains of a stout coat of transverse fibres (Pl. 8, fig. 5 at *f*), and within a smooth shining integument of quadrangular or equiaxial cells 0.012 mm. in diameter.

The actual length and breadth of the seed (as shown by the external cast, now too broken to measure accurately) must have been considerably greater than those of the internal cast (breadth about 1.3 mm., length about 2.5 mm.). Even so the seed is smaller than those from the London Clay.

REMARKS AND AFFINITIES. Three fruits and possibly a seed. Two of the fruits are external casts with style broken, the other is a fruit with style and stalk in which the shrunken placental mass is exposed. The pulpy character is indicated by the distortion due to compression which this specimen has undergone. The actual fibres of the placentae are preserved in places, especially in a longitudinal furrow along one edge of the crushed placental mass (Pl. 8, fig. 2 at *pl.*). Although no seeds have been seen *in situ* in the fruit there can be no doubt that the specimens belong to *Oncoba*, and they are closely comparable with *O. variabilis* (Bowerb.) to which species they are now provisionally referred. The characters of the external surface are better preserved here than in the London Clay specimens which are more abraded and do not show the fine network of fibres. These can be seen very clearly, however, beneath the epicarp in the living *O. spinosa*, the arrangement being exactly comparable with that of the fossil. The section *Euoncoba* to which *O. spinosa* belongs is distinguished by having five or more placentas.

It inhabits tropical Africa (almost reaching Natal) and Arabia. Its presence in the Reading Beds, like that of Icacinaceae, indicates warmer climatic conditions than were formerly supposed to prevail at that period.

- V.15353 Figured Pl. 8, fig. 1. An external impression with stalk, style partly broken.
 V.15351 Figured Pl. 8, fig. 2. Part of an external impression with long style (*st.*) and stalk within which lies the crushed placental mass, (*pl.*) indicates the position of two of the parietal placentas.
 V.15352 Figured Pl. 8, fig. 3. An external impression, broken at the apex, with well-preserved stalk. It shows signs of splitting along the suture between two segments.
 V.15339a Figured Pl. 8, figs. 4, 5. A seed represented by a broken external cast (fig. 4) showing the cell-structure, and the internal cast (fig. 5) which was lying inside it showing transverse fibres (*f*) overlying a smooth coat of square cells. It was found on the back of a small slab of matrix with a leguminous pod, and may belong to *Oncoba* but it is unusually small.
 All the above *f. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Family MYRTACEAE

Section MYRTINAE

Genus MYRTOSPERMUM Chandler, 1957:111

Myrtospermum variabile n. sp.

Plate 8, figs. 8, 9

DIAGNOSIS. Seeds variable in form and sculpture with an external coat of pits about 0.05 to 0.1 mm. in diameter. As seen in section the testa is formed of several layers of radially aligned equiaxial cells about 0.01 to 0.02 mm. in diameter. Diameter of ripe seeds, 0.75 to 1.75 mm.

HOLOTYPE. V.34248. Bournemouth Freshwater Beds: Sandbanks, Dorset.

DESCRIPTION. *Seed*: Bisymmetric, splitting on dehiscence in the plane of symmetry; sub-oval in outline, flat, curved, limbs of U-shaped cavity unequal in length and breadth as indicated by the arrangement of the surface sculpture. Hilum oval, marginal between the limbs; micropyle terminal on the longer narrower limb (Pl. 8, figs. 8, 9). Surface somewhat shining owing to compression, ornamented with polygonal or hexagonal pits, 0.05 to 0.1 mm. in diameter, arranged in rows parallel with the margin and also radiating from the area between the limbs over which they are smaller and elongate. Wall formed of equiaxial cells, 0.012 mm. in diameter, which may be clearly seen on the walls of the surface pits. Diameter of seed, 1.1 mm.

REMARKS AND AFFINITIES. One seed (now broken) appears to be identical with *Myrtospermum variabile* from the Bournemouth and Cliff End (Mudford) Beds of the Hampshire Basin as shown by careful comparison of the Woolwich seed with the actual specimens from the Bournemouth area. In its crushed condition it does not of course show all the characters which can be seen in the beautifully preserved seeds from Bournemouth. There is a fuller discussion of this species in a forthcoming catalogue in which relationship to living forms is also considered.

- V.29653 Figured Pl. 8, figs. 8, 9. A crushed seed (now broken). *A. G. Davis Coll.* Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Myrtospermum warreni n. sp.

Plate 8, figs. 10, 11

DIAGNOSIS. Coarse pits of surface frequently as much as 0.15 to 0.2 mm. in diameter. Diameter of seed, 2 by 1.75 mm.; thickness, 1 mm.

HOLOTYPE. V.29654.

DESCRIPTION. Agreeing in form and general structure with the common Tertiary species *M. variable* but considerably larger and with coarser surface pits 0.15 to 0.2 mm. in diameter (*M. variable* 0.05 to 0.1 mm.). Testa much thickened over the wall between the limbs of the curved seed, the thickening marked by the presence of a ridge of coarse cells on both surfaces. Diameter of seed, 2 by 1.75 mm.; thickness, 1 mm.

REMARKS. One seed resembling *Myrtospermum variable* in its general structure but differing considerably in size and appearance and in the coarseness of its surface pits. It has therefore been regarded as a distinct species and described as *M. warreni* after the original investigator of the beds in which it was found, the late Mr. S. Hazzledine Warren. The seed is considerably smaller than seeds of *Palaeorhodomyrtus subangulata* (Reid & Chandler, 1933: 436, pl. 23, figs. 21-31).

V.29654 Holotype, figured Pl. 8, figs. 10, 11. A seed. *C. Reid Coll.* Derivative in the late-glacial beds of Ponder's End, Lea Valley, possibly from the Reading Beds higher upstream at Broxbourne, Hertfordshire, where Reading Bed derivatives are known to occur as 'rafts' in the overlying late-glacial beds. Otherwise from the London Clay which underlies the late-glacial at Ponder's End.

Family MYRTACEAE?

Genus?

Plate 8, figs. 12, 13

Seed: Sub-oval, subcircular or subtriangular in outline, flattened; hilum and micropyle marginal, the hilum an oval aperture possibly between the two limbs of a curved seed-cavity with the micropyle terminal on one of the limbs. Surface smooth, formed superficially of equiaxial cells 0.025 mm. in diameter, finely striate (possibly as the result of decay), the striae converging towards the micropyle and lying parallel with the margin (Pl. 8, fig. 13). Wall formed in section of about six layers of equiaxial cells 0.0125 mm. in diameter arranged radially. Diameters of three seeds respectively 1.7 by 1.5 mm.; 1.6 by 1.6 mm.; 2 by 1.9 mm.

REMARKS AND AFFINITIES. Four seeds, two being well preserved. The form and cell-structure suggest relationship with Myrtaceae, but no exactly comparable living material has so far been seen nor is the shape of the seed-cavity definitely known.

V.29655 Figured Pl. 8, fig. 12. A well-preserved specimen.

V.29656 Figured Pl. 8, fig. 13. A second well-preserved specimen.

V.29657 A large much decayed specimen.

V.29658 A broken much decayed specimen.

All *A. G. Davis Coll.* Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Family HALORAGIDACEAE

Genus HALORAGIS Forst.

Haloragis sp.

1854 *Phyllites*, Hooker, p. 170, pl. 4, figs. 19, 20, 20*.

1886a Fern(?), Gardner, p. 403, pl. 2, figs. 5-12.

A small herbaceous plant with dentate leaves was re-examined by the late W. N. Edwards and is identified with the living genus *Haloragis*, a plant growing in damp places including Australia, New Zealand, South-east Asia and North America (see p. 18).

V.15472-74 Figured Hooker (1854, pl. 4, figs. 19, 20, 20*).

V.15482-85 Figured Gardner (1886a, pl. 2, figs. 5-7, 11, 12).

Other specimens: V. 786, V.790(4), V.3593, V.15470, V.15478(2), V.15479-81, V.15486.

All ♀. *Prestwich Coll.* Reading Beds: Railway Cutting, Reading, Berkshire.

Family APOCYNACEAE

Section PLUMIEROIDEAE Schumann

Genus APOCYNOSPERMUM Reid & Chandler, 1926:118

Generic diagnosis emended to include seeds without pappus as well as with.

Apocynospermum lakense n. sp.

DIAGNOSIS. Seed without pappus, elongate-oval or ovate, much flattened, without marginal rim, hilar-raphe scar conspicuous, normally median ventral. Testa ornamented with deep pits elongate near the raphe, elsewhere producing a deeply honeycombed surface, the individual pits sometimes as much as 0.1 to 0.15 mm. in diameter. Testa 0.1 to 0.23 mm. thick, formed of small rectangular cells. Length of seed about 3.5 to 4.5 mm.; breadth about 1.2 to 3.25 mm.

HOLOTYPE. V.34674. Lower Bagshot: Lake, Dorset.

?Apocynospermum lakense

Plate 8, figs. 14, 15

Two small deeply and coarsely pitted seed fragments are comparable with some perfect seeds from the Lower Bagshot of Lake, nr. Poole, Dorset, yet to be described. They are referred to a form-genus *Apocynospermum* and (?) to the species *A. lakense*.

The Reading Bed fragments are like them in form (so far as this is preserved), size, and in the character of the external pits which do not produce corresponding internal convexities as in *Actinidia*. There is no marked tendency, as in that genus, for splitting to occur along the ridges between the pits. In both Lake and Reading Bed material the pits are long and narrow along

the line of the raphe, but elsewhere they are broader and more or less equiaxial. In both, the testa is thick and crustaceous (about 0.1 to 0.15 mm. thick in the Reading Bed fragments) built up of several layers of smaller rectangular cells. Size of fragments, 1.3 by 1 mm.; 1.4 by 0.7 mm. Dimensions of pits, 0.1 to 0.2 by 0.05 to 0.1 mm.

V.29660 Figured Pl. 8, figs. 14, 15. Two pitted seed-fragments. *f. Hazsledine Warren Coll.* From a Tertiary 'raft', derivative in the late-glacial beds, Rikof's Pit, Broxbourne, Hertfordshire. Presumed to come from underlying Reading Beds.

Family CAPRIFOLIACEAE

Genus ABELIA R. Brown

Abelia palaeocenica n. sp.

Plate 8, fig. 16

DIAGNOSIS. Fruit cylindrical(?) about 9 mm. long, with five large apical obovate wings concave on the upper surface, fairly broad at the lower end. Nerves of wings sub-parallel, longitudinal, occasionally bifurcating.

HOLOTYPE. V.19148.

DESCRIPTION. Fruit winged, obovate wings arising from a small raised circular apical disc with central depression. Curvature of the whorl and of individual wings concave upwards. Although the specimen is incomplete the symmetry indicates five wings. Two adjacent ones are preserved and are perfect except at their extreme tips and along their adjacent margins. They measure respectively 4.5 by 2.5 mm. and 5 by 2 mm. In the remaining 180° of the whorl three wing bases arise. Each wing has several sub-parallel longitudinal nerves prominent on the lower, but obscure on the upper surface. They occasionally bifurcate. Seven nerves were counted on the longest wing. The upper surface is formed of equiaxial cells, 0.025 mm. in diameter except over the nerves where they vary from 0.01 to 0.007 mm. in diameter. Polygonal areas or cells, 0.05 mm. in diameter, can be seen on the lower surface as in living *Abelia*. Fruit body (if preserved) cylindrical, longitudinally ridged, with equiaxial cells externally, 0.03 to 0.05 mm. in diameter. Diameter across wings (incomplete), 8 mm. Length of supposed body about 9 mm.; breadth, 0.75 mm.

REMARKS. An incomplete impression of the wings in a block of argillaceous shelly sandstone. It shows the lower surface, the nerves being represented by furrows. Carbonaceous fragments still adhere in patches on the wings and at the middle of the impression, and these show the structure of the upper surface. Remains of a long narrow cylindrical fruit may be represented partly as an impression, partly as a carbonaceous body with internal cast, but the connexion with the wings is severed if so through fracture of the stone and only a small portion at the base remains. The length would have been about 9 mm.

The wings, nervation (and body?) indicate relationship with *Abelia*. The winged fruits of *Porana* and *Legendrea* (Convolvulaceae), *Kydia* (Malvaceae) and *Loxostylis* (Anacardiaceae) are less comparable. Most living species of *Abelia* have wings which are narrower near the central disc and convex upwards from side to side. They also have simpler less-branched nerves than those of the fossil. In *A. serrata*, however, the wings are relatively broad below and have several

longitudinal nerves of a simple type. The Bembridge species (Reid & Chandler, 1926: 132–139) again have wings which are more slender at the base, and the nervation in all is of a different type. A distinct specific name is therefore given to the fossil—*Abelia palaeocenica*.

V.19148 Holotype, figured Pl. 8, fig. 16. An impression in a block of argillaceous shelly sandstone. Remains of *Chara* nucules also occur on this block. *A. G. Davis Coll.* Woolwich Beds: Sewage Farm, Beddington, Surrey.

Genus SAMBUCUS (Tourn.) L.

Sambucus sp.

Plate 8, fig. 17

An imperfect impression of the external surface of a seed showing the typical surface with transverse rugosities.

The seed is incomplete at the proximal end. Length (preserved) about 2.3 mm.; breadth, 1.35 mm.

Figured Pl. 8, fig. 17. An external impression of a seed. Specimen now crumbled away. *J. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Family?

Genus JENKINSELLA Reid & Chandler, 1933: 481

Jenkinsella apocynoides Reid & Chandler

Plate 8, figs. 18–20

1933 *Jenkinsella apocynoides* Reid & Chandler, p. 481, pl. 28, figs. 1–5.

Jenkinsella is represented in the Woolwich and Reading Beds by three specimens.

The most complete evidence is afforded by specimen No. 41185 from Dulwich (Pl. 8, fig. 18). It shows a fruit, oval in outline, now much compressed, represented by an external impression from which most of the carbonaceous carpel has fallen. It was probably perfect originally. The impression shows a longitudinal suture from which stout longitudinal fibres (about 0.5 mm. apart) diverge obliquely over the surface. Between them fine transverse fibres can be seen. The remains of the carpel show the same features but also the inner carpellary coat formed only of transverse fibres. Length of carpel, 10 mm.; breadth, 5.25 mm.

A second carpel (V.15354) from Reading perhaps belongs to this species. It shows the external impression only, slightly incomplete at one end where it overlies a fragmentary leaf impression. The two sets of fibres can be seen. Length, 12 mm.; breadth, 3.5 mm. (Pl. 8, fig. 19).

A third specimen also from Reading (V.15355) is an internal cast buried in the matrix at one end and imperfect on the back where it adheres to the matrix (Pl. 8, fig. 20). It shows the ventral suture flanked by the rows of placentae, also the stout transverse fibres of the inner carpellary coat crossed by longitudinal ripples slightly divergent from the suture (impressions

of outer longitudinal fibres). The specimen is slightly distorted. It is unusually large, 13 mm. long (not quite complete) and 8 mm. broad, but cannot be distinguished from some of the London Clay specimens.

The fruits were originally referred to Apocynaceae? (or Asclepiadaceae). This relationship must now be questioned on the basis of evidence about the seeds from new specimens found in the London Clay. Nor can they be referred to *Cercidiphyllum*. A discussion on the evidence is given on p. 87. The Reading Bed material is too poorly preserved to yield sufficient data.

- 41185 Figured Pl. 8, fig. 18. A fruit (external impression with remains of crushed carbonaceous carpel). *J. Rickman Coll.* Woolwich Beds: Dulwich, Surrey.
- V.15354 Figured Pl. 8, fig. 19. An imperfect external impression of a carpel. On the same block is a folded leaf.
- V.15355 Figured Pl. 8, fig. 20. An internal cast showing the suture and placentae.
Both the above *J. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Genus CARPOLITHUS Linnaeus

Carpolithus gardneri n. sp.

Plate 9, figs. 1-5; Text-fig. 4

DIAGNOSIS. Fruits borne in a much branched raceme usually singly and alternately. Leaf scars on twigs in whorls of about 4-6. Pod bisymmetric, follicular, one-loculed?, elongate sub-elliptical in outline, dorsal margin less curved than ventral, style slightly reflexed, pod attenuated into stalk and style. External surface with fine transverse ridges. Internal surface more finely transversely striate. Seeds unknown. Length of pods, 20-25 mm.; breadth, 6 to 8 mm.; thickness about 2 or 3 mm.

HOLOTYPE. V.15335-7 (all parts of one raceme).

PRELIMINARY NOTE. Pods and leaves of a type referred by Brown (1939: 485-499, pls. 51-56) to *Cercidiphyllum* both occur in the Reading Beds of Reading. In spite of careful search no winged seeds of *Cercidiphyllum* have been seen. The fossil material described and figured by Brown came from various horizons, but his three types of organs were never found in organic connexion in any of them, although they were commonly associated in the same deposit. He separated these remains ascribed to *Cercidiphyllum* into five 'nominal recognizable species' which he based upon leaf characters. As regards the other organs he makes this statement (p. 489). The 'pods, like the seeds, except in the later species, are so much like one another morphologically that I cannot detect sufficient constant differences to distinguish species on this basis alone.' In actual fact the descriptions and figures Brown gives of the pods and seeds are not sufficiently detailed to offer satisfactory evidence of their true generic relationship. Such details as are shown do however appear to distinguish them in a marked degree from the two living varieties of *Cercidiphyllum*.

Certain pods from Reading which resemble Brown's figures (pl 54, figs. 12, 13) have been described above as *Jenkinsella*. Other pods are described here as *Carpolithus gardneri*.

The leaves are briefly discussed on p. 70 under the heading Hamamelidaceae? Genus?, and illustrated in Pl. 6, figs. 4-8; Text-fig. 2.

DESCRIPTION. *Fruiting head*: A much-branched raceme, fruits borne singly and alternately on short branches, occasionally in pairs.

Twigs: Longitudinally ridged so as to be almost flanged or winged in places, sometimes with a few close transverse ridges near the nodes. Leaf-scars small, sub-circular, in whorls of about four to six (Pl. 9, figs. 1, 4; Text-fig. 4).

Fruit: A bisymmetric pod sufficiently inflated to give a narrow lenticular transverse section, probably one-loculed, follicular, elongate sub-elliptical in outline, slightly curved towards the dorsal side owing to the greater convexity of the ventral margin, gradually attenuated below

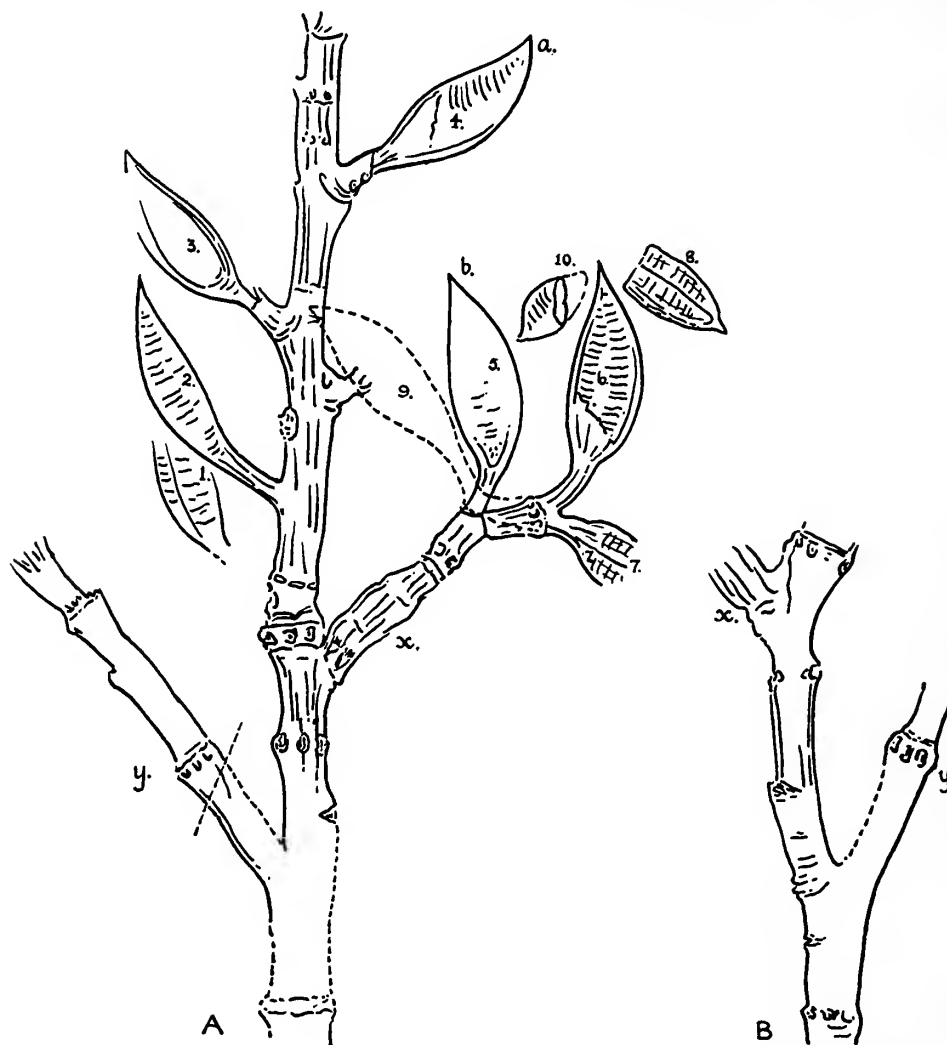


Fig. 4. *Carpolithus gardneri* n. sp. A, reconstruction of the raceme based on a single specimen (V. 15336) and two counterpart fragments (V. 15335, V. 15337). It shows the remains of ten fruits; No. 9 (now removed in V. 15336) lay at a higher level on the block and was preserved only on the counterpart V. 15337. It is indicated by dotted lines. B, counterpart of base of V. 15336. Both $\times 1\frac{1}{2}$ approx.

into the stalk, probably persistent, basal joint obscure. Apex gradually narrowed into a slightly reflexed but almost straight style. A slight longitudinal ridge along one side of the pod apparently marks the line of suture (Pl. 9, fig. 5). Features of the opposite margin not seen.

External surface of pod and style having small close-set sharp transverse ridges about

0.5 to 0.75 mm. apart, individual ridges not continuous across the whole breadth, some ridges more conspicuous and longer than others. There are also a few longitudinal folds or ripples on parts of the surface which are also visible on the internal casts; they have a slight spiral twist in some pods (Pl. 9, fig. 2). Cell-structure obscured by the grain of the matrix. Inner surface of pod more finely striate transversely (Pl. 9, figs. 2, 3). Two specimens show especially marked striations close to the dorsal margin about 0.5 to 1 mm. apart.

Seeds not seen, possibly solitary and represented by the locule-cast, less probably numerous, transverse and piled one upon another as suggested by the more marked transverse striae above described. Length of spike (as preserved), 7 cm. Length of pods, including style and narrowed base, 20 to 25 mm.; breadth, 6 to 8 mm.; thickness probably about 2 or 3 mm. Length of locule-cast about 17 mm.

REMARKS AND AFFINITIES. An inflorescence bearing remains of ten fruits, some incomplete. One or two (Pl. 9, figs. 2, 3, 5; Text-fig. 4A) are detached. V.15336 shows remains of nine of the fruits (eight only appear in Pl. 9, fig. 1, one is to the right of the picture). V.15337 is a counterpart of the upper right hand side of V.15336. It shows two incomplete external casts and one internal cast (Pl. 9, fig. 2; Text-fig. 4A and explanation on p. 90) no longer preserved on V.15336 (chiselled away presumably when the specimen was originally developed). Part of the stem is also shown. A forked stem on a third fragment (V.15335, Pl. 9, fig. 4; Text-fig. 4B) is the counterpart of the lower end of the inflorescence in V.15336.

In this species one locule is apparently indicated by the single somewhat compressed locule-cast. Dehiscence along one margin only is suggested by the fact that the locule-cast is sharply defined on one side only. On the opposite margin (which appears to have gaped) it merges almost imperceptibly into the matrix. In well-preserved internal casts in the London Clay it is not unusual to see impressions of the outlines of seeds if a number have been present in a locule even if they have already been shed, for their contours often leave corresponding impressions on the inner surface of the pod (cf. *Tamesicarpum polyspermum* Reid & Chandler, 1933: 421, pl. 22, figs. 12, 13, 17). No such impressions are visible on the locule-casts of this species, unless they be represented by the marked transverse striations seen on two casts as described above.

The association of these pods with leaves of *Cercidiphyllum* type, necessitates a very careful comparison of these fruits with *Cercidiphyllum* in view of Brown's work to which reference has already been made.

The differences which separate *Cercidiphyllum* from the Reading pods are marked, and are as follows:

In *Cercidiphyllum* the fruits are borne in a ring or cluster at the tip of a short shoot or peduncle beside which grows a large leaf-bud. Both are borne in the axil of a leaf (Text-fig. 5A-D).

The leaves are borne in opposite pairs; immediately beneath each leaf-base are a few close-set conspicuous narrow parallel leaf-scars (annual?) half encircling the stem (from 2 to 8 in the twigs examined) Text-fig. 5A, B.

The twig is smooth and rounded with a few conspicuous lenticels (Text-fig. 5B).

The fruit (a follicle with numerous seeds) is almost subcircular in transverse section (breadth, 3 mm.; thickness, 2.5 mm. in a typical specimen), more curved than the fossil, attenuated to a basal joint where it arises from the short shoot (Text-fig. 5A, D), contracted

rather suddenly at the apex into a long, persistent, often curved style, frequently bent at an angle of 90° with the pod itself (Text-fig. 5A-E). Each margin of the fruit carries a stout fibre band. That on the dorsal margin is superficial, readily detachable with the outer coat in which

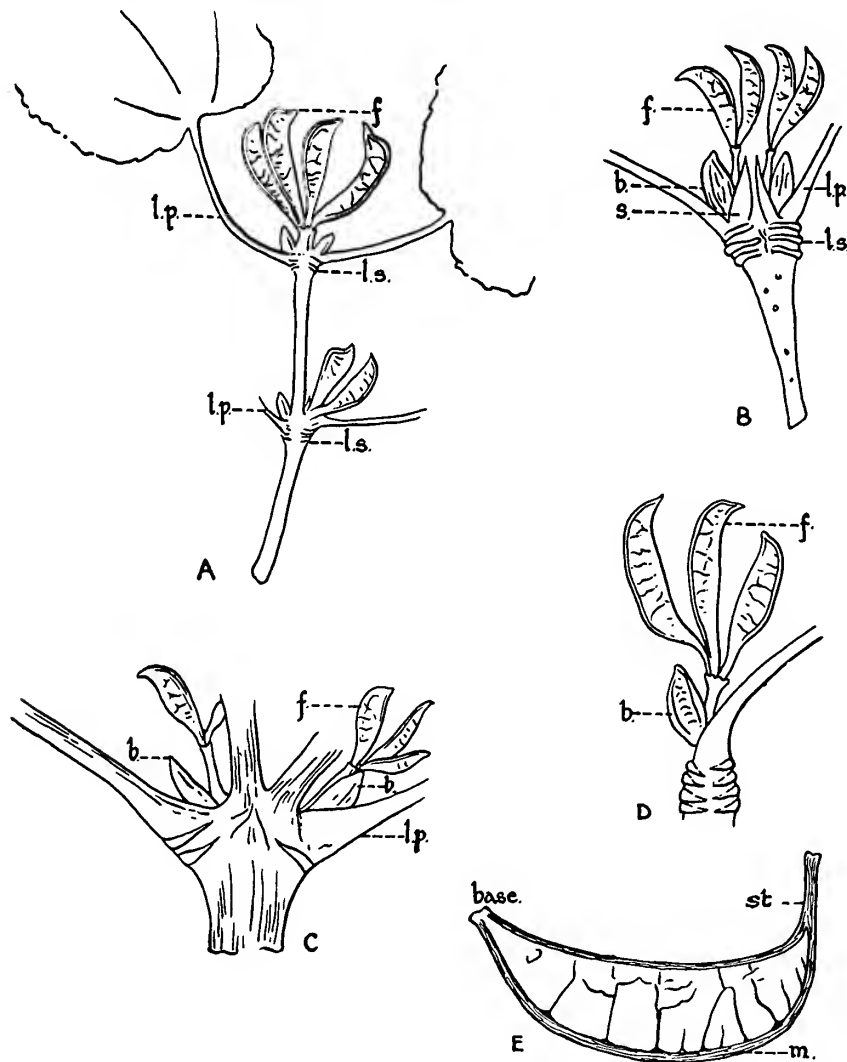


Fig. 5. *Cercidiphyllum japonicum* (Recent). A-D show mode of growth, character of pods and twigs. E shows in greater detail a single pod. *b*, bud; *f*, fruits on short shoots; *lp*, leaf petiole; *ls*, leaf scars; *m*, margin of dehiscence; *s*, scale; *st*, style.

it lies. That of the ventral margin is intimately associated with the structure and splitting and extends throughout the whole thickness from the outside to the inside. The two strands unite at the base of the style and pass into it. Across the broad surfaces of the pod the two strands are connected by nerves which arise from the ventral strand and become thinner in passing away from it. They occasionally branch and anastomose (Text-fig. 5E). They lie wholly within the outer coat of the fruit and form a conspicuous coarse network.

Except for the nerves, the outer surface of the pod is smooth (even in dried and therefore shrunken specimens). It is formed by a brittle coat, readily detachable on maceration, having

an epidermis of small quadrangular cells, about 0.016 mm. in diameter, with a tendency to be grouped in short longitudinal rows. Within the epidermis, the coat is formed of rounded equiaxial cells 0.025 mm. in diameter, very conspicuous in a microscopic preparation. No trace of such a coat, nor of the system of transverse branching fibres it carries, can be seen in the fossil.

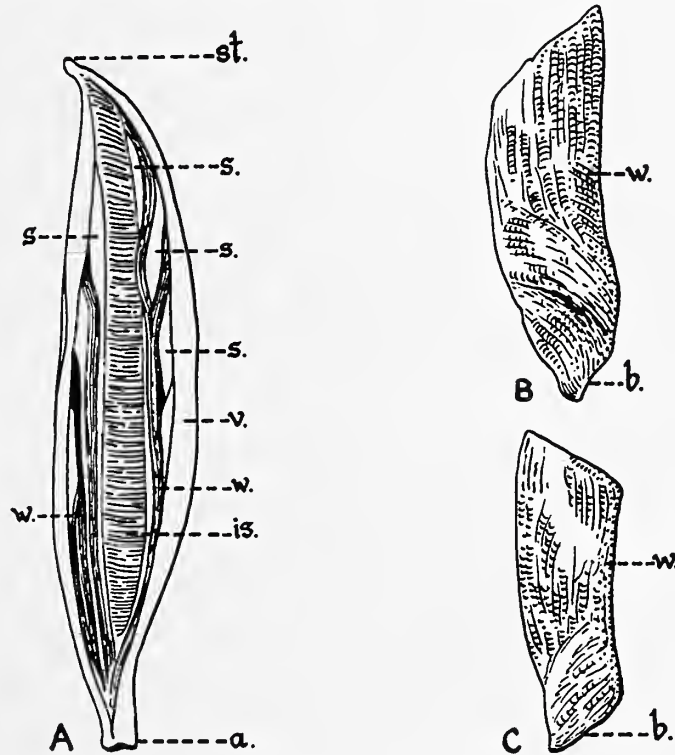


Fig. 6. *Cercidiphyllum japonicum* (Recent). A, diagram showing the suspended seeds in a gapping pod. B and C, two typical winged seeds. *a*, attachment; *b*, body; *is*, inner surface of gapping pod; *s*, seed-body; *st*, style; *v*, valve; *w*, wing.

The inner coat of the pod is thicker, formed of transverse fibres along which it readily breaks transversely. This coat is continuous over the dorsal edge of the pod which like the fossil does not split.

The seeds are suspended along the ventral margin in two overlapping rows, longitudinally aligned with their broad surfaces parallel with the broad faces of the pod (Text-fig. 6A).

They have a body at one end which, as Brown states, is 'perceptibly angular rather than smoothly elliptic' (in his fossil seeds it was smoothly elliptic). Seed and wing both show a conspicuous honeycomb structure due to coarse cells with raised margins. Over the seed-body they are arranged in oblique rows forming conspicuous oblique striations (Text-fig. 6B, C). These cells in reasonably well-preserved material would be readily seen and would, if present, at once distinguish the seeds from Conifers and many other winged seeds. This peculiar structure is not mentioned by Brown. The absence of definite evidence about seeds in the Reading Bed material is unfortunate as the seed characters are so distinctive in *Cercidiphyllum*.

It is a matter of opinion, when only two very similar living species of *Cercidiphyllum* exist

for comparison, whether it is justifiable to extend the living genus to cover fossil organs having such different characters, or whether such differences do not rather indicate that the fossils belong to a different genus and probably to a different family.

In the writer's opinion it is better to regard the Reading pods as of unknown relationship than to force them into a genus from which they differ both in the characters of the raceme and twig, and in both macro- and microscopic structure of the pods. Again and again it has been found that when a fossil fruit or seed differs in several outstanding features from some living plant which it superficially resembles, a different relationship has in the end been established *unless* the peculiar features could be demonstrated in some closely related genus or genera within the family under review. Therefore, however tempting the resemblances may be at first sight, it seems wiser not to stress them unduly, while paying too scant attention to differences which may be of even greater significance.

Hence the reference of the Reading pods to *Carpolithus* under the distinctive name *C. gardneri*, and not to *Cercidiphyllum*.

V.15335-37 Holotype, figured Pl. 9, figs. 1-5; Text-fig. 4. Text-fig. 4A is a reconstruction from the three counterpart fragments catalogued below. The fruits are numbered for convenience of reference.

V.15336, the largest fragment, shows the inflorescence with six fruits attached and three detached. Fruits 2 and 5 (see Text-fig. 4A) are good internal casts. Fruit 8 is an external cast (detached) showing well the surface and ventral suture. On the back of this block is a pinnate nerved leaf with entire margins, somewhat thick and fleshy in texture. It is figured in Pl. 8, fig. 24 to show that coriaceous leaves may occur in the deposit. This appears to have been overlooked by Hooker (1854).

V.15337 shows the external casts of fruits 4 and 5 (both incomplete). Fruit 9 represented by a good internal cast had evidently been removed, by development of the specimen, from **V.15336**. It is seen in Pl. 9, fig. 2 and its position in the inflorescence is indicated by broken lines in Text-fig. 4A.

V.15335 is the counterpart of the lower part of **V.15336** and has more of the stem preserved. It shows clearly whorls of small leaf-scars and associated transverse ridges (cf. Pl. 9, fig. 4). Corresponding branches are labelled *x* and *y* in Text-fig. 4A, B.

ƒ. *S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Carpolithus sp.

Plate 8, fig. 21

V.15356 A small stalked subcircular fruit or pod, truncate at the apex by the perianth scar. Without much more material the characters are insufficient for determination. Length without stalk, 6 mm.; with stalk, 9 mm.; breadth, 10 mm. ƒ. *S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Carpolithus sp.

Plate 8, fig. 22

An unknown seed is represented by a somewhat flattened and crumpled, oval or oboval, semi-translucent internal integument (tegmen?) 1.85 mm. long, 0.8 mm. broad. The seed was probably anatropous. There is evidence of an organ (micropyle?) at the narrower end, and of a sub-circular lobed scar (or two contiguous circular scars) 0.1 mm. broad with fluted edges (chalaza) at the broad end.

The coat appears to be formed of elongate cells which diverge from each end, cells about 0.007 mm. broad or less. There are occasional papillae at the chalazal end sometimes arranged in longitudinal rows.

V.15504a Figured Pl. 8, fig. 22. Seed detached from block (**V.15504**, catalogued under *Laurocarpum* sp.) and now mounted on glass slide. ƒ. *S. Gardner Coll.* Woolwich Beds: Dulwich, Surrey.

Carpolithus sp.

Plate 8, fig. 23; Text-fig. 7

The rounded end of an imperfect but probably ovoid seed; anatropous?, the presence of tubercles at the rounded end suggesting a chalaza.

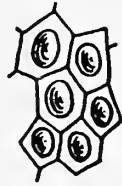


Fig. 7. Testa cells of *Carpolithus* sp. (diagrammatic).

Surface formed of equiaxial angular flat-topped or slightly convex cells, about 0.016 mm. in diameter, each with a central pit or depressed area. Testa about 0.012 mm. thick.

The imperfect condition of the specimen makes closer determination impossible at present. It may be some form of water-lily. Relationship with Thymeliaceae is suggested by the testa surface, but is excluded by the character of the chalazal end.

V.29659 Figured Pl. 8, fig. 23; Text-fig. 7 (diagrammatic). Part of a seed, showing the chalazal end. *A. G. Davis Coll.* Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

Carpolithus sp.

Plate 9, fig. 6

An elongate-oval or sub-ovoid pod or seed, about 15 mm. long, 4.5 mm. broad, may be too ill-characterized for determination without a considerable number of specimens for examination. One end is pointed, the other rounded. There appears to be a stout fibre (or narrow rim or suture line) along both margins. The rim along one margin (on the left) is continued around the rounded end and seems to die out on the opposite (right hand) margin about 3 mm. from the rounded end.

At this point a peduncle-like structure is seen extending 2.5 mm. upwards along the margin. It narrows away from the specimen, curving downwards rapidly. It may be a true peduncle as suggested by a slight indentation on the margin of the seed at this point, or it may be a foreign object accidentally associated with it. There is some slight indication of a coarse network (veins?) covering a marginal region (wing?) about 2 mm. broad along the left hand margin. This 'wing' narrows towards and sweeps around the rounded end of the specimen, dying out at the lower edge of the 'peduncle'. The surface of the netted area or wing is concave. Elsewhere the specimen has a convex surface, transversely striate. Between the peduncle and pointed end along the right hand margin is a very narrow rim or flange, perhaps merely the impression of the thickness of the pod, or testa (if the specimen is a seed).

At first sight this specimen simulates a seed of Acanthaceae with its hook-like retinaculum. The resemblance may be superficial only. The preservation is poor, and the solitary specimen is therefore inadequate for certain determination.

V.15350 Figured Pl. 9, fig. 6. Pod or seed (with curved hook-like peduncle?). *J. S. Gardner Coll.* Reading Beds: Reading, Berkshire.

Carpolithus sp.

Plate 9, fig. 7

An oval or ovoid body, 4 mm. long (as preserved) but incomplete at one end, 3 mm. broad, is represented by a shining, horny or chitinous network of stout fibres. The interstices between the strands are filled by a thin, light brown, filmy coat towards the rounded end of the specimen; elsewhere the film has disappeared (abraded?).

The nature of this object has not been discovered but organisms of a similar character will be described in forthcoming catalogues dealing with material from Lake and later beds. From Reuver (C. & E. M. Reid, 1915: 148, pl. 20, fig. 1) one has already been recorded.

V.40999 Figured Pl. 9, fig. 7. A sac-like organism composed of a horny network of fibres. *S. Hazzledine Warren Coll.* From a 'raft' of derivative Tertiary material in the late-glacial beds of Rikof's Pit, Broxbourne, Hertfordshire. Probably from Reading Beds.

Carpolithus sp.

Plate 4, fig. 14

V.30584 Plug of a seed(?) or seed. A small somewhat inflated sub-lozenge shaped body. The lateral angles of the lozenge are rounded. The margin of the body is sharply angled.

There appears to be a slight mucro at the centre of one surface, possibly indicating an organ. A thin carbonaceous exterior (now flaking off) covers a pyrites internal cast as if the organism had been hollow. Surface with more or less rectangular cells about 0.025 to 0.05 mm. in diameter on the cast, but only 0.007 mm. in diameter on the carbonaceous surface.

Maximum diameter of specimen, 1.026 mm.; diameter across the breadth of the lozenge, 0.684 mm.; thickness, 0.456 mm.

It has not been possible to determine this small obscure specimen.

A. G. Davis Coll. Woolwich Beds IV: City & S. London Tube Extension, Tooting Broadway, Surrey.

THE FLORA OF THE OLDHAVEN BEDS

(see p. 23 of Introduction)

THE PRESERVATION AND MODE OF OCCURRENCE OF THE OLDHAVEN PLANTS

The few plants from Oldhaven Beds here described are poorly preserved, their carbonaceous remains are often unrecognizable and are invariably much rotted; they lie in a hard coarse-grained sandstone and can only be released by fracturing the matrix, which cannot be disintegrated by boiling and sifting as is done with clays and uncompacted sands. The coarse matrix rarely retains the impressions of fine details such as cell-structure, and the carbonaceous entities are very liable to crack and disintegrate on release and are always much

shrunken. The task of recognizing and interpreting the specimens is therefore abnormally difficult and depends to an unusual degree on previous experience of comparable but better preserved fossils from other deposits. It is fortunate that the Oldhaven plants were not examined until experience had been gained from a wide range of Tertiary floras, but unfortunately very few of these were of pre-Ypresian age.

Angiospermae

MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus LIMNOCARPUS Reid emend

Limnocarpus cooperi n. sp.

Plate 9, figs. 8-10

DIAGNOSIS. Germination valve extending from the base almost to the style, having a median longitudinal ridge. Length apart from style about 2.5 mm.; breadth without valve, 1.6 mm. Surface smoother than *L. headonensis* or *L. spinosus*.

HOLOTYPE. V.29662.

DESCRIPTION. *Endocarp*: Sub-ovoid, bisymmetric, curved round a narrow elongate excentric process about half-way between the base of the carpel and the apex of the style (Pl. 9, figs. 9, 10). Style long, straight, patent, terminal on the ventral margin (Pl. 9, fig. 8) surface slightly rugose with a large deep elongate pit (0.2 mm. long) on each face, corresponding to the internal process, directed obliquely downwards towards the ventral margin, its ventral end 0.2 mm. from that margin. Germination valve ovate in outline with a median longitudinal ridge extending from the base of the endocarp to 0.4 mm. from the base of the style. Endocarp about 0.05 mm. thick. Testa shining, cells not distinguishable. Total length of endocarp, including style, 2.9 mm.; length of style about 0.4 mm.; breadth, without germination valve, 1.6 mm.; thickness, 1.5 mm.

REMARKS AND AFFINITIES. Eight specimens. The best is represented by an internal and an external cast almost perfect except for the missing germination valve. Another specimen (V.29663) shows the germination valve with its median ridge.

The specimens are clearly referable to the family Potamogetonaceae and to the genus *Limnocarpus* as indicated by the curved carpel and seed, the character of the condyle and external pit and the germination valve. From *L. headonensis* (Chandler, 1925: 13, pl. 1, figs. 4a-c; Reid & Chandler, 1926: 70, pl. 4, figs. 1-3) and *L. spinosus* (Reid & Chandler, 1926: 71, pl. 4, figs. 4-8) they are clearly distinguished by their much smoother surface. They have been named *L. cooperi* after J. E. Cooper, the finder of all the Oldhaven plants from Bishopstone here described.

V.29662 Holotype, figured Pl. 9, figs. 8-10. An endocarp represented by internal and external casts with remains of carpel wall. Germination valve missing.

- V.29663 An endocarp represented by internal and external casts, showing the germination valve.
 V.29664 A cast with remains of endocarp lying in matrix.
 V.29665-69 Five specimens, some represented by external, others by internal casts, others by both.
 All *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Limnocarpus sp.

Plate 9, fig. 11

A somewhat larger endocarp may represent a second species of *Limnocarpus*. It is an internal cast with remains of a carbonaceous endocarp embedded in matrix. The style appears to have been reflexed and not patent (but possibly this may have been a false appearance due to the obscuring matrix). The short stalk also appears to be slightly reflexed. The lower limb of the curved locule-cast is somewhat longer and narrower than that of *L. cooperi* (cf. Pl. 9, figs. 8-10) and more parallel-sided. The germination valve has not been seen. The lateral surface appears to be somewhat rugose and pitted. Length of endocarp, 3 mm.; breadth (without valve), 2 mm.

In the absence of further material no specific name is given, but the species appears to be distinct, and not merely a larger specimen of *L. cooperi*.

- V.29670 Figured Pl. 9, fig. 11. An endocarp represented by a locule-cast and carbonaceous remains, and a poorly preserved counterpart with external cast. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Limnocarpus (?) *magnus* n. sp.

Plate 9, figs. 12-15

DIAGNOSIS. An endocarp resembling *Limnocarpus* in the inequality of the limbs of the curved locule. Length including style, 5 mm.; breadth about 2.7 mm.

HOLOTYPE. V.29671.

DESCRIPTION. *Endocarp*: Sub-ovoid, bisymmetric, more or less laterally compressed, curved round a shallow internal process (condyle) which lies on the ventral margin nearer to the style than to the base (Pl. 9, figs. 12, 13). Style apical, more or less terminal on the ventral margin, broad at the base, narrow and pointed above (Pl. 9, fig. 12). Germination valve narrow-ovate in outline, extending from the base almost to the apex with a median longitudinal ridge (Pl. 9, figs. 12, 14). Locule-lining of elongate cells with finely sinuous walls. Length of endocarp, 5 mm. (including style); breadth about 2.7 mm. (with valve); without valve (in a second specimen) about 2 mm. Maximum breadth across the valve, 1.5 mm.

REMARKS AND AFFINITIES. Four specimens. One shows an endocarp (locule-cast) lying in the matrix with the external surface (partly exposed) represented by an impression behind it. The valve has begun to open at the apex (Pl. 9, fig. 12). The seed-cast (lying within the locule-cast) is exposed in patches by abrasion. Parts of the cast are pyritized. The second specimen shows a locule-cast (without valve) lying in the matrix (Pl. 9, fig. 13). A third is an internal cast, somewhat incomplete, with external impression and internal cast of the dorsal surface showing the valve (Pl. 9, figs. 14, 15).

The curved endocarp and dorsal germination valve indicate Potamogetonaceae. The closer relationship is doubtful. The two limbs of the locule and seed are unequal as in *Limnocarpus*. The endocarp is twice as large as *L. cooperi* (p. 93) from the same deposit, and more than twice as large as *L. headonensis* from Upper Eocene and Oligocene deposits. The species

should perhaps be referred to a distinct genus. It is smaller than *Cymodocea*, a tropical and sub-tropical genus of the family.

- V.29671 Holotype, figured Pl. 9, fig. 12. An endocarp lying in matrix, abraded so as to expose the locule-cast and in parts the seed-cast. The style (*st.*) and germination valve (*v*) can be distinguished.
- V.29672 Figured Pl. 9, fig. 13. An internal cast of an endocarp, without its germination valve, lying in the matrix. The external impression of the style is exposed where part of the apical end of the internal cast was broken in developing the specimen (*st.*). There is a star-fish on the same block close to the fruit.
- V.29673 Figured Pl. 9, figs. 14, 15. An external impression showing the germination valve, and an incomplete internal cast of the same specimen showing the curved form and internal process.
- V.29674 Part of an external cast of an endocarp showing the impression of the ridged germination valve. Also the internal cast somewhat broken showing the valve and (rather obscurely) the curvature of the endocarp.
- All *ŷ. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

DICOTYLEDONES

Family MENISPERMACEAE

Sub-section COCCULINAE Diels

Genus CANTICOCCULUS nov.

DIAGNOSIS. Endocarp referable to Cocculinae and resembling those of *Cocculus* in the marked inflation of the marginal locular area and in the deep depressed median area embraced by it. Differing from *Cocculus* in the sub-parallel ends of the limbs, the straight not incurved cotyledonary limb, the convex ventral margin, and the almost smooth, not transversely ribbed, inner side of the inflated locular area.

TYPE SPECIES. *Canticocculus cooperi* n. sp.

Canticocculus cooperi n. sp.

Plate 9, figs. 16–20

DIAGNOSIS. That of the genus.

HOLOTYPE. V.29675.

DESCRIPTION. *Endocarp*: Somewhat laterally compressed, splitting marginally into symmetrical halves, curved so as to form an inflated marginal locular area which embraces between its limbs a flattened depressed area on each surface as in Cocculinae (Pl. 9, fig. 16). The limbs are unequal in length and breadth, the styler limb being narrower, somewhat longer, and more pointed than the other which is broader and rounded at its extremity; the free ventral edge of the flattened areas is convexly angled. The marginal area over the locule has a narrow, almost linear rim, and a much inflated outer area boldly ornamented with fifteen or sixteen radial ridges. These terminate inwards against a horse-shoe shaped ridge which is emphasized on its inner side by a parallel deep narrow groove interrupted by a few coarse nodules. Next comes an inner inflated almost smooth part which abuts upon and arises abruptly from the depressed central area (Pl. 9, fig. 16). The central area is pierced from side to side by an elongate oval

foramen (Pl. 9, fig. 20), with its axis directed longitudinally, rather nearer to the stylar than to the other limb and about 0.2 mm. from the ventral margin. The walls of the endocarp are woody, somewhat fibrous in texture, the locule is lined by a shining coat showing criss-cross striations about 0.006 to 0.007 mm. broad; this coat penetrates into the flat stylar canal which pierces the tip of the narrow pointed limb. Diameter of endocarp, 2.6 mm.

Seed: Horse-shoe shaped, testa formed of equiaxial cells 0.01 to 0.012 mm. in diameter.

REMARKS AND AFFINITIES. One external cast of an endocarp with remains of the endocarp itself and of the enclosed solitary seed. The horse-shoe shaped locule with its characteristic external ornamentation of radial ridges and the smooth depressed area between the limbs at once relate the specimen to the sub-section *Cocculinae* of the family *Menispermaceae* and this relationship is confirmed by the detailed structure. The marked degree of inflation of the locular area, and the deep depression between the limbs, point to relationship with *Cocculus*. But the fossil cannot be placed in the living genus for the ends of the limbs are sub-parallel, whereas in *Cocculus* they converge so that they are brought close together, the cotyledonary limb being incurved. Hence in the fossil the greatest distance between the limbs is at the base below the foramen, but in *Cocculus* it is about the middle, above the foramen. The ventral margin is distinctly convex in the fossil, whereas in *Cocculus* it is concave. Further, although the curved inflated locular area is of about the same width in the fossil and in *Cocculus*, in the fossil its broad inner part is almost smooth but in *Cocculus* almost its whole breadth is transversely ribbed. A new generic name, *Canticocculus*, has therefore been given, the species being named *C. cooperi*, after the finder, Mr. J. E. Cooper.

V.29675 Holotype, figured Pl. 9, figs. 16-20. An external impression and remains of an endocarp and seed. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Genus ?

Plate 9, fig. 21; Pl. 10, figs. 1-3

Five fragments of horse-shoe shaped endocarps showing the characteristic form and sculpture of *Cocculinae* are too incomplete for determination.

One of them (V.29676; Pl. 9, fig. 21) shows the stylar limb which lies embedded in matrix; part of the locule-cast still remains within the locule. As the external surface cannot be seen, the identity is extremely doubtful but there is evidence of transverse ribbing. It agrees in size with that next to be described.

The second fragment (V.29677; Pl. 10, figs. 1-3) is part of the marginal locular area of a highly ornamental endocarp with conspicuous marginal ridge in the plane of symmetry. Two horse-shoe shaped channelled ridges overlie the locule, one on each side of the endocarp, and there are sharp close-set transverse ridges arising from each horse-shoe shaped ridge and ending abruptly about half-way between it and the margin of the endocarp (Pl. 10, figs. 2, 3). Part of the external impression of the same endocarp is seen in Pl. 10, fig. 1.

A third specimen (V.29678) shows the interior of a poorly preserved valve lying in matrix. It is about 3 mm. broad (measured across the two limbs), and about 2.3 mm. long (measured along the axis between them). There are sharp transverse ridges arising from a horse-shoe shaped ridge and dying out on the marginal area. The locule is horse-shoe shaped, curved

around a triangular condyle about 10 mm. broad and high arising from the ventral wall. The exact dimensions are difficult to determine in the decayed state of the endocarp.

The fourth specimen (V.29679) originally showed the ribbed carbonaceous exterior, but it has now decayed and is represented only by an obscure external cast.

There is also one other tiny fragment of an endocarp (V.29680) lying in matrix.

It seems probable that all belong to a single genus and species.

All the above are *f. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Genus MENISPERMICARPUM Chesters, 1957: 42

Menispermicarpum serratum n. sp.

Plate 10, figs. 4-9; Text-fig. 8

DIAGNOSIS. Endocarp of the type found in Cocculinae. Ornamented with three broad, conspicuously serrated thin flanges, one about 1.4 mm. deep, median marginal, the other two only about 0.7 mm. deep, over the lateral angles of the locule, reflexed so as to lie more or less parallel with the marginal flange. Close fine transverse laminae connect the median and lateral flanges. Diameter of endocarp about 5 mm.

HOLOTYPE. V.29681.

DESCRIPTION. *Endocarp:* Laterally compressed, splitting marginally into symmetrical valves; curved so as to form an inflated sub-marginal horse-shoe shaped locule; locule sub-triangular in transverse section, slightly convex on the dorsal side, sharply angled on the ventral side (Pl. 10, figs. 5, 9) decreasing in diameter towards the ventral extremities. Between the limbs of the locule lie two lateral depressed areas, as in Cocculinae, which in this species are concave (Pl. 10, figs. 4, 7, 9). Endocarp wall ornamented externally over the horse-shoe shaped locule by three conspicuous thin flanges, one median through which marginal splitting occurs, two lateral over the angles of the locule (Pl. 10, figs. 8, 9; Text-fig. 8). The margins of the flanges are conspicuously serrate. Flutings corresponding to the serrations of the lateral flanges are produced to the margins of the central depressed areas (Pl. 10, fig. 7; Text-fig. 8A). The median flange is about 1.4 mm. deep, the lateral flanges are about half as broad and are re-curved so as to lie more or less parallel with the marginal flange. Between the median and lateral flanges are thin laminae transverse to the length of flanges and locule (Pl. 10, figs. 6, 8; Text-fig. 8A, C). Endocarp wall about 0.7 mm. thick where measured, formed superficially of radially directed fibres, locule-lining formed of criss-cross fibres. Diameter of endocarp measured through the attachment about 5 mm.; estimated breadth measured across two limbs about 5 mm.

Seed: Solitary, horse-shoe shaped, testa formed of equiaxial cells 0.025 mm. in diameter. Maximum dorsiventral diameter of locule (seed) about 1 mm.; breadth from side to side about 1 mm.

REMARKS AND AFFINITIES. The specimen was entirely embedded in sandstone and was exposed, in section, by a chance fracture passing through the base of the endocarp, the lateral depressions, the inflated locule and the three flanges (Pl. 10, fig. 9).

When an attempt was made to remove the matrix so as to expose the fossil, it broke into fragments, some of which were lost. Portions of the locule and seed, and parts of the flanges

and locule-cast, were seen lying in the stone. The manner of preservation and the fragmentary character of the remains make it difficult to illustrate this specimen, and the base is incomplete so that the foramen which pierces the central depression between the limbs has not been seen.

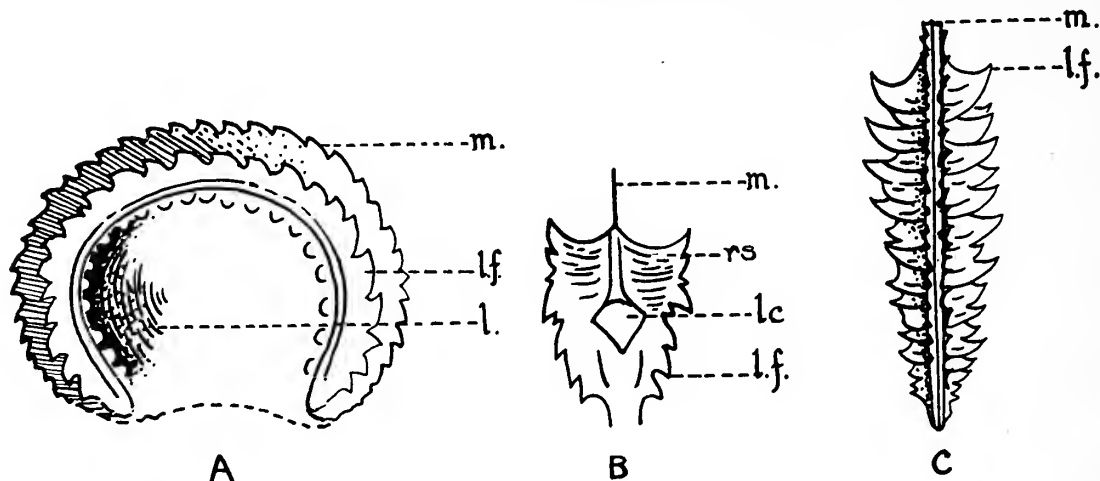


Fig. 8. *Menispermicarpum serratum* n. sp. A, diagrammatic restoration of side view, foramen not seen. Base hypothetical. B, lateral section as in Pl. 10, fig. 8. C, looking on to margin showing transverse laminae between the flanges. *l*, lateral hollow; *lc*, remains of locule-cast; *lf*, lateral recurved flange; *m*, median flange in plane of symmetry; *rs*, ridged surface due to transverse laminae between median and lateral flanges.

The laterally compressed endocarp with sub-marginal, horse-shoe shaped locule, and the details of anatomical structure, all indicate relationship with the section Cocculinae of the family Menispermaceae. No comparable living endocarps with broad serrated flanges have so far been seen. In view of the poor preservation, however, a new generic name has not been given but the fossil has been referred to the form-genus *Menispermicarpum*.

V.29681 Holotype, figured Pl. 10, figs. 4-9; Text-fig. 8. Remains of a specimen represented by six broken fragments of external cast, locule-cast, endocarp and seed. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone Herne Bay, Kent.

Section TINOSPORA Diels

Genus TINOSPORA Miers

Tinospora excavata Reid & Chandler

Plate 10, figs. 10-13

1933 *Tinospora excavata* Reid & Chandler, p. 165, pl. 4, figs. 7-10; text-figs. 3, 4.

The discovery of additional better preserved specimens of *Tinospora excavata* shows that the external surface of the endocarp was originally tubercled as in many living species, the internal cast (the part usually preserved) being smooth. It is necessary, therefore, to amend the diagnosis of the species as follows:

AMENDED DIAGNOSIS. Endocarp finely and conspicuously tubercled externally, with a conspicuous sharp median ridge on the dorsal surface, and small ventral aperture about 1.3 by 1.1 mm. in diameter. Locule-cast smooth with inconspicuous ridge on the dorsal surface, and fairly sharp ridge on the ventral surface, the aperture to the ventral hollow being about 2.5 mm. in diameter.

DESCRIPTION. A detailed description of the species based on the new material (V.29825) is given on p. 153. The upper part of the distinctive boat-shaped endocarp of a *Tinospora* is preserved as an external and internal cast with the carbonaceous endocarp lying between the two. On exposure to the air the carbonaceous substance cracked and chipped away, but not before microscopic examination had shown the characteristic structure of fine criss-cross cells or fibres seen in endocarps of Menispermaceae. Criss-cross cells or fibres also form the smooth locule-lining. The external surface of the endocarp is covered with blunt-ended tubercles (Pl. 10, fig. 13); it was formed by narrow elongate cells arranged in clusters radiating from the tubercles, the cells being about 0.009 to 0.01 mm. broad. The endocarp was originally hemispherical or gibbous in profile, with a median dorsal ridge, and deep ventral depression, one margin of which is preserved at the stylar end (Pl. 10, fig. 10). The specimen appeared to fade out just below the middle, its lower half was not embedded in the stone as shown by chipping. Length (estimated) about 7 mm.; breadth about 5.5 mm.

The incomplete condition of this specimen, together with the mode of preservation, make it difficult to illustrate in a convincing manner, but to anyone acquainted with the endocarps of *Tinospora* the material itself is unmistakable, agreeing both in form and detailed cell-structure with this genus. It falls within the range of size of *T. excavata* and is almost certainly referable to that species.

V.29682 Figured Pl. 10, figs. 10-13. Part of the external and internal cast of an endocarp with fragments of carpel now fallen away. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family LAURACEAE

Genus LAUROCARPUM Reid & Chandler, 1933: 225

Laurocarpum (*Cinnamomum*?) sp.

Plate 10, fig. 14

A sub-globular endocarp, now crushed, lying in the matrix, is clearly referable to Lauraceae, and perhaps to the genus *Cinnamomum*. The exocarp and endocarp are seen in section, the locule or seed-cast is exposed over most of the surface by the abrasion of these integuments. A gap in the endocarp may be accidental, or may mark the foramen for the funicle (Pl. 10, fig. 14). The exocarp is formed of more or less equiaxial slightly sinuous cells which appear to have been secreting and are about 0.025 mm. in diameter. The thickness of the coat as preserved is about 0.075 mm. The epicarp cannot be distinguished. The endocarp is well defined, about 0.2 mm. thick, formed of columnar cells as seen in section, and of small equiaxial polygonal cells as seen in surface view. Remains of the testa, and impressions on the calcite cast of testa cells show that it was formed of large thin-walled sinuous secreting cells sometimes as much as 0.1 mm. in diameter. The chalaza cannot be distinguished and may of course be on the surface of the specimen embedded in the stone. In the absence of further

evidence from better material it is not possible to determine the specimen more definitely, but of the family relationship there can be no doubt, while the size and coats suggest *Cinnamomum*. Diameter of berry, 6.5 mm.

V.29683 Figured Pl. 10, fig. 14. A crushed berry. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Laurocarpum sp.

Plate 10, figs. 15-17

A second species of the family Lauraceae is represented by a locule-cast with partially embedded fragmentary remains of a columnar endocarp. The cast is pointed-ovoid, with a transverse scar (the funicular opening) immediately below the pointed apex (Pl. 10, fig. 15). The extent of the chalaza appears to be indicated by an approximately transverse but somewhat irregular and oblique constriction of the surface situated just above the middle of the cast (Pl. 10, figs. 15, 17). Between this constriction and the pointed apex there is a longitudinal angle on the surface opposite to the funicular opening, which probably corresponds with the raphe on the enclosed seed (Pl. 10, fig. 17). Length of cast, 5.5 mm.; diameter, at right angles to plane of raphe, 4.25 mm.; diameter in plane of raphe, 4 mm.

The endocarp is smaller than most of the London Clay lauraceous species and differs from the smallest, *L. minutissimum*, in having a much larger chalaza and a more pointed and longitudinally-angled endocarp. It appears to differ in form from the two other species described from the Oldhaven Beds.

V.29684 Figured Pl. 10, figs. 15-17. A locule-cast with remains of endocarp. Also part of the external cast lying in the matrix. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Laurocarpum sp.

Plate 10, fig. 18

An ovoid berry about 8 mm. in length and with an estimated breadth of about 5 mm. (actually now incomplete) must be referred to the family Lauraceae, although the state of preservation makes closer determination inadvisable. It has a shining epicarp formed of equiaxial cells, 0.016 mm. in diameter, and an endocarp, 0.05 mm. thick formed, as seen in section, of columnar cells.

V.29685 Figured Pl. 10, fig. 18. Remains of an ovoid berry. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family RUTACEAE

Section ZANTHOXYLEAE

Genus ZANTHOXYLON Linnaeus

Zanthoxylon sp.

Plate 10, figs. 19-21

DESCRIPTION. *Seed*: Subcircular in outline, truncate at the hilar end, somewhat laterally compressed. Hilar scar narrowly triangular, about 1.8 mm. long with the micropyle at its

narrow end, and the hilar aperture, where the raphe penetrates the testa, at its broad end. Chalaza marked by a large circular hole on the inner face of the testa at the opposite pole to the micropyle (Pl. 10, fig. 21), and by a black circular scar, 0.7 mm. in diameter, on the tegmen. Testa somewhat rough, formed of equiaxial cells about 0.025 mm. in diameter, giving a pitted surface; wall formed of hard compact parenchyma, varying in thickness from 0.2 to 0.25 mm.; within is a thin brown coat fused with the thick outer coat. Tegmen free from the testa, semi-translucent, formed of oblong or equiaxial cells, 0.025 mm. in diameter, with a tendency to be aligned in rows. Diameter of seed, 2.5 by 2.5 mm.; thickness about 2 mm.

REMARKS AND AFFINITIES. One seed, now broken to show the structures described above. The form and the character of the hilum, raphe and chalaza, indicate relationship with the family Rutaceae and probably with the section *Zanthoxyleae*. There is a strong resemblance to the genus *Zanthoxylon* itself. But in living *Zanthoxylon* seeds, there appears to be a coat of thin-walled honeycomb cells between testa and tegmen, the coat varying in thickness in different species. No such coat has been seen in the fossil; probably its absence may be accounted for by decay due to fossilization.

In the Bembridge flora, Reid & Chandler (1926) referred a seed of somewhat similar form to *Zanthoxylon*?, but it had a more ornamental surface than the species here described. It, too, had no coat of honeycomb cells between testa and tegmen.

V.29693 Figured Pl. 10, figs. 19-21. A seed now broken. It shows the raphe and chalaza. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family EUPHORBIACEAE

Genus ?

Plate 10, fig. 22

Fruit: Sub-globular or ovoid, syncarpous with central axis, probably originally 5-loculed, now split longitudinally and represented by two locule-casts only, lying in the carbonaceous remains of the carpels which are embedded in matrix. Ventral margins of carpels straight where they abut on the central axis, dorsal margins convex, transverse section triangular or wedge-shaped.

The fruit has split septically. The top of the axis is obscure but appears to lie somewhat above the middle of the fruit. From it, a stout vascular bundle traverses the face of the septum obliquely to the exterior of the fruit. Surface of septum shining, thickness of septum formed of diagonal fibres. The specimen is poorly preserved, and no trace of the seeds has been seen. The structure of the septum, with its stout, oblique, vascular bundle, indicates Euphorbiaceae, but the evidence is too poor to admit of generic or specific diagnosis.

V.29694 Figured Pl. 10, fig. 22. A fruit embedded in matrix, longitudinally fractured so as to expose two septa and locules. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family ICACINACEAE

Genus NATSIATUM Buch.-Ham.

Natsiatum eocenicum Chandler (see p. 76)

Plate 10, figs. 23-26

DESCRIPTION. *Endocarp*: Ovate in outline, lenticular in cross-section, rounded at the base, somewhat pointed at the apex, angled at the margin; ornamented externally with numerous, irregularly arranged, shallow, concave areas separated by ridges, a few of the stronger ridges being aligned longitudinally. One conspicuous longitudinal ridge on each face arises from the basal attachment. The concave areas are sometimes partially sub-divided by incomplete ribs. On the worn endocarp with its internal cast the ridges appear low and rounded. The impression of the apex (V.29686) shows the style and projections which flank it; the funicle is marginal in the thickness of the wall on one side. The locule-lining is finely papillate, the papillae about 0.03 to 0.05 mm. apart. Estimated length of incomplete endocarp, 8 mm.; estimated breadth, 6.5 mm. Length of abraded endocarp with locule-cast, 7 mm.; breadth, 5.5 mm.

REMARKS AND AFFINITIES. Four specimens and remains of three others. One is preserved as an external impression with the abraded endocarp (detachable) enclosing a locule-cast. A second is represented by an external impression only. The third is a poorly preserved, much abraded valve of an endocarp. The others show poor or incomplete casts and external impressions. The specimens are clearly referable to the Icacinaceae, while the structure, ornamentation and regularly papillate locule-lining indicate *Iodes* or *Natsiatum*. They have been compared with specimens of *Natsiatum eocenicum* from the Lower Bagshot of Lake, Dorset, the Blackheath Beds of Chislehurst, Kent (see p. 110) and from the Lea Valley (derivative), p. 76 (Pl. 7, figs. 14, 15). While there is some difference of appearance due to the degree of abrasion of the Oldhaven fruits, it does not seem possible to distinguish them from that species in spite of their somewhat smaller size.

- V.29686 Figured Pl. 10, figs. 23-25. An abraded endocarp and its external cast. Owing to the degree of battering which the specimen has undergone, the sharpness of the surface reticulations has been destroyed, but it can be seen in the external cast itself which also shows projections flanking the style (not seen in figure).
- V.29687 Figured Pl. 10, fig. 26. An external cast of another endocarp.
- V.29688 One valve of an endocarp, much encrusted externally with sand and showing the locule wall. The specimen is broken obliquely.
- V.29689 An internal cast with abraded remains of endocarp and external impression.
- V.29690 An incomplete external impression (much worn) on a block with *Vitis* sp.
- V.29691-92 Fragments of two endocarps embedded in matrix with the external cast.
All *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family RHAMNACEAE

Genus ?

Plate 11, figs. 1-5; Text-fig. 9

DESCRIPTION. *Seed*: Anatropous, much compressed so as to be lenticular in section, sub-circular in outline, but somewhat flattened or truncate at the chalazal end, rounded at the opposite end. Hilum on the median line of one broad surface, about 0.5 mm. below the

rounded margin, raphe median on the same side of the seed, ventral, short, about 0.7 mm. long opening at its inner end into a large chalazal cavity about 0.6 mm. long (Text-fig. 9C). Inner chalaza marked by a circular gaping aperture leading into the seed-cavity (Pl. 11, fig. 5; Text-fig. 9B, c). The inner walls of the chalazal cavity are thin, and impinge closely on the testa on the dorsal side leaving an impression on the lining of the seed (Pl. 11, fig. 2). Seed-cavity and detachable tegmen sub-reniform, pointed at the micropyle, emarginate at the chalaza where the tegmen lies athwart the aperture and protuberance of the chalazal cavity (Pl. 11, fig. 1; Text-fig. 9A). Chalaza scar circular. Micropylar scar black, conspicuous. Testa of variable thickness, the maximum thickness about the chalaza, 0.26 mm.; elsewhere about 0.17 mm., the hard compact coat formed of equiaxial cells about 0.025 mm. in diameter arranged in radial rows giving a 'beaded' columnar effect. Internal surface striate, cells about 0.001 mm. broad diverging from the chalaza.

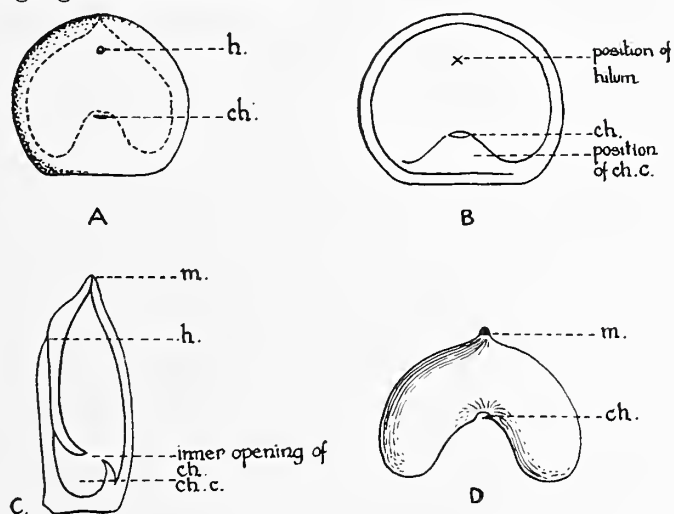


Fig. 9. Rhamnaceae, Genus? A, outline of seed. Dotted outline shows position and form of tegmen within. B, longitudinal section parallel with plane of flattening. C, longitudinal section through seed at right angles to plane of flattening. D, detached tegmen of seed. *ch*, chalaza; *ch. c.*, chalazal cavity; *h*, hilum; *m*, micropyle.

Outer layers of tegmen formed of equiaxial cells, 0.016 mm. in diameter. Inner layers translucent, shining, striate, formed of elongate cells, 0.008 to 0.01 mm. in diameter, which diverge from the micropyle and chalaza. The cells of both integuments are also aligned concentrically around the micropylar scar. Maximum diameter of seed, 2.3 mm.; length from micropyle to chalaza, 1.3 mm.

REMARKS AND AFFINITIES. One seed with testa and tegmen preserved. Testa now badly shattered owing to its brittle condition. The characters of the seed, its cell-structure as seen in section, the character of the chalazal scar, and the wall around it arising as a thin flap from the testa all suggest Rhamnaceae of the shape of *Noltea*. Identity with a living genus has not yet been established.

V.29695 Figured Pl. 11, figs. 1-5; Text-fig. 9. A seed, now in fragments, and remains of tegmen. It was originally perfect but was extremely brittle and broke when removed from the matrix. *J. E. Cooper Coll.* Oldhaven Beds; Bishopstone, Herne Bay, Kent.

Family VITACEAE

Genus VITIS (Tourn.) L.

Vitis sp.

Plate 11, figs. 6-8

A species of *Vitis* appears to be represented by four specimens. Three are external impressions showing the ventral surface only with the hilar end which, in two of the specimens, is partially embedded in the stone. The fourth is a somewhat asymmetric and distorted calcite cast showing both surfaces, and an impression in the matrix of the larger facet of the ventral surface. In size and general structure, the specimens are comparable with one another so far as they are known, but evidence as regards the dorsal surface is absent in three seeds.

One specimen (Pl. 11, fig. 6) is a seed with rounded contours. The ventral infolds (represented by ridges on the cast) are about 1.6 mm. long, and are somewhat nearer to the base than to the apex of the seed; they flank a rounded raphe-ridge and are very slightly concave towards it, the breadth across the ridge being 0.6 mm. at the base, 0.9 mm. about the middle, 0.7 mm. at the apical end. The base is stipitate. There is some evidence of a furrow at the apex of the seed towards the dorsal side. Remains of testa, 0.15 mm. thick, lie within the cast; its surface is formed of equiaxial cells both internally and externally, 0.016 mm. in diameter. It is columnar in section. Estimated length of seed (difficult to measure owing to buried base), 3.4 mm.; breadth, 2.6 mm.; depth (as broken), 1.5 mm. (probably about 1.8 mm. when perfect).

The mode of preservation as a hollow cast in the stone makes the specimen difficult to illustrate adequately, and the absence of information about the dorsal surface makes comparison with other specimens incomplete, and specific determination unsatisfactory. The generic characters are clearly those of *Vitis*.

The two other external casts are similar but rather broader (length, 3.5 mm.; breadth about 3 mm.), and one is somewhat asymmetric having one ventral facet considerably wider than the other.

The fourth specimen, a seed originally with rounded contours, has suffered considerable distortion both during growth and fossilization. The facets of the ventral surface are very unequal and the seed has undergone some measure of lateral folding and compression so that the facets lie one upon the other and only one can be clearly seen at a time. The internal cast in calcite is incomplete at the hilar end. As distorted, the seed appears roundly triangular, pointed at the base, somewhat emarginate at the apex. The infolds of the ventral surface are very slightly concave to the raphe-ridge and lie nearer to the broken base than to the apex of the seed. They diverge upwards and occupy about two-thirds of the total length of the seed (Pl. 11, figs. 7, 7a). The raphe-ridge, which appears narrower than it really is because it is folded on itself, broadens upwards and is narrowly triangular. The dorsal face has a more or less median oval chalaza about 1 mm. long as measured on the cast (Pl. 11, figs. 8, 8a). There is a median longitudinal groove extending from the chalaza to the base and apex (Pl. 11, figs. 8, 8a). Testa columnar seen in the infolds. Length of cast, 3.5 mm.; breadth, 3 mm.

REMARKS AND AFFINITIES. The size of the seeds and character of the ventral infolds suggest that they belong to a single species, but as stated above, the evidence at present available is not quite conclusive.

- V.29696 Figured Pl. 11, fig. 6. A seed represented by the external cast of the ventral surface.
- V.29697 Figured Pl. 11, figs. 7, 8. An internal seed-cast in calcite (broken at the extreme hilar end), also an external cast of one facet of the ventral surface.
- V.29698 An external cast showing the ventral surface of a somewhat broader and slightly asymmetric seed.
- V.29699 Another external cast (ventral surface). There is also a cast of a second larger species of *Vitis* (see below) and part of a poorly preserved external cast of *Natsiatum eocenicum* (see p. 102).
All the above *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Vitis sp. (*V. obovoidea*?)

Plate 11, figs. 9, 10

A second more distinctive species of *Vitis* is represented by two external casts. One is an impression of a seed, ventral surface (imperfect on one side), the other of the very imperfect dorsal surface of a second seed showing the chalaza.

The seed is large, rounded and scarcely emarginate at the apex, stipitate at the base. The ventral infolds are deep and rather short and narrow (about 3 mm. long) occupying only about half the length of the seed, situated much nearer to its base than to its apex, they are almost straight with a conspicuous narrow parallel-sided raphe-ridge between them (Pl. 11, fig. 9). Part of the testa (columnar in section) was originally preserved over the raphe-ridge but has now fallen away.

The second specimen showing the incomplete dorsal surface appears to belong to the same species as it is comparable in size and form (so far as this is preserved). It shows a slight channelling below the large oval chalazal scar (Pl. 11, fig. 10). Length of a seed represented by a ventral cast, 6.5 mm.; breadth about 4 mm. Length (imperfect) of a second seed represented by dorsal cast about 3 mm.; breadth about 4 mm. Length of chalaza scar as preserved, 1.2 mm.; breadth of scar, 0.8 mm.

REMARKS AND AFFINITIES. The cast of the dorsal surface needs careful interpretation. It represents the lower half of a seed which is also imperfect at the base. The upper end above the chalaza is not preserved at all on the fragment of stone. The fact that it is the lower half is clearly shown by the form of the chalaza. This organ always narrows towards the apex of the seed where it merges into the raphe. The absence of the stipitate base owing to the angle at which the surface of the stone cuts the impression gives, at first sight, a misleading idea that it is the apex of a seed which is preserved. These casts do not appear to be identical with any fossil species so far seen, although they are not wholly unlike *V. platyformis* from Sheppey and they closely resemble *V. obovoidea* from Bognor and Nursling, but the Oldhaven fossil is more slender and stipitate than either of these species, possibly because it is represented by an internal cast.

In view of the limitations of the material, no definite attempt to define them specifically has been made.

- V.29699 Figured Pl. 11, fig. 9. A seed represented by the external cast of the ventral surface.
Figured Pl. 11, fig. 10. Part of a second seed represented by an external cast of the dorsal surface. The stipitate base and the upper part of the seed are not preserved. The oval chalaza is clearly seen. Specimen now decayed.
Both *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Vitis sp.

Plate 11, fig. 11

A small seed, about 2.3 mm. long and 2 mm. broad, is represented by a calcite cast, now broken, lying in the matrix.

The seed seems to have been sub-globular, but sharply pointed at the base and possibly shortly stipitate. The apex is broken. The testa seen in section is columnar. The surface of the cast shows longitudinally aligned equiaxial cells about 0.016 mm. in diameter. The dorsal surface of the cast has chipped away, exposing a longitudinal section, in which the two ventral infolds appear projecting into the calcite-filled seed-cavity. They are represented by two broad longitudinal rounded parallel ridges.

The specimen is so much smaller and more globular than the two previously described species that it must certainly represent a third species of *Vitis* in the Oldhaven Beds. The material is too limited to justify the giving of a specific name.

V.29699 Figured Pl. 11, fig. 11. A calcite seed-cast, broken on the dorsal side. *J. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Vitis sp.

Plate 11, fig. 12

V.29700 Figured Pl. 11, fig. 12. A fragment of a *Vitis* seed showing a stipitate base and rounded internal chalazal scar about 0.6 mm. in diameter. Only the internal cast of the basal end (dorsal surface) is preserved, and the fragment is too imperfect for closer determination. The columnar testa is seen in section embedded in the stone.

J. E. Cooper Coll. Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family MYRTACEAE

Section MYRTINAE Niedenzu

Genus MYRTOSPERMUM* Chandler, 1957: 111

Myrtospermum cooperi n. sp.

Plate 11, figs. 13-17

DIAGNOSIS. Outer coat of testa of coarse prismatic cells three deep and aligned at right angles to the surface in the dorsal wall, radially elongate and diverging from the condyle between the limbs over the lateral surfaces of the seed. Inner coat compact formed of two or three layers of small equiaxial cells. Seeds smaller than those of *Palaeorhodomyrtus subangulata* (Bowerb.), about 2 to 2.5 mm. in diameter.

HOLOTYPE. V.29701.

DESCRIPTION. *Seed*: Laterally compressed, gibbous or subcircular in outline, cavity U-shaped. Testa thick, especially over the dorsal margin, formed externally of large prismatic or bolster-shaped cells, three deep in the dorsal wall, aligned at right angles to the surface (Pl. 11, figs. 13, 17), producing superficial nodulations (depressions where the walls have collapsed).

* While this work was in the press the writer's attention was called by Professor P. I. Dorofeev to the resemblance between '*Myrtospermum*' and *Eurya* (Theaceae). Examination of Theaceae suggests that '*Myrtospermum*' ought to be included in section Taonabeae. A revision will shortly be published in a Museum Bulletin on the Hengistbury and Barton floras.

Over the lateral faces, the large superficial cells diverge from an area between the limbs of the U-shaped embryo (Pl. 11, fig. 14), they are radially elongate, and increase in size towards the margin, some of the larger measuring 0.2 by 0.05 to 0.1 mm. in diameter. Within the layers of coarse cells and immediately surrounding the seed-cavity are two or three compact layers of equiaxial cells 0.016 mm. in diameter (Pl. 11, fig. 13). Limbs of seed-cavity somewhat unequal in length and diameter, chalazal limb in one specimen 0.6 mm. broad, micropylar limb, 0.45 mm. broad, usually longer than the chalazal limb; chalaza sub-terminal on the inner angle of the shorter limb (Pl. 11, fig. 15). Tegmen formed of equiaxial cells, 0.016 to 0.025 mm. in diameter, aligned transversely to the limb except around the micropyle where they are longitudinally aligned and elongate.

Diameter of a seed measured across the two limbs, 2.5 mm.; diameter at right angles to the last measured from the hilum, 2 mm. Diameters of a second and third seed 2.2 by 2.2 mm. and 2.5 by 2.5 mm. respectively.

REMARKS AND AFFINITIES. The species is represented by five specimens. The best preserved seed originally showed the external impression, carbonaceous testa, and internal cast (now lost) of the U-shaped seed-cavity. Two other external casts show the coarse cells of the testa, while one of them shows part of the carbonaceous coat itself and a cast of one limb of the seed-cavity. There are also a poorly preserved external impression with decayed testa, and a U-shaped seed-cast belonging to a fifth specimen.

The U-shaped seed-cavity and testa structure indicate relationship with the Myrtaceae of the section Myrtinae. The seeds have been referred to the form-genus *Myrtospermum*, under the specific name *M. cooperi* after the finder.

M. cooperi differs from any living Myrtaceae seed so far seen in the thick compact coat which lines the seed-cavity and lies within the outer coat of coarse bolster-shaped cells. A similar coat is seen in the much smaller seeds of the fossil species *Myrtospermum variabile* (see pp. 80, 108).

In its form and coarse testa cells it resembles the living genus *Rhodomyrtus*, and the fossil *Palaeorhodomyrtus* from the London Clay. These two genera differ from one another in the arrangement of the seeds in the fruits. As the arrangement of the seeds is unknown in the Oldhaven fossil, it is uncertain to which of the two it is most closely akin. Both differ from it in the absence of the thick compact coat of small cells lining the seed-cavity.

The seeds of *Palaeorhodomyrtus subangulata* are on the whole larger than those of *M. cooperi* while its radially arranged testa cells also appear to be larger (Reid & Chandler, 1933: 436, pl. 23, figs. 21-31).

M. cooperi differs from all hitherto described fossil species of *Myrtospermum*.

- V.29701 Holotype, figured Pl. 11, figs. 13-15. An external cast of a seed with remains of carbonaceous endocarp (Figs. 13, 14), and internal cast (Fig. 15), the last unfortunately lost after photography.
- V.29702 Figured Pl. 11, fig. 16. An external impression showing the coarse cells of the testa.
- V.29703 Figured Pl. 11, fig. 17. Seed lying in matrix with coarse cells of testa and finer inner layers. Also the cast of one limb of the seed-cavity and counterpart of the seed.
- V.29704 An incomplete seed showing the chalazal limb, also the poorly preserved external cast.
- V.29710 An internal cast, possibly referable to this species, embedded in matrix. On block with a specimen of Epacridaceae, Genus? (see p. 108).
- All ♀. *E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Myrtospermum variabile Chandler

Plate 11, fig. 18

A subcircular seed represented by an internal impression of one valve about 1.6 mm. in diameter. The U-shaped cavity is seen clearly, the limbs are shorter and thicker and more closely approximated to one another than in *M. cooperi*, hence the condyle between the limbs is relatively narrower. There are indications of coarse testa cells at the circumference of the seed-cast and of the finer cells of which the wall is built up in fragments of testa still remaining at the base of the seed. The specimen agrees in form, character and size with *Myrtospermum variabile*, a species already described on p. 80 from the Woolwich and Reading Beds.

V.29705 Figured Pl. 11, fig. 18. The impression of the inner surface of one valve of a seed showing U-shaped cavity and condyle between the limbs. *f. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Myrtospermum sp.

Plate 11, figs. 19, 20

DESCRIPTION. *Seed*: Laterally compressed, with U-shaped cavity (most of the chalazal limb missing); micropyle terminal, gaping, 0.35 mm. in diameter at the extremity, narrowing to 0.25 mm., and then broadening to the limb which is 0.55 mm. in diameter (Pl. 11, fig. 19). Testa on the exterior of the micropylar limb 0.75 mm. thick, condyle poorly preserved, broad. Cells of cavity, 0.016 to 0.025 mm. in diameter, aligned transversely to the length of the limb. Wall compact, formed throughout (as preserved) of about eight to ten layers of equiaxial cells, 0.016 to 0.025 mm. in diameter. No large external cells have been seen. Length of seed about 2.3 mm.; estimated breadth, 2 mm. (assuming that the two limbs were more or less equal) but possibly broader; breadth of condyle about 0.8 or 0.9 mm.

REMARKS AND AFFINITIES. The seed is clearly referable to Myrtaceae. It differs from *Myrtospermum cooperi* in its gaping micropylar opening, and in the absence of large cells forming the exterior of the testa. The specimen is too incomplete and badly preserved for a specific name.

V.29706 Figured Pl. 11, figs. 19, 20. A seed embedded in matrix showing the gaping micropyle which widens towards the exterior of the seed and is occupied by a plug of matrix.

V.29707 The micropylar limb of a second specimen.

V.29708 Cast of a micropylar limb found detached after fracture of a block. Possibly belonging to this species. All *f. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family EPACRIDACEAE

Genus ?

Plate 11, fig. 21

DESCRIPTION. Three small, sub-globular, incomplete fruits slightly lobed externally, with carpels radially arranged around a central axis. The complete fruit may well have consisted of five carpels, but only two can be seen in each specimen owing to the way they have been fractured as they lay in the matrix. Mode of dehiscence obscure, but one specimen shows some

evidence of septicial splitting. Surface somewhat rugose; wall thick, woody, formed of compact parenchyma with cells 0.01 mm. in diameter. Locule-lining shining, formed of transversely-aligned elongate cells 0.012 mm. broad. Length of endocarp (as preserved), 1.25 to 2 mm.; breadth, 1.25 to 1.5 mm.

REMARKS AND AFFINITIES. So far as the structure of these fruits can be determined they agree with Epacridaceae and with no other family. Similar cell-structure may occur in the locule-lining, for example, in species of *Cyathodes*.

V.29709 Figured Pl. 11, fig. 21. A fruit, in section, lying in matrix so that two locules are exposed.

V.29710 A fruit partly in matrix and part chipped out of the stone. It again shows two locules. On the same block is also a specimen of *Myrtospermum cooperi*.

V.29711-12 Two fruits showing two locules, lying in matrix, and part of a fruit chipped out of the stone. All *ŷ. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

Family SYMPLOCACEAE

Genus SYMPLOCOS Jacquim

?*Symplocos* sp.

Plate 11, figs. 22, 23

DESCRIPTION. *Fruit*: Sub-globular (now somewhat compressed), slightly truncate at the apex with a circular apical depression, bounded by smooth incurved edges, communicating with the locules (the depression and locules are now filled with matrix); obtusely pointed at the base where there is a small depressed scar of attachment 0.15 mm. in diameter; syncarpous, four-loculed (one abortive). Carpel wall much decayed, about 0.5 mm. thick, somewhat rough, with crumples diverging from the base; cell-structure obscure, cells apparently measuring 0.016 mm. in diameter. Septa thin, hard, formed of small cells which give a finely crumpled surface. Length of endocarp, 3.5 mm.; breadth (as compressed), 2.5 by 1.5 mm.

REMARKS. The form and structure of this syncarpous fruit, the apical depression communicating with the locules (as shown by the continuity of the matrix in both), and the small basal scar strongly suggest a thin-walled species of *Symplocos*. No central axial canal has been seen, however, perhaps owing to the mode of preservation and poor quality of the material, and the relationship, although most probably with *Symplocos*, cannot therefore be regarded as conclusively established. The species differs in its thin walls from any London Clay species so far described.

V.29713 Figured Pl. 11, figs. 22, 23. An imperfect endocarp. *ŷ. E. Cooper Coll.* Oldhaven Beds: Bishopstone, Herne Bay, Kent.

THE FLORA OF THE BLACKHEATH BEDS

(See p. 25 of Introduction)

Angiospermae

DICOTYLEDONES

Family ICACINACEAE

Genus NATSIATUM Buch.-Ham.

Natsiatum eocenicum Chandler

Plate 11, figs. 24, 25

1925 *Natsiatum eocenicum* Chandler, p. 29, pl. 4, fig. 7; text-fig. 11.

DESCRIPTION. *Endocarp*: Bisymmetric, oval in outline, lenticular in transverse section, rounded at the base, narrowed and somewhat pointed at the apex, sharply angled at the margin. Surface ornamented with from forty to fifty shallow concave areas separated by sharp prominent ridges as preserved on the external cast (on the internal cast the areas are shallower and the ridges between them more rounded). The areas and ridges show no definite arrangement except that a few ridges which are longitudinally aligned are stronger than the others, one such ridge arises from the attachment and extends to about the middle of each face. Placenta sub-apical, marginal, transversely oval. Locule-lining obscure, cells of endocarp digitate, some about 0.05 mm. in diameter. Testa, seen only as an impression in parts of the cast, of equiaxial angular cells 0.03 to 0.05 mm. in diameter. Length and breadth of external cast of endocarp incomplete; length of locule-cast, 11 mm.; breadth, 7 mm.; thickness, 3.75 mm.

REMARKS AND AFFINITIES. A calcite cast, partly of the locule and partly of the seed, lying in a block of shelly sandstone from Chislehurst. Part of the external impression is also preserved but the endocarp itself has decayed. The block was originally recorded as 'Basement Beds of the London Clay' but a re-examination of the shells and matrix by Dr. E. I. White has shown that it is derived from Blackheath Beds. The cast shows the placenta clearly. The relationship is either with *Natsiatum eocenicum* or with *Iodes multireticulata*. Careful examination suggests that it is a specimen of *Natsiatum*. The ridges as preserved on the external cast are sharper than in *Iodes multireticulata* and the endocarp appears to be considerably larger than that species and to agree in form also with *N. eocenicum*.

V.307 Figured Pl. 11, figs. 24, 25. An external impression showing the base and part of one face of an endocarp (Fig. 25), also a calcite seed and locule-cast of the same specimen. *S. C. Cockerell Coll.* Blackheath Beds: Chislehurst, Kent.

THE FLORA OF
THE BASEMENT BEDS
(LONDON CLAY)

(See p. 34 of Introduction)

Angiospermae
DICOTYLEDONES
Family LAURACEAE

Genus LAUROCARPUM Reid & Chandler, 1933:225

Laurocarpum minimum Reid & Chandler

Plate 12, fig. 1

1933 *Laurocarpum minimum* Reid & Chandler, p. 231, pl. 7, figs. 44, 45.

An ovoid berry 8 mm. long, 6 mm. in transverse diameter, probably referable to *L. minimum* although a little larger than the specimens from Bognor and Sheppey.

Basal scar of attachment 3 mm. in diameter. The specimen is represented by an incomplete external impression with adherent remains of epicarp formed of equiaxial angular cells 0.012 to 0.016 mm. in diameter, and an internal cast showing the form and pointed apex.

V.29714 Figured Pl. 12, fig. 1. An ovoid berry probably referable to this species. *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.

Family ICACINACEAE

Genus IODES Blume

Iodes multireticulata Reid & Chandler

Plate 12, figs. 2, 3

1933 *Iodes multireticulata* Reid & Chandler, p. 325, pl. 15, figs. 1-11.

An external impression in a rather coarse sandy matrix showing the characteristic network (Pl. 12, fig. 3). Length of impression about 6 mm.; breadth, 5.5 mm. Also the internal cast (rather poorly preserved) of the same specimen showing the knob-like casts of the apical canals which flank the stylar canal and the sub-apical placenta (Pl. 12, fig. 2). Length of cast, 5.5 mm.; breadth, 4.5 mm.; thickness, 3 mm. The surface of the cast is too poorly preserved, owing, in part at least, to the coarseness of the matrix, to show clear impressions of papillae.

The size and arrangement of the meshes of the external network point to identity with *Iodes multireticulata* rather than with *I. corniculata*, but the specimen is below the normal size for either species although comparable specimens have been seen from Sheppey.

V.29715 Figured Pl. 12, figs. 2, 3. *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.

Family SABIACEAE

Genus MELIOSMA Blume

Meliosma cantiensis Reid & Chandler

Plate 12, figs. 4, 5

1933 *Meliosma cantiensis* Reid & Chandler, p. 376, pl. 18, figs. 24-30.

An endocarp represented by a fragment of the external cast within which lie remains of the carbonaceous endocarp, and a perfect internal cast (Pl. 12, figs. 4, 5) on which elongate digitate cells can be seen diverging from the ventral attachment or plug.

Dorsiventral diameter of cast, 4 mm.; maximum diameter in plane of symmetry, 4.5 mm.; diameter at right angles to the preceding, 4.5 mm.

V.29716 Figured Pl. 12, figs. 4, 5. *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.

Meliosma jenkinsi Reid & Chandler

Plate 12, figs. 6, 7

1933 *Meliosma jenkinsi* Reid & Chandler, p. 375, pl. 18, figs. 16-23, text-fig. 13.

The internal cast of half an endocarp of *M. jenkinsi*, which has split vertically along the plane of symmetry (Pl. 12, fig. 7), the split passing, therefore, through the ventral attachment. Traces of a coarse network of fibres can be seen on the surface of the cast (Pl. 12, fig. 6), and some evidence of coarse elongate digitate cells. Dorsiventral diameter of cast in plane of symmetry, 6 mm.; maximum diameter in same plane, 9 mm.; diameter at right angles to the two preceding (that of half the endocarp), 4.5 mm. Estimated diameter of the whole endocarp, 9 mm.

V.29717 Figured Pl. 12, figs. 6, 7. Half an endocarp. *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.

Family BORAGINACEAE

Section EHRETIOIDEAE

Genus EHRETIA Linnaeus

Ehretia ehretioides (Reid & Chandler) nov. comb.

1933 *Davisella ehretioides* Reid & Chandler, p. 483, pl. 28, figs. 6-9.

AMENDED DIAGNOSIS. Pyrene semi-obovoid with convex dorsal face, bisymmetric about a median dorsiventral plane, dorsal face with a deep median groove, conspicuously pitted in

symmetrically arranged longitudinal rows, two-loculed, germinating by two sub-marginal arcuate sutures in the upper half of the pyrene on the smooth ventral face. Length, 1.5 to 1.75 mm.; breadth, 1.2 mm.; thickness, 0.25 to 0.4 mm.

HOLOTYPE. V.23094.

Two pyrenes from Harefield were separated from the genus *Ehretia* itself, on the grounds that they were smaller with more regular pits on the dorsal surface. Since this opinion was expressed two more related fossil species have been found, one in the Bagshot Beds to be described in a forthcoming catalogue, and the other in the London Clay at Nursling described on p. 336 as *Ehretia clausentia* n. sp. Further consideration of the three fossils and comparison with living *Ehretia* have led to the conclusion that all should be referred to the genus *Ehretia* itself.

The original account of the species now described as *E. ehretioides* (formerly *Davisella ehretioides*) needs modification in that the specimens were then described the wrong way up. The pyrenes are really semi-obovoid, broadly emarginate at the apex, and narrowly emarginate at the base. Germination is by a pair of elongate arcuate sub-marginal apertures *in the upper half*. It can now be added that the difference of form makes it certain that the two pyrenes did not come from a single fruit, so that two fruits must be represented. In the living tropical genus *Ehretia* L. the pyrenes, which may be four and one-loculed or two which are two-loculed, germinate by elongate arcuate sub-marginal apertures opening (initially at least) in the upper half. The split may, however, be continued marginally below. There is no evidence in *E. ehretioides* that further division of the two-loculed pyrenes into one-loculed segments occurred. Length, 1.5 to 1.75 mm.; breadth, 1.2 mm.; thickness, 0.25 to 0.4 mm.

The species from the Bagshot Beds of Lake, Dorset, also has two two-loculed pyrenes. They are ornamented on the dorsal surface with about four shallow angular depressions and there is a median longitudinal furrow. The sub-marginal ventral sutures are seen in the upper part of the endocarp. The length of the pyrenes is 1.2 to 2.25 mm.; breadth, 1.2 to 1.75 mm. The living *Ehretia acuminata* is 2.5 to 3 mm. in length, 2.25 to 2.5 mm. in breadth, and 1.5 mm. in thickness.

The genus is essentially tropical in the Old World. It has limited extensions only in the tropics of the New. Herbarium sheets at Kew record its occurrence along river valleys, beside a stream, in open parts of forests up to 5,000 feet. The occurrence in fine silt at Lake (Lower Bagshot Beds) well accords with a waterside habit where there were lagoons or undisturbed pools.

Family ?

Genus JENKINSELLA Reid & Chandler, 1933:481

Jenkinsella apocynoides Reid & Chandler

Plate 12, figs. 8, 9

1933 *Jenkinsella apocynoides* Reid & Chandler, p. 481, pl. 28, figs. 1-5.

V.29718 Figured Pl. 12, fig. 8. A locule-cast, incomplete at both ends, showing the characteristic transverse striations and the ventral suture and fibres.

- V.29719 A second incomplete internal cast lying in the matrix.
Both the above *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.
- V.29720 Figured Pl. 12, fig. 9. A perfect locule-cast showing the ventral suture and impressions of the transverse fibres lining the locule. *H. A. Toombs Coll.* London Clay, Basement Beds: Sewer cutting 400 yards N.W. of Met. Rly. Stn., North Harrow, Middlesex.

Carpolithus sp. (*Laurocarpum*?)

A sub-globular, somewhat brittle fruit, which has cracked on one side so that the outside matrix of coarse sandstone passes into that which fills the interior and all organs are obliterated or obscured. Represented by internal and part of external casts. Diameter, 5.5 by 4.5 mm.

- V.29722 A fruit. *H. A. Toombs Coll.* London Clay, Basement Beds: Harefield, Middlesex.

Carpolithus sp.

Plate 12, fig. 10

Half of one valve apparently of a two-valved bisymmetric fruit lying in matrix. One margin (the ventral?) appears to have been straight, and the other convex. There is a narrow flat rim on the straight side which broadens at the end. The evidence is insufficient for determination at present. Length preserved, 4 mm.; greatest breadth, 3.25 mm.

- V.29721 Figured Pl. 12, fig. 10. Part of a bisymmetric fruit. *H. A. Toombs Coll.* London Clay, Basement Beds: Sewer cutting 400 yards N.W. of Met. Rly. Stn., North Harrow, Middlesex.

THE LONDON CLAY FLORA (SUPPLEMENT)

(See p. 35 of Introduction)

Where no new information is available, the descriptions already published by Reid & Chandler in 1933 are not repeated. All plants recorded in this and the previous work are included in a list on pp. 39-48. Synonyms listed in full in 1933 are not repeated here. Specimens actually found *in situ* are so recorded.

Many of the species now described, or figured, are from Mr. E. M. Venables' locality at Bognor discovered since 1933. For the first time, thanks to his labours, a London Clay flora from the Hampshire Basin is really known. The great majority of the specimens found by Mr. Venables and his associates are from his 'Upper Fish Tooth Bed'; a few, where the fact is specifically mentioned, are from other horizons.

Pteridophyta

LYCOPODIALES

Family SELAGINELLACEAE

Genus SELAGINELLA Spring

?*Selaginella* sp.

Plate 12, figs. 11, 12

A solitary sub-globular spore with prominent apical triradiate mark (each ridge about 0.2 or 0.3 mm. long) and without any trace of an equatorial ridge or flange. The surface is ornamented all over with shallow flat-bottomed angular depressions delimited by low ridges, the ornamentation extending to the apex of the spore between the arms of the triradiate mark. Length of spore measured through the apex, 0.45 mm.; transverse diameter, 0.45 by 0.5 mm. Diameter of meshes of surface pattern, 0.05 to 0.125 mm.

This large sub-globular tetrahedral spore can belong to but few living genera. In size and character combined it is comparable only with the macrospores of *Selaginella* and *Isoetes*; in *Isoetes*, however, the spores are usually divided by an equatorial ridge into two hemispheres. The closest resemblance appears to be with *Selaginella*, many species of which have similarly ornamented spores. The genus, represented by some 500 species, although world-wide, is highly characteristic of tropical latitudes. There appears to be no reason why the fossil should not be referred to *Selaginella* itself. It has yet to be established that similarity of appearance between spores is any indication of relationship (cf. Knox, 1938: 464), but *Selaginella* is a plant that might be expected to occur in the London Clay. As the formation is geologically-speaking but Recent, and the *Selaginellas* have a long history it seems more reasonable to refer the fossil provisionally at least to *Selaginella* itself, rather than to postulate that it belongs to some extinct genus with spores of identical character.

V.29723 Figured Pl. 12, figs. 11, 12. A spore. *E. M. Venables Coll.* London Clay, Craigweil Bed: Bognor, Sussex.

FILICALES

Family ?

In such a tropical flora as the London Clay, the true ferns must have formed a considerable element, yet they are rare among the plant-remains hitherto discovered. A few short fragments only of the rachis or petiole of fronds have been found.

Three of these (hereafter referred to as Type 1) are identical in arrangement, and show in transverse section throughout their length a pair of curved steles like an S and an S reversed back to back (Pl. 12, fig. 13). Several other fragments (referred to as Type 2) may represent a different genus or species, or more probably, from the great similarity of cell-structure, a

different part of the rachis of the same species in which the two steles have each subdivided so that one limb of each S has become separated from the other, thereby producing four steles. One pair (the upper) curves outwards, the other pair (the lower) curves inwards at each end (Pl. 12, fig. 15). It is not unknown among Recent ferns for a single stele in one part of a petiole or rachis, to give rise to a pair of steles in another part of the same petiole or rachis.

Unfortunately, comparable transverse sections among living ferns have not been traced. Referring to Type 1, the late A. H. G. Alston writes that it perhaps most resembles a species of *Pteris* 'if one supposes their horse-shoe shaped steles divided into two', and he adds: 'There are two steles in many species of *Dryopteris*, but these are curved inwards at the end, while yours is turned outwards as in *Pteris*.' For the present, therefore, the more precise relationship cannot be determined. Mr. F. Ballard of Kew Herbarium suggests tentatively that the fern may be a tree-fern, and the fragments may represent the axis of pinnae or pinnules, rather than the stipe itself. The two types are described below.

Rachis, Type 1

Plate 12, figs. 13, 14

All three specimens are beautifully preserved and show admirably the S-shaped steles (one S reversed). Every detail of cell-structure is reproduced in pyrites including the abundant starch grains which crowd the parenchyma. The longest fragment is about 50 mm. The largest in transverse section is 8 by 5.5 mm. in diameter.

One specimen is approximately roundly quadrangular in transverse section, slightly concave above, and rounded below. Another has a deep median furrow on the ventral and dorsal surfaces, and a shallow lateral furrow on each side above the middle. The epidermis is infrequently preserved but occurs in a fragment from Sheppey in one furrow of the stem. It shows longitudinally aligned and elongate cells with finely toothed walls. The cells are about 0.025 mm. broad. No stomata were detected. Beneath the epidermis there is a narrow band of sclerenchyma, 0.2 to 0.3 mm. broad, many of the cells being 0.016 to 0.025 mm. in diameter. In longitudinal section these cells are long, narrow, bevelled at the ends or dove-tailed into one another. The marginal sclerenchyma band merges into a cortex of equiaxial cells full of starch grains as described, the cells being continued into the centre of the stem between the S-shaped steles. The largest cells are at the centre of the stem and in the outwardly curved upper loops of the steles; they may be 0.05 to 0.075 mm. in diameter. Towards the margin they gradually diminish in size and are often only 0.025 mm. in diameter. In longitudinal sections the parenchyma cells appear square, oblong, or elongate with transverse or oblique end walls. They are often 0.1 to 0.3 mm. long, sometimes even longer, and are arranged in longitudinal rows. The steles are clearly defined owing to a thin coat of small cells equiaxial in transverse section, square or oblong in longitudinal section, about 0.012 mm. broad, arranged in longitudinal rows. Each stele has a line of large, somewhat variable, vascular elements which follow the curvature as seen in transverse section, except that there is a marked break in their continuity near the base of the upper limb of the S, and a broadening and doubling of the line at the top of the lower limb of the S (cf. Pl. 12, figs. 13, 14). In longitudinal sections they are finely scalariform straight-sided vessels. The breadth varies from 0.5 to 0.75 mm. and may be rarely as much as 0.1 mm. Between these vascular canals and the bounding tissue of the steles

are equiaxial parenchymatous cells, 0.012 mm. broad in transverse section. There may be a band of sclerenchyma, lens-shaped in transverse section and concave upwards, connecting the upper ends of the S and reversed S (Pl. 12, figs. 13, 14).

- V.29724 Figured Pl. 12, figs. 13, 14. A fragment 30 mm. long. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.29725 Another fragment, now broken.
 V.29726 A third fragment 50 mm. long. *In situ.*
 Both the above *A. G. Davis Coll.* Warden Point, Sheppey.

Rachis, Type 2

Plate 12, fig. 15

In the details of structure this type is identical with Type 1. It differs only in the presence of four steles instead of two. It is roundly quadrangular in section. One specimen with a cracking carbonaceous surface shows elongate cells, 0.016 mm. broad with bevelled ends. The largest fragment seen is 13.7 cm. long. So far Type 2 has only been found at Herne Bay.

- V.29727 Figured Pl. 12, fig. 15. A well-preserved fragment showing the four steles very clearly. Hampton shore.
 V.29728 Two fragments, both now fractured in an attempt to find a clearer section. East Cliff shore.
 V.29729 Several fragments. East Cliff shore.
 V.32170 A fragment 13.7 cm. long. East Cliff shore.
 All *D. J. Jenkins Coll.* Herne Bay, Kent.

Gymnospermae

CONIFERALES

Family ARAUCARINEAE

Genus ARAUCARITES Presl, 1838:203

Araucarites sp.

Plate 12, fig. 16

1933 *Araucarites* sp., Reid & Chandler, p. 92, pl. 1, figs. 1, 2.

Eight twigs from Sheppey and nine from Bognor have now been added to those originally described.

The Bognor specimens show spirally-arranged imbricate falcate leaves angled on the dorsal surface in which the cell-structure is more apparent than in the much abraded Sheppey twigs. The cuticle has usually been destroyed, but casts of the stomatal pores are clearly visible aligned in longitudinal rows. One better preserved partially calcified twig shows cuticle in patches, but owing to incrustations of pyrites only a small part of the upper (ventral) surface of the leaf could be examined. It shows longitudinal lines of transversely aligned stomata with contiguous auxiliary cells, also, near the margin, short rather rectangular epidermal cells about 0.02 to 0.03 mm. long.

The dorsal surface is more clearly exposed. About a dozen interrupted longitudinal rows of stomata can be distinguished, some few stomata occurring even over the median angle. There may be as many as nine or ten contiguous stomata in a row without intervening epidermal cells. Their orientation may be oblique, longitudinal or transverse, but is usually oblique. The outer pore of the stomata in the lower part of the leaf is about 0.02 mm. long, 0.01 mm. wide. The leaf tip is absent or poorly preserved. The subsidiary cells are narrow and arranged in a ring end to end round the pore, sometimes in a double ring. The guard cells are obscured by pyrites. Where not contiguous the stomata of a row may be separated by ordinary, often transversely-aligned, epidermal cells. Between the rows of pores are other epidermal cells often more or less equiaxial, sometimes square. Epidermal cells outside the stomatal bands near the leaf margin or midrib may be more or less rectangular or rounded at the extremities, oblong, alternating in adjacent rows, about 0.006 mm. broad and 0.02 mm. long.

Unfortunately the pyritized condition makes it impossible to prepare cuticle. The characters seen clearly indicate the genus *Araucarites*, and suggest relationship with *A. goepperti* (Bandulska, 1923: 248, pl. 20, figs. 13, 14). But on the whole the stomata of the lower surface are more numerous in the London Clay species, more conspicuously aligned in longitudinal rows on the underside of the leaf, and (in the fragment seen) more conspicuously transversely oriented and arranged in longer contiguous rows on the upper surface.

V.29730 Figured Pl. 10, fig. 16. A twig, originally calcified, relatively free from pyrites.

V.29731-37 Seven twig fragments.

Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29738 A short twig fragment. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.

V.29739 A twig much encrusted with pyrites. *In situ.*

V.29740 Two twigs one much encrusted with pyrites. *In situ.*

V.29741 Four twigs, one about 30 mm. long with falcate leaves; three smaller fragments.

All the above *A. G. Davis Coll.* Warden Point, Sheppey.

V.29742 A twig. *J. G. Turner Coll.* Sheppey.

?*Araucarites* sp.

Plate 12, figs. 17-19

A small cylindrical ovoid cone (male?), broken at the apex, with stout straight stalk below and about twelve spirally arranged closed scales. The scales appear to have been imbricate, but at the surface they present quadrangular to hexagonal outlines. Length (as preserved) about 7.5 mm. (including the stalk, 2 mm.); breadth, 2.75 mm. Length of a scale about the middle of the closed cone, 2.2 mm.; breadth about the same. It has not been possible to see what organs are borne on the scales as the whole cone is cemented by pyrites. It contains much resin. On fracture, fragments of axis showed tracheids with several rows of bordered pits, thereby indicating the coniferous, and probably araucarinean nature. The cone may be a male cone of *Araucarites*, which is represented by fairly abundant fragments of twig in the London Clay at Bognor and Sheppey.

V.29743 Figured Pl. 12, figs. 17-19. A small cone (now decomposed) from which a slide preparation has been made. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.

Family ABIETINEAE

Genus PINUS (Tourn.) L.

? *Pinus macrocephalus* (Lindley & Hutton) Gardner

(see p. 52)

Plate 12, figs. 20-24

1886 ? *Sequoia Shrubsolei* Gardner, p. 91, text-fig. 35.1933 *Sequoia*(?) *Shrubsolei* Gardner: Reid & Chandler, p. 95.

DESCRIPTION. The lower part of a cone of *Pinus* was found at Herne Bay by J. E. Cooper (Pl. 12, figs. 22-24). The length of the fragment was 32 mm.; the breadth (also incomplete), 32 mm. It was abraded so as to expose the axis with oval scars marking the origin of the scales. The remaining scales had evidently gaped and shed their seeds, pyrites infiltrating into the space between them which, after hardening and decay of the true carbonaceous organs, simulates scales. The nature of the infillings is nevertheless clearly indicated by their confluent edges, and by the amorphous pyrites of which they are formed when seen in section (cf. the mode of preservation of *Petrophiloides* strobils demonstrated by Reid & Chandler, 1933: 136, 137). The much decayed bases of the carbonaceous scales still lie between the persistent pyrites infillings. The seeds were borne in pairs as in *Pinus*, their bodies lying in hollows on the upper surfaces at the base of the scales. Casts of these hollows, approximating in size to the seeds, were about 5 mm. long and 4 mm. broad (Pl. 12, fig. 22). Each cast showed on its surface three longitudinal ridges separated by shallow furrows (Pl. 12, figs. 22-24). Owing to the abrasion of the distal ends of the scales the evidence as to the character of the wing is incomplete. Only in the lowest scales are the much-abraded apophyses preserved where they are thickest over the middle; around the margins their precise outlines are obliterated.

A fragment of a second cone, about 30 mm. long and 20 mm. broad, comes from Warden Point, Sheppey (Pl. 12, figs. 20, 21). Its breadth (slightly incomplete) was probably about 20 to 25 mm. It appears to have been more or less ovoid. The scales (of which twelve are represented complete or imperfect) have somewhat abraded, lozenge-shaped to hexagonal, carbonaceous apophyses, slightly convex superficially, about 10 mm. in diameter and 4 mm. thick, smaller at the basal end of the cone (Pl. 12, fig. 20). The slender axis, about 5 mm. in diameter, is exposed; near the base a ring of large longitudinal ducts or deep rounded furrows represented by casts can be seen surrounding it near the circumference. Bordered pits are visible on the vascular tissue of the axis. The scales, now largely decayed, and the pyrites infillings between them are seen in section (Pl. 12, fig. 21). They arise from the axis at obtuse angles and bend sharply upwards beyond the seeds. The upper surface of the scales as seen impressed on the pyrites layers is formed of longitudinally aligned cells about 0.025 mm. broad and of variable length, many only 0.025 mm. long, others as much as 0.1 mm. Although the evidence is not absolutely clear, there are again indications of two seeds about 5 mm. long, 2.5 mm. broad. Only incomplete impressions of wings are preserved on one or two pyrites films (Pl. 12, fig. 21).

The discovery of these two specimens now makes it virtually certain that Gardner's

Sequoia shrubsolei (1886: 91, text-fig. 35) was a *Pinus*. His figure and description indicate specific identity with the two imperfect cones described above. All three cones have in common the peculiar smooth apophyses which meet in a valvate manner. Gardner's figure shows an ovoid cone, length, 37 mm.; breadth, 20 mm., as compressed, but before crushing it was thought to have been cocoon-shaped and about twice as long as broad. The scales, about forty in number, were lozenge-shaped or imperfectly hexagonal '10 mm. across and 8 in height, becoming smaller towards the apex of the cone and very slightly diminishing towards its base'. As the cone was closed no seeds could be seen, nor pyrites infillings between the pyritized scales. The apophyses were much worn and somewhat sunk in the middle. There was a stout footstalk 7 mm. across. It is interesting to notice that in discussing the relationship of this species Gardner wrote: 'there is no other existing genus [than *Sequoia*] to which it could possibly be referred except *Pinus*.' It was sent by W. H. Shrubsole from Sheerness, but no information was given as to where it was collected. It is unfortunate that the specimen is no longer extant. In 1933 Reid & Chandler drew attention to certain resemblances to *Petrophiloides*, but on account of differences then noted, refrained from referring it to that genus.

The three cones here discussed differ from *P. macrocephalus* only in their much smaller size, more ovoid form, and smaller apophyses. But V.29633 from the Thanetian appears to be ovoid and not very large. These features alone might merely indicate smaller specimens (and in the case of Shrubsole's specimen an immature one), for in living species of *Pinus* considerable variation in the size of cones and scales can be observed. Both *P. macrocephalus* from Thanet and the two cones described above show the ring of large ducts just within the periphery of the axis. Although in *P. macrocephalus* the basal scales are usually larger than those of the body, a peculiar character not seen in living pines, one specimen already mentioned, V.29633, shows smaller basal scales. Hence there are no definite characters except size by which these specimens can be separated from *P. macrocephalus* to which they are therefore provisionally referred.

The occurrence of *Pinus* in a flora as tropical as that of the London Clay is curious, for the genus is essentially temperate. Very few species extend into tropical latitudes even at considerable altitudes, and none lives at the present day at low altitudes strictly within the tropics. Perhaps the cones were transported a considerable distance from some upland area. But it seems more probable that this is a tropical species and that the range of the genus has contracted since early Eocene times. Moreover, as stated on p. 17, pine-forests now occur behind the mangroves in Florida.

- V.29744 Figured Pl. 12, figs. 20, 21. A cone fragment showing worn apophyses, axis and films of pyrites between the decayed scales. *A. G. Davis Coll.* Warden Point, Sheppey.
Figured Pl. 12, figs. 22-24. A much abraded cone now decomposed. *J. E. Cooper Coll.* Herne Bay, Kent.

Pinus bowerbanki (Carruthers) Gardner

- 1884 *Pinus Bowerbankii* (Carruthers) Gardner, p. 68, pl. 14, figs. 3, 8.
1933 *Pityostrobus* sp., Reid & Chandler, p. 94.

As observed by Reid & Chandler (1933: 94) the species named *P. Bowerbankii* (Carr.) by Gardner from the London Clay was based on poor material and consequently not well-defined. Clearly, however, the figures represent a larger cone, although the evidence is quite insufficient

to indicate the actual size. Unfortunately, neither figure (Gardner, 1884, pl. 14, figs. 3, 8) shows the character of the apophyses seen by Gardner on a 'few perfect scales', but he states that the 'heads' of the scales were about 20 mm. broad and resembled those of a cone from Bracklesham (Gardner, 1884, pl. 13, fig. 9). This figure shows a transversely keeled apophysis with median recurved umbo. As Gardner was an astute and careful observer, his statement suggests the presence in the London Clay of a second species of *Pinus* distinguished by its keeled apophyses from *P. macrocephalus* (?). It is not impossible for a species from the London Clay to have persisted into Bracklesham times, just as a species from the Thanet Beds (*P. macrocephalus*) may have persisted into the London Clay.

Gardner's further statement that the London Clay specimens showed rather large winged seeds adhering to the axis must be interpreted in the light of recent studies. There can be little doubt that the apparent winged seeds were pyrites casts intercalated between carbonaceous scales which had decayed subsequently. But such casts do represent the form and size of the seeds. Wings also would have been impressed upon them, the impression probably showing distinctive cell-structure.

Unfortunately no evidence is given in detail. Gardner's figure certainly suggests paired seeds such as in *Pinus* and appears to indicate seed-bodies about 8 mm. long and 3 to 4 mm. broad.

It seems reasonable to accept Gardner's determination of a second species of *Pinus*, but on the evidence now available nothing further can be said. It is to be hoped that further discoveries at Sheppey may establish definitely that a species distinct from *P. macrocephalus* occurs there.

Family CUPRESSINEAE

Genus CUPRESSINITES Bowerbank, 1840:51

Cupressinites oviformis n. sp.

Plate 13, figs. 1-3

DIAGNOSIS. Fruit shortly stipitate, with four slightly unequal elongate oval scales more or less pointed at the apex, without umbo, thin at the margins, finely crumpled externally. Length of valves about 11.5 mm.; breadth, 4.5 mm.

HOLOTYPE. V.29745.

DESCRIPTION. *Fruit*: Shortly stipitate, four-scaled, scales slightly unequal (possibly owing to unequal contraction on dehiscence), not peltate, elongate-oval more or less pointed at the apex, thin at the margins, without any umbo, finely crumpled on the external surface. At the base around the stalk are remains of about five small rounded bracts. Length of cone (in present gaping condition) about 8.5 mm. Length of valves about 11.5 mm.; breadth, 4.5 mm.

REMARKS AND AFFINITIES. One cone, the scales of which have gaped and curled, but the dimensions and form of the scales show that when closed the cone must have been ovoid as in *Thuja*, not squat and sub-globose as in *Cupressinites curtus* (Reid & Chandler, 1933: 96, pl. 1, figs. 3, 4), *Tetraclinis*, or *Widdringtonia*. There is, however, no evidence of an inner scale or whorl of scales as in *Thuja orientalis*, nor does the shape of the scales at the apex leave room

for them. The ovoid form and small size combined distinguish this cone from *Cupressinites curtus*. A distinct specific name *C. oviformis* has therefore been given.

V.29745 Holotype, figured Pl. 13, figs. 1-3. A gaping cone. *F. M. Wonnacott Coll.* Warden Point, Sheppey.

Angiospermae

MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus POSIDONIA Kon.

?*Posidonia parisiensis* (Brongniart) Fritel

Plate 13, fig. 4

1909 *Posidonia parisiensis* (Brongniart) Fritel, p. 384, pl. 13, figs. 1-3; text-fig. 1a-f.

Several pieces of a distinctive abraded rhizome? showing deep obconical pits spirally arranged and close-set over the surface, sometimes concentrated on one side only like the root-scars of a creeping rhizome. The pits appear to mark the point of emergence of rootlets; each has a small basal hollow surrounded by a rim, perhaps indicating the fibro-vascular bundle. The rhizomes also show a series of close sub-parallel alternating ridges and furrows sometimes on one side only. These may represent leaf-scars. At the bottom of the furrows a row of pits may sometimes be seen again representing the point of egress of fibro-vascular bundles in this case passing into the leaves. A transverse fracture across one specimen suggests that it is a pyrites cast of a more or less hollow rhizome with adherent remains of the surrounding stem tissue all over its surface. The tissue merges gradually and without a sharply defined surface into the pyrites as if the hollow of the rhizome had formerly been filled with a loose textured parenchyma which readily decayed or broke away.

The fragments strongly recall specimens from the Eocene of the Paris Basin referred by Fritel (1909) to the living genus *Posidonia*. He states with confidence that some fossil specimens cannot be separated from the Recent *Posidonia caulini* Kon. when its leaf-bases have been removed.

Whatever the true relationship may be (and the writer cannot claim a sufficient knowledge of plant rhizomes to offer an alternative suggestion) there can be little doubt that the French Eocene specimens and those from the London Clay are closely related. Under the name *P. parisiensis* Fritel unites more than twenty-four species previously separated (Fritel, 1909: 384). In his opinion the same species occurs in the Palaeocene of Gelinden, the Calcaire Grossier of the Paris Basin, and at Radoboj in Croatia. Other species are mentioned from the Eocene of Kiev, and from Cretaceous beds.

Gardner (1886a: 400) reported that the surface of the higher beds at Selsey (presumably Auversian) was covered with rhizomes of *Posidonia* associated with beautifully preserved

Tellina. But the determinations must be regarded as suspect since he also states that the plant differed in its mode of growth from the Calcaire Grossier species as the rhizomes radiated from a centre whereas in the French species they were long and branching. Reid (1897) makes no mention of the plant. There are two living species of *Posidonia*, one in the Mediterranean and along the Atlantic coast of Spain, the other along the extratropical coasts of Australia.

- V.29746 Figured Pl. 13, fig. 4. A worn stem or rhizome fragment showing pits with basal hollows, and transverse ridges.
 V.29747 A second abraded stem or rhizome fragment.
 The above *ŷ. E. Cooper Coll.* Herne Bay, Kent.
 V.29748-50 Three specimens, two fractured in an attempt to show the internal structure, the third fragment much abraded. *D. ŷ. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Family PALMAE

The sorting of the Palm seeds into species presents great difficulties owing to the variation in appearance caused by differing degrees of abrasion. The testa is sometimes preserved, but more often an internal cast only is found with or without the hilar-chalazal thickening which may be worn in a greater or lesser degree. If a large number of specimens were available of each species it would be easy to arrange a graded series showing changes in appearance, but most palms are represented by few seeds, or by one only. The chief characters used in sorting species are size and form, the form and position of the hilar-chalazal scar or of the cavity it occupied, the position in relation to it of the embryo-scar and the ruminant or non-ruminant character of the endosperm.

Using such characters as these, the following species are now added to those previously described by Reid & Chandler (1933): *Palmospermum bracknellense*, *P. minutum*, *P. davisii*, *P. pulchrum*, *P. elegans*, *P. subglobulare*, *P. ornatum*, *P. ovale*, *P. cooperi* and a few unnamed species.

The specimens previously described as *Palmospermum pusillum* (Reid & Chandler, 1933: 115, pl. 1, figs. 32-34) are not now regarded as belonging to the Palmae and are described on p. 304 as *Carpolithus pusillus*.

Section CORYPHEAE

Genus SABAL Adanson

Sabal sp. (*S. grandisperma?*)

Plate 13, figs. 5-7

1933 *Sabal* sp. (*grandisperma?*) Reid & Chandler, p. 107, pl. 1, figs. 16, 17.

- V.29751 Figured Pl. 13, fig. 5. Fragment of a leaf near the centre showing pinnae on one side of the rachis (visible on the lower surface). The ligule on the upper surface has been torn away. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.29752 Figured Pl. 13, figs. 6, 7. A well-preserved fragment representing the central part of a leaf shows both the ligule (upper surface) and the rachis (on both surfaces). The origins of the pinnae are clearly seen. The specimen is better preserved than any formerly described or figured.

- V.29753 Fragment of a leaf.
The above *A. G. Davis Coll.* Warden Point, Sheppey.
V.29754 Fragment of a leaf. *G. F. Elliot Coll.* Sheppey.
V.29755 A leaf fragment. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Genus PALMOSPERMUM Reid & Chandler, 1933:110

? *Palmospermum jenkinsi* Reid & Chandler

Plate 13, figs. 8, 9

1933 *Palmospermum jenkinsi* Reid & Chandler, p. 110, pl. 1, figs. 23, 24.

DESCRIPTION. *Seed-cast*: Hemispherical (probably originally sub-globular but the thickness is now reduced both by compression and by the abrasion of testa and hilar-chalazal thickening). Inner chalaza a large sub-circular ventral concavity about 7.5 mm. in diameter, having a deeper obovate central part at the middle of which is a short longitudinal ridge, probably the cast of a groove or canal for fibres associated with the hilum and chalaza (Pl. 13, figs. 8, 9). The inner chalaza is produced at the hilar end to form a small tongue-like prolongation associated with the raphe and hilum. Embryo-scar circular, in the plane of symmetry close to the hilum at the base of the dorsal surface (Pl. 13, fig. 9e). The scar, although obscure, is indicated by its circular outline around which the cells diverge. Surface of cast smooth, showing impressions of equiaxial angular cells, 0.016 to 0.025 mm. in diameter, outside which are impressions of criss-cross fibres (testa). Remains of finer fibres diverge around the margin of the chalazal area. Length of seed, 8.5 mm.; thickness (reduced by compression) measured at right angles to the hilar scar, 7 mm.

REMARKS AND AFFINITIES. One seed-cast. In size and form it resembles *Palmospermum jenkinsi* but the type of that species was less abraded, hence the two differ somewhat in appearance. The embryo-scar is better preserved in the type so that it appears more conspicuous in that specimen. The newly discovered specimen is referred doubtfully to *P. jenkinsi*.

V.29756 Figured Pl. 13, figs. 8, 9. A seed-cast. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Palmospermum minutum n. sp.

Plate 13, figs. 10-14

DIAGNOSIS. Seed sub-globular. Chalazal area depressed, circular, sharply defined embryo seen closely adjacent to the chalazal scar on the ventral side. Transverse diameter of seed, 3.5 by 3.25 mm.; dorsiventral diameter (or thickness), 2.75 mm.

HOLOTYPE. V. 29757.

DESCRIPTION. *Seed*: Sub-globose, somewhat flattened ventrally, rounded dorsally, with a clearly marked sunk circular scar at the middle of the ventral surface. One cast shows a narrow tongue-like prolongation extending from the depressed scar almost to the circumference of the ventral surface (Pl. 13, fig. 12). The circular area may be presumed to represent the chalaza exposed by abrasion of the testa. Embryo-scar clearly defined, circular, close to the circular chalazal scar (Pl. 13, fig. 10). External surface where seen smooth and shining, its cell-structure obscure. The outer integument is preserved only around the chalaza scar, it is carbon-

aceous, 0.1 mm. thick, formed in section of fine columnar cells whose inner ends are 0.01 mm. in diameter. Immediately beneath this coat are a few layers of equiaxial cells also 0.01 mm. in diameter and well seen in V.29757. Next comes a coat, about 0.05 mm. thick, formed of several layers of equiaxial cells, 0.016 to 0.025 mm. in diameter, those of the outer layers being somewhat coarser than those within. This coat forms most of the surface now exposed by abrasion in the Bognor specimens. It appears smooth and pyritized owing to the pyrites which fills the cell-cavities. A coat of finer equiaxial cells, about 0.012 mm. in diameter, follows within (cf. Pl. 13, fig. 11). Around the ventral circular scar it gives place abruptly to coarser double-walled equiaxial but angular cells, 0.05 to 0.1 mm. in diameter, perhaps the tissue of the chalaza. The coarse-celled area is about 2.4 mm. in diameter.

The innermost coat (tegmen?) obscurely seen in the same specimen from Bognor, well exposed on a seed from Herne Bay, is formed of elongate narrow cells arranged in parallel groups aligned along the longer axis of the seed and converging towards the ventral scar; these cells are about 0.001 to 0.012 mm. broad, and 0.05 to 0.1 mm. long; they converge also around the embryo-scar.

Transverse diameter of seeds, 3.5 by 3.25 mm.; dorsiventral diameter, 2.75 mm.

REMARKS AND AFFINITIES. Four seeds, the form, embryo-scar and structure of the coats indicate *Palmae*. The seed is smaller than that of any other species described. It is the only species of plant so far recorded confined to Bognor and Herne Bay. It is referred to a new species, *Palmospermum minutum*.

- V.29757 Holotype, figured Pl. 13, fig. 10. A seed showing the hilum, embryo scar and several coats (dorsal side broken). It does not show the coarse cells over the chalaza.
- V.29758 Figured Pl. 13, fig. 11. A seed perfect, but cracked and fissured. It shows the coarse-celled coat around the hilum and traces of the striate tegmen, neither of which are exposed in the holotype.
- V.29759 Figured Pl. 13, fig. 12. A seed-cast showing the form, ventral hilar-chalazal scar with a channel diverging from it for a short distance. The embryo scar is also seen.
- The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29760 Figured Pl. 13, figs. 13, 14. A seed, imperfect on the dorsal surface. *D. J. Jenkins Coll.* Herne Bay, Kent.

Palmospermum bracknellense n. sp.

Plate 13, figs. 15, 16

DIAGNOSIS. Seed sub-globular. Chalazal area sub-circular with a narrow shallow prolongation to the hilum. Embryo-scar closely adjacent to the hilum situated on the dorsal surface of the seed. Surface crumpled and fluted around the edge of the hilar-chalazal depression. Length of seed, 5.25 mm.; breadth, 5.25 mm.; dorsiventral diameter, 4.5 mm.

HOLOTYPE. V.29761

DESCRIPTION. *Fruit*: One-seeded, sub-globular (circular as seen in section embedded in the matrix), closely investing the seed. Structure obscure.

Seed: Sub-globular, non-ruminate with a circular rather shallow depression occupying most of the ventral face, the centre of the depression being inflated (Pl. 13, fig. 15). This differentiated ventral area is continued as a narrow shallow channel to the basal hilum. The depression is occupied by a mass of coarse cells with black contents representing the thickened hilar-chalazal scar, giving rise to the inflated area described above. Around the margin of the depression the surface is radially crumpled and fluted. Embryo-scar circular convex, approximately basal, closely adjacent to the hilum (Pl. 13, fig. 16). Obscure shallow furrows diverge

from the embryo and sweep over the surface converging towards the margin of the chalazal area. Testa about 0.1 mm. thick, formed of about four or five thicknesses of closely compacted equiaxial cells, 0.03 to 0.1 mm. broad, as seen in section. On the external cast of the seed are narrow elongate cells with bevelled ends producing a striate or criss-cross effect. On the lining of the testa two sets of cells can be detected, the outer parallel-sided narrow cells, 0.016 mm. broad, diverging from the hilar-chalazal region to the embryo; the inner of equiaxial cells, 0.016 mm. in diameter, which may be merely the impressions of endosperm cells; they are seen especially clearly around the chalaza but elsewhere are more or less hidden by adherent testa. Length of seed, 5.25 mm.; breadth, 5.25 mm.; thickness, 4.5 mm.

REMARKS AND AFFINITIES. One seed with the remains of the fruit embedded in surrounding matrix. Although it corresponds in size approximately with *Palmospermum* sp. 6 from Sheppey (Reid & Chandler, 1933: 116, pl. 1, figs. 35, 36) it is clearly distinguished by the breadth of the sub-circular chalazal depression. No closely comparable living genus has so far been traced, the few genera with small seeds that it has been possible to examine have a much deeper chalazal depression. The specimen is of importance because it is one of the few plants found in division 5 of the London Clay at Bracknell.

V.29761 Holotype, figured Pl. 13, figs. 15, 16. A seed with the remains of the fruit embedded in the matrix from which it was extracted. *A. G. Davis Coll.* From a septarian nodule, Modiola Beds of the Down Mill Brick Yard, London Clay, division 5: Bracknell, Berkshire.

Palmospermum davisii n. sp.

Plate 13, figs. 17-24

DIAGNOSIS. Seed hemispherical, somewhat excavated on the ventral surface for the chalaza with short channel for raphe. Embryo on the rounded dorsal surface close to its junction with the ventral surface. Diameter of seed-cast, 5 by 6 mm.; dorsiventral diameter, 4 mm.

HOLOTYPE. V.29762.

DESCRIPTION. *Seed-cast*: Non-ruminate, hemispherical, rounded on the dorsal surface, slightly excavated on the ventral. Ventral depression with a short shallow prolongation, or raphe channel in which are impressions of elongate cells or fibres. The ventral depression is occupied in the best preserved specimens by a thick plug of tissue (the hilar-chalazal plug) the cells of which are coarse but obscure. Embryo-scar circular, sunk, close to the junction of the rounded surface with the concave ventral surface, i.e. nearly marginal. Testa black, compact, fine-celled, finely striate, cell outlines obscure, preserved chiefly around the edges of the ventral plug from which they diverge. Elsewhere they appear to be aligned irregularly, the striae being about 0.016 mm. apart. A network of fibres can sometimes be seen within the testa. Surface of seed-cast showing equiaxial cells about 0.01 to 0.025 mm. in diameter. Diameter of seed-cast, 6 by 5 mm.; dorsiventral diameter (including plug), 4 mm., or without plug about 3.5 mm.

REMARKS. Six seed-casts with remains of testa and sometimes of hilar-chalazal plug, but one specimen is very doubtfully referred to this species. There is some resemblance to *Palmospermum bracknellense* Chandler, but this has a more conspicuous hilar furrow extending from the sunk chalaza which produces a marginal groove. Also its embryo-scar is somewhat more dorsal in position, and there are conspicuous but slight furrows radiating from the embryo-scar.

- V.29762 Holotype, figured Pl. 13, figs. 17, 18. A seed-cast with remains of testa and chalazal plug. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29763 Figured Pl. 13, fig. 19. A somewhat crumpled and compressed seed-cast 5 mm. in diameter, 3.5 mm. dorsiventrally as compressed. It shows the embryo-scar.
- V.29764 Figured Pl. 13, fig. 20. A much worn seed-cast.
The above *Reid & Chandler Coll.* Minster, Sheppey.
- V.29765 Figured Pl. 13, figs. 21, 22. A much compressed and puckered seed-cast. Some of the integuments are preserved on the dorsal surface, and a network of fibres can be seen. The internal cast where exposed shows convex impressions of equiaxial cells, 0.025 mm. in diameter, diverging from the ventral depression. Associated with them are traces of fine diverging striae. Diameter of seed, 4.8 to 5.2 mm.
- V.29766 Figured Pl. 13, fig. 23. A small much crushed seed-cast.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29767 Figured Pl. 13, fig. 24. A much crushed and flattened seed with worn hilar-chalazal plug. It may belong to this species but distortion and abrasion together make its determination rather doubtful. *Reid & Chandler Coll.* Minster, Sheppey.

Palmospermum pulchrum n. sp.

Plate 13, figs. 25-31

DIAGNOSIS. Seed sub-globular or broadly obovoid, with an elongate, broad, deep hilar-chalazal concavity sub-circular at the upper end, narrowing to the hilum. Embryo in the median line on the dorsal face about 1.5 mm. from the base of the hilar depression. Diameter of seed, 5.5 mm.

HOLOTYPE. V.29768.

DESCRIPTION. *Seed*: Non-ruminate, sub-globular or broadly obovoid with a long, deep, broad, ventral hilar-chalazal concavity sub-circular at one end, narrowing to the hilum (Pl. 13, fig. 25). Embryo-scar circular, situated in the median line on the dorsal face about 1.5 mm. from the base of the hilar depression (Pl. 13, fig. 26). Testa formed in part of criss-cross fibres; within are equiaxial cells 0.012 to 0.016 mm. in diameter. The dorsal surface of the cast is finely puckered concentrically, probably partly, but only partly, as the result of compression. Diameter of seed, 5.5 mm.

REMARKS AND AFFINITIES. One good seed and six more doubtful abraded or distorted specimens. On the good specimen the testa was originally preserved in patches and there was a thick mass of tissue in the hilar-chalazal hollow. The impressions of the criss-cross fibres which form the testa are visible over most of the surface, but around the ventral concavity these cells diverge in a radial manner. The equiaxial cells within are exposed where the cast of the fibrous layer has chipped away. The embryo-scar is clear and unmistakable. The relationship to *Palmae* cannot be doubted. There is considerable resemblance in size and structure to *Palmospermum* sp. 6 (Reid & Chandler, 1933: 116, pl. 1, figs. 35, 36), but in that species the embryo-scar is closely adjacent to the hilum, not definitely on the dorsal surface. Also the hilar-chalazal depression is narrower. There is also some resemblance to *P. bracknellense* (p. 125, Pl. 13, figs. 15, 16), but, like *Palmospermum* sp. 6, this also differs in the closer approximation of embryo-scar and hilum; also in the broader, shallower, more sub-circular hilar-chalazal depression with fluted margins. Among living Palms a similar type of seed is seen in *Corypha olivaeformis*, but the fossil is very much smaller, with a much larger hilar-chalazal depression relative to the seed, and its embryo is not at the middle of the dorsal face as in this living seed.

- V.29768 Holotype, figured Pl. 13, figs. 25, 26. A seed originally with carbonaceous testa, now represented by the internal cast. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.
- V.29769-73 Figured Pl. 13, figs. 27-31. Five worn palm seeds possibly referable to this species, but the determination is uncertain owing to their abraded condition. Length of seeds, 5, 5.5 or even 5.75 mm.; breadth about 4.5 mm.; thickness about 3.5 mm. In these specimens the hilar-chalazal depression narrows at the hilar end so as to be oboval in outline, the remains of the hilar-chalazal plug is seen in the depression. The embryo-scar is obliterated by abrasion in all but one specimen where it is situated on the median line of the dorsal surface closely adjacent to the base of the hilar depression (not seen in fig. 27 which shows ventral surface). Some of the casts are much crushed and distorted. There is a resemblance to *P. minimum* Reid & Chandler (1933: 114, pl. 1, figs. 30, 31) especially in the position of the embryo-scar, but the seeds of that species are smaller and less oval in outline. *Reid & Chandler Coll.* Minster, Sheppey.

Palmospermum elegans n. sp.

Plate 13, figs. 32, 33

DIAGNOSIS. Seed: Sub-globular, with an oboval steep-sided hilar-chalazal concavity, broad and rounded at one end, occupying less than one-third of the breadth of the seed, narrowed to the hilar end. Embryo-scar in the median line, dorsal, close to the hilum. Surface of internal cast smooth. Diameter of seed, 6.5 mm.

HOLOTYPE. V.29774.

DESCRIPTION. *Seed*: Sub-globular, non-ruminate, having a long, deep, steep-sided hilar-chalazal concavity, broad and rounded at the chalazal end, occupying less than one-third of the breadth of the seed, narrow at the hilar end. Surface of internal cast smooth, not concentrically puckered. Embryo-scar in the median line on the dorsal surface near to but not contiguous with the hilum. The testa is largely abraded, but adherent fragments show criss-cross fibres; equiaxial cells, 0.012 to 0.016 mm. in diameter, are preserved as impressions over most of the surface. Diameter of seed, 6.5 mm.

REMARKS AND AFFINITIES. One seed which somewhat resembles the species described as *Palmospermum pulchrum*, but it is somewhat larger and quite smooth, not puckered nor dimpled. Also the hilar-chalazal depression is deeper, narrowed and more steep-sided. It occupies a relatively smaller area of the ventral surface than in *P. pulchrum*.

V.29774 Holotype, figured Pl. 13, figs. 32, 33. A seed-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

Palmospermum subglobulare n. sp.

Plate 13, figs. 34, 35

DIAGNOSIS. Seed sub-globular with deep, funnel-shaped, ventral hollow for hilar-chalazal thickening, but no circular chalazal scar adjoining it on the seed-cast as in *P. excavatum*. Embryo-scar on the rounded dorsal surface close to the broader end of the chalazal hollow. Dorsiventral diameter of seed-cast, 6 mm.; diameters at right angles to the preceding, 6.25 and 5.5 mm.

HOLOTYPE. V.29775.

DESCRIPTION. *Seed*: Non-ruminate, sub-globular, with a deep median ventral hollow, as in *Livistona* and *Oncosperma*, occupied by the remains of a thickened hilar-chalazal plug. At the surface the hollow is sub-oval with a slight prolongation at the hilum (Pl. 13, fig. 34); in section it is funnel-shaped, narrowing rapidly at first, then becoming parallel-sided (Pl. 13,

fig. 35); it is about 4.5 mm. deep, and the same in maximum diameter at the surface, the latter measurement being somewhat exaggerated by the lateral compression of the seed. The plug is formed of angular equiaxial cells, about 0.016 mm. in diameter, each enclosing a black shining secretion. There is no trace of a large circular chalazal scar with fibres on the surface of the internal cast adjacent to the hilar depression, as in *Palmospermum excavatum* (Reid & Chandler, 1933: 111, pl. 1, figs. 25, 27); presumably the chalaza lay within the ventral hollow. The embryo-scar is preserved on the rounded dorsal surface close to the broad end of the chalazal hollow, a peculiar position (Pl. 13, figs. 34, 35). Although the whole surface of the cast is much abraded, cell-structure is preserved as impressions in one or two folds, while in one narrow fold two coats can be seen, the outer, 0.3 mm. thick, but obscure in structure, the inner about 0.075 mm. thick, columnar in section. Otherwise only equiaxial cells, 0.012 to 0.016 mm. in diameter, are seen, preserved as impressions in the furrows as described. They probably represent the impressions of endosperm cells or tegmen. Diameter of seed-cast, measured from the ventral plug to the dorsal surface, 6 mm.; diameters at right angles to the preceding, 5.5 and 6.25 mm. (the seed is compressed laterally in fossilization).

REMARKS. The seed-cast bears a general resemblance to *Palmospermum excavatum* in its deep ventral hollow, but differs markedly in size from that species, and in the absence of a well-defined chalazal scar abutting on the ventral hollow, the structure is certainly that of a Palm seed.

V.29775 Holotype, figured Pl. 13, figs. 34, 35. A seed-cast with part of the hilar-chalazal thickening preserved in the ventral hollow. The specimen has been fractured longitudinally. *Reid & Chandler Coll.* Minster, Sheppey.

Palmospermum cooperi n. sp.

Plate 13, figs. 36, 37

DIAGNOSIS. Seed sub-globular; chalazal depression sub-circular, shallow, with a narrow hilar prolongation. Embryo on the dorsal surface well above the notch due to the hilar groove on the seed-cast. Diameter of seed, 7 mm.; dorsiventral thickness, 6 mm.

HOLOTYPE. V.29776.

DESCRIPTION. *Seed*: Sub-globular, non-ruminate, with a sub-circular shallow depression occupying most of the ventral surface having a narrow prolongation towards the hilum. Ventral hollow filled by a hilar-chalazal plug of equiaxial cells, 0.1 to 0.3 mm. in diameter, with black shining contents, the coarsest cells apparently the most superficial. At the centre of the plug is a foramen (now filled with pyrites) marking the attachment of the fruit? (Pl. 13, fig. 36). Obscure impressions of the fruit are seen on a film of pyrites close to the foramen. Embryo-scar circular, somewhat hidden by crumpling of the seed and adherent pyrites but clearly indicated by the divergence of the cells around it on the cast, sunk, situated on the rounded dorsal surface well above the margin in the plane of the hilar-chalazal scar. Testa thin (preserved as an external impression on pyrites in which the cast was embedded, and as an internal impression on a few thin patches of pyrites still closely adherent to the seed-cast) showing criss-cross oblong cells about 0.025 mm. broad, sometimes arranged in slightly sinuous lines. Internal cast of seed showing equiaxial angular cells with thickened lateral walls so arranged in groups as to produce a striate effect, the striae about 0.012 mm. apart. Beneath

this striate coat are rounded equiaxial cells, from 0.016 to 0.025 mm. in diameter, perhaps representing the impressions of albumen cells. Length of seed-cast, 6.5 mm.; transverse diameter, 7 mm.

REMARKS AND AFFINITIES. One seed-cast with remains of testa and hilar-chalazal plug. The species somewhat resembles *Palmospermum jenkinsi* (Reid & Chandler, 1933: 110, pl. 1, figs. 23, 24); but is considerably smaller. It is larger than another rather similar form, *P. bracknellense* in which also the embryo-scar is situated nearer to the hilar thickening and depression, and adjacent to the margin of the rounded dorsal surface.

V.29776 Holotype, figured Pl. 13, figs. 36, 37. A seed-cast and fragments of pyrites (showing impressions of the testa cells) in which the cast was formerly embedded. *J. E. Cooper Coll.* Herne Bay, Kent.

Palmospermum ovale n. sp.

Plate 13, figs. 38, 39

DIAGNOSIS. Seed-cast elongate-ovoid, 8.5 mm. long, 5.25 mm. broad. Ventral depression of the chalaza large and conspicuous.

HOLOTYPE. V.29777.

DESCRIPTION. A much distorted seed-cast belonging to a species of Palm not hitherto described, but its condition is poor. In its compressed state it is 8.5 mm. long, 5.25 mm. broad; one face shows the chalazal depression with traces of the chalazal thickening lying within it (Pl. 13, fig. 38). The embryo-scar cannot be detected. The surface of the cast shows impressions of equiaxial cells, 0.02 mm. in diameter; they tend to diverge from the margins of the chalazal scar. There are also obscure impressions of fibres similarly arranged around the chalaza, elsewhere variously oriented. The seed resembles *Serenoa eocenica* (Reid & Chandler, 1933: 108, pl. 1, figs. 18, 19) in form, but is considerably larger than that species.

V.29777 Holotype, figured Pl. 13, figs. 38, 39. A distorted sub-ovoid seed-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

Palmospermum ornatum n. sp.

Plate 13, figs. 40, 41

DIAGNOSIS. Seed-cast elongate obovoid with narrow, spatulate, deeply sunk chalazal thickening. Ruminations shallow and irregular on the dorsal side, transversely elongate on the ventral side. Length about 9 mm.; breadth, 5.5 mm. (somewhat crushed).

HOLOTYPE. V.29778.

DESCRIPTION. *Seed-cast*: Elongate obovoid, bisymmetric about a deep, narrowly-spatulate hollow which extends the whole length of the ventral surface and carries the deeply-embedded, thickened hilar-chalazal scar. Ruminations shallow, especially on the dorsal surface where they are obscure and irregularly distributed. On the ventral surface they are elongate and transversely aligned, deeper and more conspicuous. Surface of the cast with impressions of equiaxial cells, 0.016 to 0.025 mm. in diameter. In transverse section, the layers of the hilar-chalazal scar, in contact with the endosperm, are formed of several rows of coarse secreting cells, 0.1 mm. in diameter, which pass gradually into a single layer of smaller quadrangular cells as the ventral surface of the seed is approached. The chalazal thickening within the coarse-celled coat is formed of fibres surrounded by several

layers of small quadrangular cells, 0.016 mm. in diameter. Owing presumably to the worn condition of the cast, the embryo-scar has not been seen. Length of seed-cast, 9 mm.; breadth, 5.5 mm.; thickness through, and at right angles to, the chalazal scar, 4 mm.

REMARKS AND AFFINITIES. The form of this ruminant seed-cast, with its deeply sunk, thickened, ventral hilar-chalazal scar and associated coarse secreting cells suggests relationship with *Palmae*, but the distinctive circular embryo-scar has not been seen. The seed differs from any other Palm-seed described from the London Clay, and has been named *Palmospermum ornatum*, on account of the ornate surface produced by the ruminations.

V.29778 Holotype, figured Pl. 13, figs. 40, 41. A seed-cast. *D. J. Jenkins Coll.* Herne Bay, Kent.

Palmospermum sp.

Plate 13, figs. 42, 43

A sub-hemispherical fruit enclosing a single seed. Both fruit and seed have a deep hemispherical depression on the ventral surface and are rounded on the dorsal surface. The seed is somewhat collapsed on the dorsal side. A chalazal scar with branching fibres can be seen within the ventral hollow adjacent to the margin on one side (Pl. 13, fig. 42 *ch*); striae diverge from the margin of the hollow over the dorsal surface near this scar. On the opposite margin just outside the ventral hollow, a small circular scar, around which striae diverge, suggests an embryo. The surface of the fruit is much abraded but a few layers of equiaxial cells, about 0.016 mm. in diameter, can be seen over part of the circumference. The seed-cast shows long narrow cells about 0.008 to 0.01 mm. broad. The specimen appears to be distinguished by its large-mouthed deep ventral hollow from other species described. Diameter of specimen, 4 by 3.5 mm.; dorsiventral thickness, 2.75 mm.

Figured Pl. 13, figs. 42, 43. A fruit with seed-cast partially exposed (somewhat collapsed), now fractured to show the structure in section. *J. E. Cooper Coll.* Herne Bay, Kent. (The specimen is no longer extant.)

Palmospermum sp.

Plate 13, figs. 44, 45

The characters of this seed are partially obscured by adherent remains of the fruit. The form is sub-spherical, but flattened on the ventral side, a depression marking the hilar-chalazal scar appears to be sub-circular, and there is no evidence exposed of a hilar prolongation. A coarse network of furrows over the dorsal surface may represent fibres (removed by abrasion) lining the fruit-wall and remaining as impressions only on a film of pyrites between the fruit and seed. There is a coat of flattened, coarse, angular cells, 0.05 to 0.1 mm. in diameter, with black shining contents beneath the pyrites film seen when it is chipped away. In section the chalazal depression is about 4 mm. deep. Diameter of specimen, 7.5 by 7 mm.; dorsiventral thickness, 7 mm.

The characters of this specimen are insufficiently known for specific diagnosis. In size it is comparable with *Palmospermum cooperi* and *P. elegans*, but it apparently has a deeper ventral hollow than the latter species.

V.29779 Figured Pl. 13, figs. 44, 45. A seed with remains of fruit. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Palmospermum sp.

Plate 13, figs. 46-48

Fruit or seed: Sub-globular but somewhat laterally compressed, with an oval scar of attachment, about 3 by 2 mm. in diameter, leading into a deep, slightly curved, club-shaped hollow, deeper, narrower, and more curved than that of *Palmospermum* (?) sp. 7?. Structure of external coat obscure, represented by a few fragments only. Within is a coat, 0.2 mm. thick (endocarp?), formed in section of columnar cells. The whole interior (of the endocarp?) is filled with crystalline pyrites embedded in which are traces of a shining coat of obscure structure which may represent a testa or tegmen, or an accidentally included foreign body. Diameter measured through, and at right angles to, the hilum, 10 mm.; transverse diameters, 9 and 12 mm.

V.29780 Figured Pl. 13, figs. 46-48. An endocarp or fruit fractured to show the hilar-chalazal(?) hollow, and the structure of the carpel wall. *D. J. Jenkins Coll.* Herne Bay, Kent.

Palmospermum (?) sp. 7

Plate 13, figs. 49-51

1933 *Palmospermum*(?) sp. 7, Reid & Chandler, p. 116, pl. 1, figs. 37, 38.

Seed: Globular, with a ventral circular aperture associated with the hilum. The aperture leads into a symmetrical, club-shaped hollow, 5 mm. deep, full of decaying carbonaceous (chalazal) substance. The external surface is covered by a coat of coarse cells flattened parallel with the surface, arranged in part at least in stellate clusters, the cells at the centre of each cluster being about 0.03 mm. in diameter; thickness of coat about 0.1 mm. Within is a second coat, also about 0.1 mm. thick, formed of cells arranged in radial rows giving an irregularly columnar effect. A third inner coat is about 0.1 mm. thick but its structure is obscure. On the internal cast the cells diverge from the hilar aperture. Diameter of specimen measured at right angles to the hilum, 9.5 mm.; transverse diameter, 10.5 mm.

The characters suggest *Palmospermum* (?) sp. 7.

V.29781 Figured Pl. 13, figs. 49-51. A seed fractured longitudinally to show the chalazal hollow. *G. F. Elliott Coll.* Warden Point, Sheppey.

V.29782 A seed showing attachment. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

V.29783 A seed. *D. J. Jenkins Coll.* Herne Bay, Kent.

V.29784 A seed with chalazal depression exposed. *A. G. Davis Coll.* Warden Point, Sheppey.

?Palmospermum sp.

Plate 14, figs. 1-3; Text-fig. 10

Fruit: Ovoid, one-loculed, one-seeded, inconspicuously bisymmetric at one end, having uneven, sometimes discontinuous longitudinal ribs which converge towards one end (apex?) and meet along a short transverse angle in the plane of symmetry at the other (base?). A slight depression occurs in the middle of the angle, possibly marking the attachment. Pericarp, 0.4 mm. thick, formed of two regions, an outer thicker region of columnar cells, an inner region formed by two or three layers of cells, flattened at right angles to the surface, the cells being about 0.05 mm. broad.

Length of fruit about 9.5 mm.; estimated breadth (not quite complete) about 8 mm.

Endocarp: As preserved, formed superficially of black, inflated, irregular, often elongate cells about 0.05 mm. broad, forming a somewhat irregular surface. A small circular scar occurs

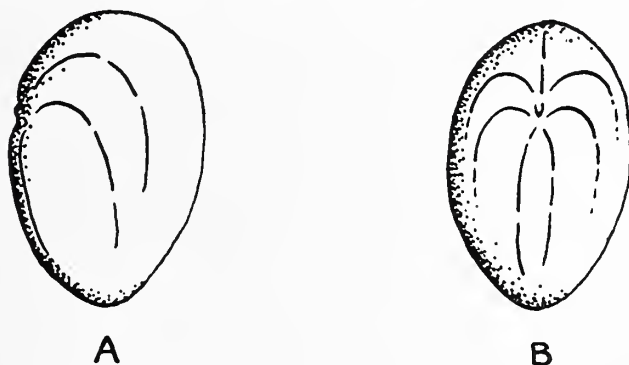


Fig. 10. ?*Palmospermum* sp. Endocarp or seed. Reconstructed. A, seed, looking on to plane of symmetry. B, at right angles to it, looking on to scar in plane of symmetry. In both fibres diverge from the scar.

in a depression in the plane of symmetry at about one-third of the length from the apex. There are traces of curved furrows (veins?) diverging from this scar. An outer coat may have decayed as the surrounding pericarp does not fit quite closely to the irregular surface described above.

Seed: Exposed in the upper part only on one side, smooth except for a few obscure ridges, formed of irregular flat-topped angular cells, varying from 0.025 to 0.05 mm. in diameter, producing a beautiful smooth tessellated surface.

REMARKS AND AFFINITIES. One specimen only of this beautiful little fruit has so far been found. In form and structure it somewhat resembles a Palm, but without more material its relationship must be regarded as doubtful. It is unlike any species of Palm hitherto described.

V.29785 Figured Pl. 14, figs. 1-3; Text-fig. 10. A fruit fractured to expose endocarp and (in one patch only) seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family NIPACEAE

Genus NIPA Thunberg

Nipa burtini (Brongniart) Ettinghausen

Plate 14, figs. 4-9

1933 *Nipa Burtini* (Brongniart): Reid & Chandler, p. 118, pl. 2, figs. 1-6.

To the description given in 1933 the character of the epicarp (seen on a specimen from Herne Bay) can now be added. It is papery and smooth, formed of longitudinally aligned, short, oblong, quadrangular to hexagonal cells, 0.012 to 0.016 mm. broad. In a small living *Nipa* fruit the epicarp cells are similar but larger, 0.016 to 0.025 mm. broad.

A number of new localities for this fossil have now been found in addition to those previously recorded. Outstanding among these are Bognor, which has yielded a number of fruits to

E. M. Venables' untiring efforts, and Herne Bay, where D. J. Jenkins and J. E. Cooper have now established that these fruits are almost as abundant as at Sheppey, both at the East Cliff and Swale Cliff ends of the shore.

Two good fruits have been found in division 5 of the London Clay at Bracknell, Berkshire by Davis (1936: 143). There is a record from dumped material on Clapham Common (division 2 beds).

Other localities where fruits are reported are Beddington Lane, Worcester Park (horizon *a*), Mogden Lane (in an excavation on the West Middlesex Sewage Disposal works) and at Whitton, near Twickenham, in division 3 beds (see Wrigley, 1924; 1940). Davis has added several records from Sheppey (see below).

The most westerly record of this genus and species from the London Clay comes from Verwood, Dorset, where a poorly preserved but unmistakable specimen (Pl. 14, fig. 9) was found in the Cockle Bed associated with the septarian band which forms the base of the Brick Pit.

- V.29786 Figured Pl. 14, fig. 4. The apex of a compressed and possibly abortive fruit 26.5 mm. broad.
- V.29787 Figured Pl. 14, fig. 7. A small, three-angled, immature fruit, almost perfect. Length, 55 mm., breadth, 23 mm. Now partly decayed and in fragments.
Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
Figured Pl. 14, fig. 6. A much compressed abortive fruit, imperfect at the base. Now decayed.
- V.29788 Figured Pl. 14, fig. 5. A small abortive but well-preserved fruit. Now partly decayed.
Both *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.
- V.24143 Figured Pl. 14, fig. 8. A fruit with part of the exocarp preserved, part broken away exposing the seed with typical corrugated surface. *A. G. Davis Coll.* In a concretion from the Modiola Beds (Division 5 of London Clay): Down Mill Company's Brickpits, Bracknell, Berkshire.
- V.36340 Figured Pl. 14, fig. 9. A poorly preserved specimen showing the seed-cast over most of the surface. The specimen is truncate below but the basal aperture is obscured by adhering matrix. The cast is angled longitudinally and over the angle at the upper end and to the right of it below are the typical impressions of the inner surface of the testa as described in 1933. Above and below poorly preserved remains of fibrous sarcocarp can be seen. Near the top of the seed are obscure impressions of the transverse endocarp fibres. *F. C. Stinton Coll.* Septaria in Cockle Bed at base of Brick Pit, Verwood, Dorset.
- V.29789 Three almost perfect immature specimens, one of which shows the epicarp and the basal aperture for the nutrient fibres exposed by the abrasion of the frayed basal fibres. Also fragments of three small fruits. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.
- V.29790 The middle part of a fruit showing characteristic fibres and cell-structure. The endocarp is exposed in a few patches.
D. J. Jenkins Coll. Dump I, Clapham Common (see p. 31).
- V.29791 Two small worn fruits. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
- V.29792 A small elongate fruit. *A. G. Davis Coll.* Swale Cliff, Herne Bay, Kent.
- V.29793 Six specimens mostly fragments, except one which is part of a medium sized abortive fruit. *J. E. Cooper Coll.* Herne Bay, Kent (all from a small area west of the town).
- V.29794 A fruit broken on one side near the base. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29795 A small compressed fruit. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex (*In situ*).
- V.29796 Three very small immature fruits. *A. G. Davis Coll.* Warden Point, Sheppey.

Family NIPACEAE or PALMAE

Genus?

Plate 14, fig. 10

A much compressed perianth, elongate-obovate in outline, is formed of three sepals united at the base but free for half or three-quarters of their length. Each has a number of conspicuous

raised longitudinal nerves. Length of perianth, 16.25 mm.; maximum breadth (increased by compression), 5.5 mm.

The form and structure suggest that the specimen may be the male flower of *Nipa*, or more probably of a palm. Small male flowers of similar type referred to *Calamus daemonorops* (Unger) have been recognized in the Bovey Lignite (Chandler, 1957: 88, pl.12, figs. 24-42).

V.29797 Figured Pl. 14, fig. 10. A male flower represented by three bracts united at the base. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

DICOTYLEDONES

Family JUGLANDACEAE

Whereas the family Juglandaceae is represented in the London Clay by eight species, the majority are very imperfectly known owing to the limited material which has been found. This may be due, in part at least, to the inconspicuous appearance of these rounded nuts,

<i>Name of species</i>	<i>Form of nut</i>	<i>Size (approx.)</i>	<i>Length of seed (approx.)</i>	<i>Number of basal lobes</i>	<i>Breadth of lobes at right angles to plane of dehiscence</i>	<i>Thickness of lobes at base in plane of dehiscence</i>	<i>Distance between lobes (approx.)</i>
<i>Juglandicarya lubbocki</i> (Reid & Chandler, 1933:140)	Globular or sub-globular	7 or 8 mm. in diameter	6.5 to 7 mm.	Deeply 4-lobed, bases of the four lobes closely adjacent	—	—	—
<i>J. cantia</i> (Reid & Chandler, 1933:142)	Globular	12 mm. in diameter	10 mm.	Two each slightly emarginate	7 mm.	—	—
<i>J. minuta</i> (see p. 138)	Sub-globular or ovoid	5 mm. long. Breadth in plane of dehiscence, 5 mm.; at right angles to this, 4.5 mm.	4 mm.	Two	2.8 mm.	1.9 mm.	2 mm.
<i>J. bognorensis</i> (see p. 140)	Sub-globular but compressed at right angles to plane of dehiscence	Incomplete (estimated length, 4mm.; breadth, 3 to 3.5 mm.)	2.5 mm.	Two? obscured by remains of endocarp	About 2.5 mm.	About 1mm.	0.5 mm.
<i>J. cooperi</i> (see p. 141)	?Sub-globular (incomplete)	Incomplete	5 mm.	Two	3-3.5 mm.	1 and 1.5 mm.	1.75 mm.
<i>J. depressa</i> (Reid & Chandler, 1933:143)	Roundly quadrangular or circular, dorsiventrally compressed	Length (always incomplete), 4 to 6 mm. Diameter, 6.5 to 12 mm.	3.5 mm.	Two	3 mm.	1 mm.	1.5 mm.
<i>J. crassa</i> (Reid & Chandler, 1933:145)	Not seen	Not seen	14 mm.	Four	—	5 or 6 mm.	7-8 mm.

which may have caused them to be overlooked. The only species abundant are *Petrophiloides richardsoni* with its characteristic cones, and *Juglandicarya depressa*. The remaining six species are based on one or two specimens only. The external surface is usually much abraded so that the true external characters are not seen, nor is the locule-cast (= seed) always fully displayed. Hence the species are not so well-defined as could be wished. Nevertheless the differences observed so strongly suggest distinct species that it seems more desirable to separate them provisionally, rather than to let them be overlooked through failure to define their characteristics so far as they are known.

The table on page 135, giving approximate measurements and outstanding features, may be useful for future work. *Petrophiloides richardsoni* is not included because of its very distinctive unmistakable characters.

Genus PETROPHILOIDES Bowerbank, 1840:43

Petrophiloides richardsoni Bowerbank

Plate 14, figs. 11-14

1840 *Petrophiloides Richardsonii* Bowerbank, p. 44, pl. 9, figs. 9-15; pl. 10, figs. 5-8.

1933 *Petrophiloides Richardsonii* Bowerbank: Reid & Chandler, p. 133, pl. 2, figs. 7-20; text-fig. 1.

Since the publication of the London Clay Flora in 1933, the late A. G. Davis and A. Wrigley called attention to another early record of this species in a paper by Richardson (1841: 211) which gave a full account of the cliff section and of an exposure of London Clay full of vegetable remains at Studd Hill, between Herne Bay and Tankerton, after a storm in 1839. Among the remains were bushels of *Petrophiloides* cones, of which about 500 were collected. The occurrence in the beds of *Balanocrinus sub-basaltiformis* (Miller) was confirmed by Davis, who stated in a letter that the species indicated the lower 100 feet of London Clay as at Herne Bay. Richardson's record is briefly alluded to by Bowerbank (1840: 44).

In 1939 Davis found sparse recognizable plant-remains at Holland-on-Sea, Clacton (Fiddle Dock), Essex, in pyrites patches, among which was a good cone of *Petrophiloides*. This is an entirely new locality for the species and indeed for plants. Several cones have also been found at Bognor.

- V.29798 Figured Pl. 14, fig. 11. A strobil embedded in pyrites so that only the outer surfaces of the scales are visible. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29799 Figured Pl. 14, fig. 12. A good but somewhat abraded cone from which most of the fruits have fallen. *A. G. Davis Coll.* Holland-on-Sea, Clacton (Fiddle Dock), Essex.
- V.29800 Figured Pl. 14, fig. 13. A cone abraded to show fruits variously sectioned and a few protruding intact between the worn down bases of the bracts. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.29801 Figured Pl. 14, fig. 14. A denuded cone-axis, narrowly obovoid in form and showing lozenge-shaped scars on the surface.
- V.29802 A somewhat distorted cone showing the fruits lying between the bracts.
Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29803 A distorted cone. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Genus *JUGLANDICARYA* Reid & Chandler, 1933: 140*Juglandicarya depressa* Reid & Chandler

Plate 14, fig. 15

1933 *Juglandicarya depressa* Reid & Chandler, p. 143, pl. 3, figs. 8-13.

V.29806 Figured Pl. 14, fig. 15. An incomplete endocarp, 4 mm. long, 5.75 by 4.25 mm. broad with the apex of the seed (locule-cast) exposed by abrasion. Size and proportions indicate this species.

V.29807 An endocarp abraded at the apex to show the seed.

Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29808 An endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

? Juglandicarya lubbocki Reid & Chandler

Plate 14, figs. 16, 17; Text-fig. 11

1933 *Juglandicarya lubbocki* Reid & Chandler, p. 140, pl. 3, figs. 1-4.

DESCRIPTION. *Endocarp*: Sub-globular, very thick-walled relative to the size, dehiscing into two symmetrical valves, one-loculed, one-seeded, seed erect. Locule simple, compressed at the apex, divided longitudinally below by an incomplete septum at right angles to the plane of dehiscence. Placenta median on the margin of the septum. Endocarp wall without visible cavities, formed of close coarse parenchyma. Length of endocarp (somewhat reduced by abrasion), 7 mm.; breadth in plane of dehiscence, 7 mm.; breadth at right angles to the plane of dehiscence, 8.5 mm.

Seed (locule-cast): Erect, orthotropous, agreeing with the locule in shape, much compressed, narrowly triangular above at right angles to the plane of dehiscence (Pl. 14, fig. 16;

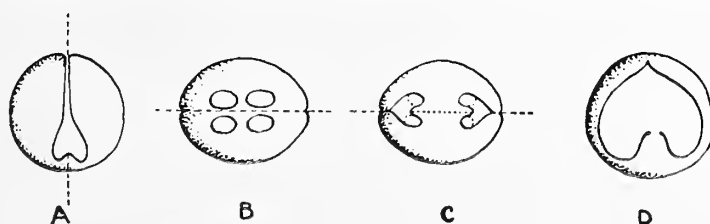


Fig. 11. *Juglandicarya lubbocki* Reid & Chandler. Diagrammatic figures. A, side looking on to suture, abraded so as to expose locule-cast (=seed). B, base slightly abraded to expose four lobes of the extreme base of the seed. C, the same more abraded. D, longitudinal section in plane of symmetry showing the lobed seed. Dotted lines indicate plane of dehiscence.

Text-fig. 11); in the plane of dehiscence broadly triangular above, expanded and deeply bilobed below owing to the projection of the incomplete septum into the locule (Text-fig. 11D); the basal primary lobes are slightly emarginate in the plane of dehiscence, thus producing four small secondary lobes (Text-fig. 11B) which, in the abraded cast, appear markedly concavo-convex as seen from the base with their concavities towards the septum (Pl. 14, fig. 17; Text-fig. 11C). Micropyle apical, hilum basal sunk between the primary lobes. Length of

seed, 6.5 mm.; breadth in plane of dehiscence, 6.5 mm.; breadth at right angles to plane of dehiscence, 2.5 mm. Length of primary lobes obscured by remains of the endocarp. Depth of emarginations of primary lobes, 1 mm. (i.e. less than one-sixth the length of the seed); breadth across the secondary lobes, 1 mm.; breadth between them, 1 mm. Surface of seed smooth without corrugations.

REMARKS. One endocarp abraded so as to expose the locule-cast in the plane of dehiscence and at the base. The specimen was fractured, but a clear view of the locule-cast was not exposed. It resembles *Juglandicarya lubbocki* Reid & Chandler in general appearance, but differs in the more compressed form of the locule-cast and in the shallower and more widely separated secondary lobes. It should, therefore, perhaps be regarded as a distinct species, but in view of the considerable variation in the proportions shown by the originals described in 1933, it may merely be another individual variant. Hence it is ascribed provisionally to *J. lubbocki*.

V.29804 Figured Pl. 14, figs. 16, 17; Text-fig. 11. An endocarp abraded so as to expose the locule-cast around the margin. It has been fractured in an unsuccessful attempt to expose the locule-cast completely in the plane of dehiscence. *J. E. Cooper Coll.* Herne Bay, Kent.

Juglandicarya sp. (*J. lubbocki*?)

Plate 14, fig. 18

DESCRIPTION. *Endocarp*: Broadly obcordiform, bisymmetric externally, sharply angled in the plane of dehiscence, one-loculed, one-seeded. Attachment sunk, apex (slightly incomplete) apparently pointed. Endocarp wall worn externally, formed of parenchyma and fibres, thick in section. Locule with an abnormal three-fold symmetry, simple but three-angled at the apex, sub-divided below into three deep compartments by three incomplete septa. Length of endocarp (as preserved), 7.5 mm.; estimated complete length about 8.5 mm.; greatest breadth, 10 mm.; thickness at right angles to this, 6.5 mm.

Seed: Partly obscured by adherent endocarp, conforming to the locule in shape, hence three-sided above, deeply three-lobed below, each lobe probably emarginate or bifid as suggested by a section seen on fracturing the specimen. Dimensions obscured by the endocarp.

REMARKS. One endocarp, abraded above. The trisymmetry of locule and seed is an unusual feature, but has been recorded both in fossil and living Juglandaceae (Kirchheimer, 1938: 625, 626, who quotes Kronfeld, Panzig and others). Hence the anomalous form is probably an individual peculiarity, not of generic or specific value. In size the endocarp approaches *Juglandicarya lubbocki* (Reid & Chandler, 1933: 140, pl. 3, figs. 1-4); it is smaller than *J. cantia* (1933: 142, pl. 3, figs. 5-7); and larger than *J. bognoensis*, *J. cooperi* and *J. minuta*, all of which are described below.

V.29805 Figured Pl. 14, fig. 18. An endocarp abraded at the apex so as to expose the trisymmetric seed (locule-cast). *J. E. Cooper Coll.* Herne Bay, Kent.

Juglandicarya minuta n. sp.

Plate 14, figs. 19-24; Text-fig. 12

DIAGNOSIS. Endocarp sub-globular or ovoid, slightly compressed at right angles to the plane of dehiscence. Seed deeply bilobed below, primary lobes elongate at right angles to

the plane of dehiscence, scarcely emarginate at the base? Length of endocarp about 5 mm. Length of seed about 4 mm.; breadth of cotyledons at right angles to plane of dehiscence, 2.8 mm. Thickness of cotyledons at base in plane of dehiscence, 1.9 mm.; distance between them about 2 mm.

HOLOTYPE. V.29809.

DESCRIPTION. *Endocarp*: Sub-globular or ovoid, slightly compressed laterally at right angles to plane of dehiscence, probably smooth externally, dehiscing into two equal valves, one-loculed, one-seeded, locule simple above, sub-divided below into two deep compartments by a septum transverse to the plane of dehiscence, placenta median at the edge of the septum. Attachment scar large, circular, about 1.5 mm. in diameter, probably enlarged by abrasion. Endocarp woody, formed of coarse parenchyma, with no visible cavities, cells angular, equiaxial, 0.03 mm. in diameter, with embedded longitudinal fibre strands near the exterior, thickness of carpel wall at the sides in the plane of symmetry, 0.6 mm. Length of endocarp about 5 mm.; breadth in plane of dehiscence about 5 mm.; breadth at right angles to plane of dehiscence about 4.5 mm. A second more abraded specimen gave the following measurements: length (imperfect especially at the apex), 3 mm.; breadth in plane of dehiscence, 5.6 mm.; breadth at right angles to plane of dehiscence, 4.5 mm.

Seed: Erect, orthotropous, seated astride the septum and placenta, conforming to the locule in shape, entire above, deeply bilobed below. Apex triangular, somewhat attenuated,

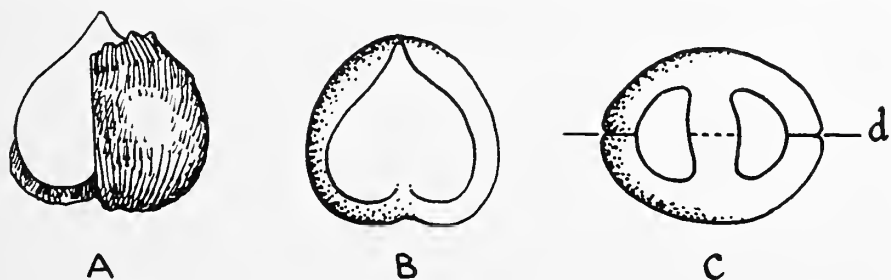


Fig. 12. *Juglandicarya minuta* n. sp. A, nut with part of the endocarp worn away on the left and at the apex exposing the locule-cast (=seed). Viewed at right angles to plane of dehiscence. B, nut sectioned longitudinally looking on to plane of dehiscence (diagrammatic restoration). C, lobes of the locule-cast (=seed) as seen from the base when exposed by abrasion. *d*, plane of dehiscence.

compressed at right angles to the plane of dehiscence, primary lobes elongate at right angles to the plane of dehiscence, scarcely emarginate, or bifid, at the base, so far as can be seen, hence without secondary lobes (Text-fig. 12C). Length of locule-cast (virtually of seed) about 4 mm.; breadth of lobes at right angles to plane of dehiscence, 2.8 mm.; thickness of lobes at base, in the plane of dehiscence, 1.9 mm.; distance between lobes about 2 mm.

REMARKS. Two fruits, one with about half of each valve broken away at right angles to the plane of dehiscence (Pl. 14, fig. 20); showing the locule-cast (seed) within, the extreme tip of which broke during examination of the specimen. The two valves had begun to gape at the apical end and pyrites had filtered into the gap thus formed, producing a longitudinal median ridge on the primary lobes of the cast within. The second specimen was much abraded and

imperfect at the apex so that the worn seed (locule-cast) was exposed; it was subsequently fractured longitudinally (asymmetrically).

The endocarp is smaller than *Juglandicarya depressa*, the smallest species hitherto described from the London Clay (Reid & Chandler, 1933: 143, pl. 3, figs. 8-13). It is also relatively narrower and more elongate than that species, thinner walled and more rounded in outline.

V.29809 Holotype, figured Pl. 14, figs. 19-21. An endocarp with about half of each valve broken away exposing one primary lobe of the locule-cast (seed). The extreme tip of the seed broke during examination of the specimen. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

V.29810 Figured Pl. 14, figs. 22-24. An endocarp (fractured irregularly longitudinally) much worn at the apex. *G. F. Elliott Coll.* Warden Point, Sheppey.

Juglandicarya bognoensis n. sp.

Plate 15, figs. 1, 2; Text-fig. 13

DIAGNOSIS. Endocarp sub-globular, not conspicuously dorsiventrally compressed. Seed compressed at right angles to plane of dehiscence, deeply bilobed below, lobes entire, but fluted at the extreme base. Length of locule-cast (seed), 2.5 mm.; breadth in plane of dehiscence, 2.5 mm.; breadth at right angles to plane of dehiscence, 2.25 mm.; thickness of lobes in plane of dehiscence probably about 1 mm.; distance between lobes about 0.5 mm.

HOLOTYPE. V.29811.

DESCRIPTION. *Endocarp*: Sub-globular (now much broken) evidently dehiscing into two valves, one-loculed, surface much worn. Locule simple at the apex, sub-divided at the base into two deep compartments by an incomplete septum transverse to the plane of dehiscence. Placenta not seen. Length and breadth of endocarp incomplete; length as estimated about 4 mm.; breadth (estimated), 3 or 3.5 mm. (In another specimen (?) length, 5 mm.; breadth, 6.5 by 5 mm.)

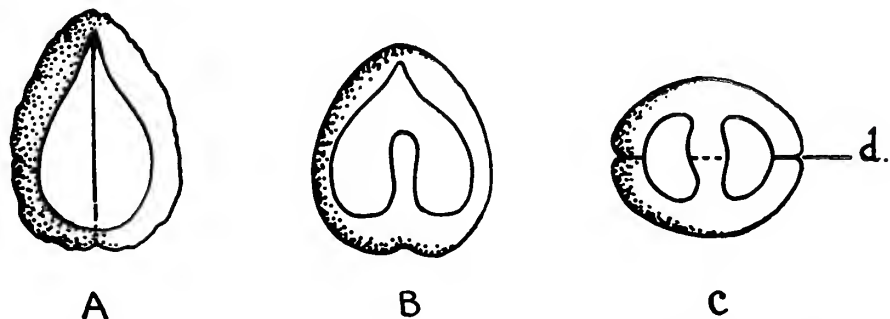


Fig. 13. *Juglandicarya bognoensis* n. sp. A, looking along the plane of dehiscence, near part of endocarp removed to show locule-cast (diagrammatic). B, looking on to plane of dehiscence, near valve removed so as to show locule-cast. C, base abraded so as to show lobes of locule-cast (=seed). *d*, plane of dehiscence.

Seed: Conforming to the locule in shape, simple above, deeply bilobed below, apex broadly triangular in the plane of dehiscence of the nut, somewhat compressed at right angles to that plane, basal lobes apparently entire but fluted at the extreme base, closely approximated,

concavo-convex with the concave sides towards the septum. Length of locule-cast (virtually of seed), 2.5 mm.; breadth in plane of dehiscence, 2.5 mm.; breadth at right angles to plane of dehiscence, 2.25 mm.; thickness of lobes in plane of dehiscence apparently 1 mm.; distance between lobes about 0.5 mm. (The last two dimensions are somewhat obscured by the remains of the endocarp and are therefore approximate only.)

REMARKS AND AFFINITIES. One locule-cast surrounded at the base by remains of the much abraded endocarp, and a second with remains of endocarp at the base and covering one lobe. There is also an abraded endocarp referred provisionally to this species. While the form relates the species definitely to Juglandaceae, it differs from small-fruited living genera such as *Pterocarya* and *Engelhardtia* in the entire pair of basal lobes of the seed and corresponding hollows of the locule. The nut is much smaller than any *Juglandicarya* from Sheppey or Herne Bay except *J. depressa* and *J. minuta* and is considerably smaller even than those two species. It is more ovoid than *J. minuta* and is of an entirely different shape both in its endocarp (so far as can be seen) and in its seed (locule-cast) from *J. depressa*. Thus, the endocarp appears to have been sub-globular or more or less ovoid and relatively thin, whereas in *J. depressa* it is dorsiventrally compressed, roundly quadrangular or sub-circular in outline, thick as seen in section. The basal lobes of the seed are somewhat closer together, and are less compressed in the plane of dehiscence than in *J. depressa*.

V.29811 Holotype, figured Pl. 15, figs. 1, 2; Text-fig. 13. A locule-cast with remains of the endocarp at the base.

V.29812 A locule-cast with remains of the endocarp at the base and completely concealing the cast and its lobe on one side.

V.29813 A much abraded endocarp with locule-cast exposed only in section. The size indicates that it belongs to this species.

All *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Juglandicarya cooperi n. sp.

Plate 15, figs. 3-5; Text-fig. 14

DIAGNOSIS. Endocarp probably sub-globular, not dorsiventrally compressed. Seed broadly triangular in plane of dehiscence, deeply bilobed below, lobes entire. Length of seed, 5 mm.; breadth in plane of dehiscence, 4 mm.; breadth of lobes at right angles to plane of dehiscence, 3 and 3.5 mm.; thickness of lobes at base of seed, 1 to 1.5 mm.; their distance apart, 1.75 mm.

HOLOTYPE. V.29814.

DESCRIPTION. *Endocarp*: Sub-globular? but original form destroyed by abrasion, apparently not dorsiventrally compressed, dehiscing into two symmetric valves. One-loculed, one-seeded, locule simple above, deeply sub-divided below into two compartments by an incomplete septum at right angles to the plane of dehiscence. Remains of endocarp formed of close woody parenchyma. Length and breadth of endocarp imperfect.

Seed (locule-cast): Erect, orthotropous, conforming to the locule in shape, apex broadly triangular in the plane of dehiscence, compressed at right angles to that plane (Pl. 15, figs. 3, 4). Expanded and deeply bilobed below. Lobes entire. Hilum sunk, median on the basal septum, 3 mm. from the base of the seed. Length of seed, 5 mm.; breadth in plane of dehiscence, 4 mm.; breadth of lobes at right angles to plane of dehiscence, 3 and 3.5 mm. respectively;

thickness of lobes at the base of the seed, 1 and 1.5 mm. respectively; distance apart at base of seed, 1.75 mm.

REMARKS AND AFFINITIES. One much abraded endocarp with well-preserved locule-cast. The species resembles *Juglandicarya depressa* (Reid & Chandler, 1933: 143, pl. 3, figs. 8-13)

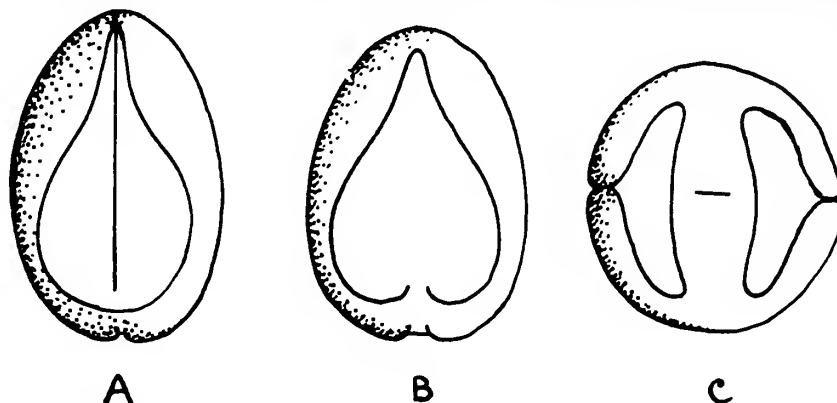


Fig. 14. *Juglandicarya cooperi* n. sp. A, diagram of endocarp viewed along the edge of the plane of dehiscence, abraded so as to expose the locule-cast. B, the same looking on to the plane of dehiscence after removal of the near valve. C, base abraded to show the arrangement of the lobes of the seed and locule-cast.

in its small size and bilobed seed, but differs in being relatively longer with thicker lobes more convex on their outer (dorsal) surfaces as seen at the base. From *J. bognorensis* (p. 140, Pl. 15, figs. 1, 2), another small species, the seed is distinguished by the relatively less closely approximated thicker basal lobes, the somewhat larger size, and the more attenuated apex.

V.29814 Holotype, figured Pl. 15, figs. 3-5; Text-fig. 14. A locule-cast exposed by the fracture of the much abraded endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

Genus PTEROCARYOPSIS nov.

DIAGNOSIS. Bisymmetric, flattened, winged fruits belonging to Juglandaceae, having two large rounded lateral wings, one on each side of the endocarp in the plane of symmetry. Wings probably opaque owing to parenchymatous tissue between their two surfaces. Attachment basilateral on the lower surface producing a small deep concavity. Locule and seed with two deeply-separated primary lobes. Secondary lobes, if any, not known.

Length of fruit about 3.5 mm.; breadth, 5.75 mm.; thickness, 1.48 mm. Breadth of seed about 1.6 mm.

TYPE SPECIES. *Pterocaryopsis bognorensis* n. sp.

Pterocaryopsis bognorensis n. sp.

Plate 17, figs. 1, 2

DIAGNOSIS. As for genus.

HOLOTYPE. V.30585.

DESCRIPTION. *Fruit*: Bisymmetric, flattened, having a somewhat flattened endocarp flanked by the two large rounded lateral wings, one on each side in the plane of flattening of the nut.

Style and perianth segments abraded but clearly originally terminal and median. Lower surface of fruit more or less flat, upper slightly convex. Base deeply emarginate with deeply sunk concave scar of attachment basal on the lower surface. Where best preserved near the base the surface of the wing is formed of narrow cells aligned so as to produce striations about 0.018 mm. apart. These diverge from the attachment area. Over most of the surface the striate epicarp is abraded exposing the parenchyma which forms the thickness of the wing, its convex cells being about 0.027 mm. in diameter. Over the endocarp the abrasion has removed all the carpellary coats, thereby exposing the locule-cast or seed. This is solitary erect deeply bilobed at the cotyledonary end, flattened and triangular in outline at the micropyle end towards the apex of the fruit, as seen on the upper surface of the specimen. The primary lobes occupy half the length of the seed on this surface, whether or not their bases are divided into secondary lobes cannot be seen owing to adhering carpel wall. If present they must have been small. Abrasion on the lower surface of the specimen is less and the two primary lobes appear to be closer together and separated by a deeper steeper sided furrow. On this surface one lobe of the cast shows equiaxial rounded cells about 0.038 mm. in diameter. In the furrow between the lobes on the upper surface a fragment of testa is preserved as an impression on a film of pyrites showing longitudinally aligned cells.

Length of fruit about 3.5 mm.; breadth, 5.75 mm.; thickness, 1.48 mm. Length of locule-cast (virtually seed) about 2.05 mm. (the precise limits a little obscure); breadth about 1.6 mm.

REMARKS AND AFFINITIES. One specimen, including the wings, preserved in pyrites. It resembles certain species of *Pterocarya* in having a lateral wing in the plane of symmetry on each side of the endocarp. But in its shape and its rounded wings it even more resembles *Hooleya hermis* (Unger) (Reid & Chandler, 1926: 93, pl. 6, figs. 7-9). *Pterocarya* is invariably much larger than the fossil, but is like it in the stiffness of its wings and their internal thickening of parenchyma. *Hooleya* is about the same size as the fossil but its wings are thin, rather resembling those of a *Betula* in texture. Its nut is very much compressed and so far as can be seen there is no basilateral deep excavation marking the attachment. Its locule-cast and seed are virtually unknown.

It appears from the above that the Bognor fossil cannot be placed in either of these genera. A new name, *Pterocaryopsis*, has therefore been given, the specific name, *bognorensis*, indicating the place of discovery. The diagnosis of the genus is incomplete in certain respects pending the finding of more material, especially as regards its secondary lobes. Moreover, there is no evidence whether stout superficial nerves diverging from the body were, or were not present in the unabraded wings. But in spite of these defects in knowledge, the fossil appears sufficiently distinctive to be readily recognizable again.

The marked bisymmetry, coupled with the deep excavation on the lower surface, marking attachment to a stem or axis, almost certainly indicate growth in a cluster or loose spike. *Platycarya* has a similar sub-basal excavation, but the large wings in *Pterocaryopsis* suggest a looser type of inflorescence.

V.30585 Holotype, figured Pl. 17, figs. 1, 2. A winged fruit abraded over the middle especially on the upper surface so as to expose the locule-cast or seed. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.

Family MORACEAE

Genus MORUS (Tourn.) L.

? *Morus* sp.

Plate 15, figs. 6, 7; Text-fig. 15

DESCRIPTION. *Endocarp*: Ovoid-triangular, rounded at the base, triangular above having one face somewhat narrower than the other two. Placenta indicated by a triangular aperture (Pl. 15, fig. 6) with slightly incurved edges at the apex of the narrow face. Wall compact, smooth superficially, at least 0.15 mm. thick in parts, formed of more or less equiaxial, finely digitate cells. Locule-lining of elongate, finely digitate cells variously and irregularly oriented, measuring about 0.1 by 0.05 mm. in diameter. Seed solitary pendulous. Length of endocarp, 4.75 mm.; maximum breadth, 3.25 mm.; breadth of narrow face, 3 mm.

Seed: Agreeing with the locule in shape. Testa formed of irregular equiaxial cells, about 0.016 to 0.025 mm. in diameter, arranged approximately in longitudinal rows.

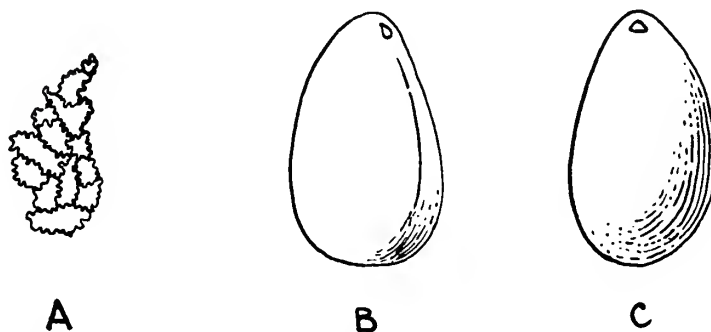


Fig. 15. ?*Morus* sp. A, cells of locule-lining. B, endocarp with placental aperture turned partly to the right. C, endocarp with placental aperture facing observer.

REMARKS AND AFFINITIES. One specimen with the carpel wall preserved. The form of the endocarp, the character and position of the sub-apical placental aperture, and the solitary seed, indicate Moraceae. The finely digitate cells of the carpel wall and the character of the testa confirm this relationship. In the Recent *Morus nigra* the digitate cells of the locule-lining are more or less equiaxial, and the remains of the funicle persist as a woody process projecting from the placenta and lying parallel with the ventral margin of the seed, but this process is relatively easily broken away. While the endocarps of this species are smaller than the fossil they are sometimes closely comparable with it in form. Clearly, if the relationship of the fossil is not with *Morus* itself, it must be with some closely allied genus. This is the first record of the Moraceae in the London Clay, a tropical and subtropical family with a few temperate species. *Morus* itself is a genus restricted to north temperate regions.

V.29815 Figured Pl. 15, figs. 6, 7; Text-fig. 15. An endocarp originally with carpel preserved in carbonaceous substance, now with the wall and part of the locule-cast chipped away so as to expose the seed. A. G. Davis Coll. Warden Point, Sheppey. *In situ*.

Genus?

Plate 15, figs. 8, 9

DESCRIPTION. *Fruit*: One-loculed, one-seeded, with obscure bisymmetry in a plane passing through the major axis marked by a short longitudinal ridge or angle which rapidly dies out below the sub-apical placenta. The fruit is somewhat distorted; probably owing to pressure of adjacent fruits in a head. Placenta marked externally by a small oval scar or aperture close to the apex, slightly asymmetrically placed (Pl. 15, fig. 8); carpel wall largely abraded, but where preserved (in a few patches only) showing in section a maximum thickness of 0.6 mm. The woody wall appears to be formed mainly of equiaxial cells, finer outside and inside, with a few layers of coarser cells, about 0.016 mm. in diameter, in the middle; lining the locule are a few layers of narrow elongate cells, about 0.012 mm. broad, transversely aligned so as to give the locule-cast a transversely striate appearance. Seed pendulous. Length of locule-cast, 8.15 mm.; transverse diameter in plane of symmetry, 6 mm.; at right angles to plane of symmetry, 5 mm.

Seed: Agreeing with the locule in shape. Testa with superficial longitudinal striae near the hilum where exposed and with underlying equiaxial cells, variable in shape and size, from 0.025 to 0.05 mm. in diameter.

REMARKS AND AFFINITIES. The form with slightly asymmetrically placed sub-apical placental aperture suggests relationship with Moraceae or Urticaceae. Similar elongate transverse cells lining the locule are seen in *Maclura* (Moraceae). No living genus exactly comparable with the fossil in size and form has yet been found.

V.29816 Figured Pl. 15, figs. 8, 9. An endocarp with carpel wall largely abraded. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus?

Plate 15, figs. 10-13; Text-fig. 16

A fruiting spike (very slightly imperfect at each end) is difficult to interpret and describe in the absence of closely comparable living material. The study of a transversely fractured surface and of a series of longitudinal tangential sections as they were exposed by gradual rubbing down of the specimens on a hone stone has, however, thrown much light upon the structure.

The length of spike actually preserved is 11.5 mm. The curvature of the ends suggests that when perfect the length was about 13 mm. Breadth of spike, 4.5 mm.

DESCRIPTION. *Spike*: Sub-cylindrical, tapering gently towards the apical end. There is an axis about 1.5 mm. in diameter on which are borne the fruits and spirally arranged bracts. The bracts are close-set and contiguous at the surface of the spike where they produce lobed quadrangular areas, the largest at the base about 2.5 to 3 mm. broad and 2 mm. high. Each bract has one large median convex lobe at its base (as seen on the surface of the spike) and a pair of smaller lobes aligned obliquely, one pair on each side of the median lobe, but above it (Pl. 15, fig. 10; Text-fig. 16c). The lobes are separated by deep furrows. In section the bracts appear to have been fleshy with many cavities (now heavily impregnated with pyrites). They may have been formed by the fusion of five bracts forming the lobes; if so, however, the fusion

is complete except at the extreme apex, as shown by the transverse sections of the bracts when the spike was rubbed down tangentially (Pl. 15, fig. 13). The surface of the bracts (as exposed in the transverse fracture of the spike) is finely striate with striae about 0.012 mm. apart. There

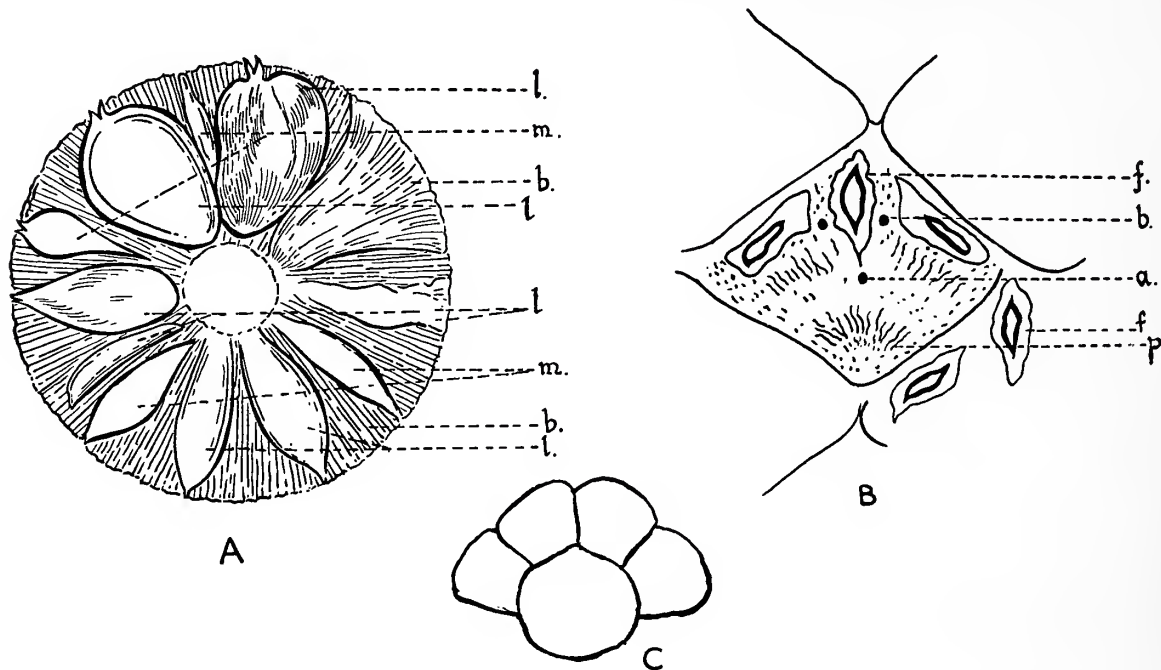


Fig. 16. Moraceae. Genus ? A, transverse section of catkin showing a bract in surface view (*b*, top right) and the fruits variously sectioned which are associated with the bracts (*b*) below fruits, cf. Pl. 15, fig. 11; *l*, lateral fruits which flank the median ones and lie on the upper surfaces of the bracts; *m*, median fruits partly embedded in bracts with longitudinal orientation. B, longitudinal tangential section of part of fruiting spike with quadrangular areas due to bracts. *a*, median axis of a bract; *b*, symmetrically placed bundles; *f*, fruitlets showing epicarp and endocarp in section; *p*, pulpy tissue of bract. C, surface of a bract showing five lobes.

is some evidence in the section, of a small median axis in each bract from which the coarse pulpy cells (0.016 to 0.025 mm. in diameter) diverge. Also a pair of small symmetrically placed bundles may be indicated by black dots near the upper surface of the bract on each side of a median fruitlet (Pl. 15, fig. 13; Text-fig. 16B).

The fruitlets are borne in groups of three, consistently arranged upon, or possibly partially embedded within, the surface of each bract. There is one median fruitlet with its broader transverse axis vertical (i.e. parallel with the axis of the spike) in a median furrow. It is flanked by two lateral fruitlets, one on each side, with their broader transverse axes parallel with the oblique surfaces of the bract (Pl. 15, fig. 13; Text-fig. 16B). As seen on the transversely fractured surface of the spike, the fruits, when complete, are oboval in outline, sometimes slightly emarginate at the apex, with a pair of terminal apical styles which project between the edges of the bracts. The fruitlets are attached probably directly to the axis of the spike at the opposite extremity to the styles. In the transverse section of the spike several of the fruitlets are themselves sectioned, the section varying in outline according to the direction of the fracture (Pl. 15, figs. 11, 12). In transverse sections of the fruitlets there is always a more or less lenticular outline (Pl. 15, fig. 13) but the size of the lens varies according to the position of the section

near the base, apex or middle of the fruitlet. Two integuments are clearly visible. An outer loose-fitting coat giving an irregular lenticular section, only 0.025 mm. thick or less, probably represents the epicarp. Between it and the endocarp there is evidence of thin-walled cells at right angles to the latter (usually broken down?). The inner coat (endocarp) is stouter, usually about 0.05 mm. thick, except at the margins, where it may be 0.15 to 0.2 mm. thick. Possibly there is a suture connected with germination at the margins. The surface of the fruit was apparently formed of sinuous or finely digitate, more or less equiaxial cells difficult to see clearly, 0.012 to 0.025 mm. in diameter. On the marginal suture the cells are longitudinally elongate. Locule-lining of elongate cells with finely sinuous outlines, about 0.012 mm. broad. Seed solitary in the locule (seen in section only); testa very thin. Length of fruitlets from attachment to base of style, 1.2 to 1.4 mm. Length of styles, 0.2 to 0.3 mm. Breadth of median fruitlets (epicarp), 0.9 mm.; (endocarp), 0.75 mm. Breadth of lateral fruitlets (epicarp), 1.2 to 1.3 mm.; (endocarp), 0.75 to 0.9 mm. Thickness of median fruitlet (epicarp), 0.45 to 0.5 mm.; (endocarp), 0.35 mm. Thickness of lateral fruitlets (epicarp), 0.45 mm.; (endocarp), 0.25 to 0.3 mm.

REMARKS. One spike of fruits and bracts. Comparison was made with *Alnus* and *Betula* but the fruit structure of the fossil with its solitary locule does not agree with either. The oboval fruit with apical pair of styles, single locule, sinuous cells and solitary seed point to relationship with Moraceae. The nearer connexion has not been established.

V.29817 Figured Pl. 15, figs. 10-13; Text-fig. 16. A fruit spike now fractured transversely and rubbed down longitudinally, to show the structure of the fruitlets and bracts. *D. J. Jenkins Coll.* Herne Bay, Kent.

Family OLACACEAE

Genus ERYTHROPALUM Blume

? *Erythropalum europaeum* Reid & Chandler

1933 *Erythropalum europaeum* Reid & Chandler, p. 147, pl. 3, figs. 15-17.

An ovoid fruit with basal circular scar, endocarp wall, 0.6 mm. thick, composed of small radially-aligned cells about 0.025 mm. in diameter. The wall is broken away over most of the surface exposing the locule-cast with low, rounded, longitudinal ridges separated by fibro-vascular bundles sunk in furrows. Surface of the locule-cast showing longitudinally-elongate and equiaxial cells about 0.03 mm. in breadth. The solitary seed with crumpled surface and testa of fine equiaxial cells, 0.01 to 0.012 mm. in diameter, is poorly preserved in soft decaying pyrites. Length of fruit as preserved, 10.5 mm.; breadth, 9 mm.

The specimen resembles *Erythropalum europaeum*, but does not show the network of anastomosing fibres on the locule-cast, instead longitudinal fibres are seen. This apparent difference may, however, be due to the degree of abrasion.

V.29818 An ovoid fruit with the endocarp wall broken away exposing the locule-cast. *A. G. Davis Coll.* Warden, Sheppey.

Erythropalum turbinatum n. sp.

Plate 15, figs. 14, 15

DIAGNOSIS. Endocarp turbinate, with a circular scar of attachment at one end, and a depressed scar, 3 mm. in diameter, at the other. Internal surface with longitudinal strands of fibres giving off finer fibres to form a network. Length of cast, 6 mm.; breadth, 9 mm.

HOLOTYPE. V.29819.

DESCRIPTION. *Endocarp*: One-loculed, turbinate with a circular scar of attachment at one end, and a depressed circular apical scar about 3 mm. in diameter at the other. Carpel wall preserved in small patches only at the apex. Structure obscure. Locule-cast bearing impressions of longitudinal strands of fibres giving off finer fibres which branch and anastomose to form a fine network. Length of cast, 6 mm.; breadth, 9 mm.

REMARKS. A single specimen which differs from both *Erythropalum europaeum* and *E. striatum* (Reid & Chandler, 1933: 149, pl. 3, figs. 18-20) in its turbinate form; from the former also in its much more complicated system of fibres lining the locule, and from the latter in its larger size.

V.29819 Holotype, figured Pl. 15, figs. 14, 15. A locule-cast. *D. J. Jenkins Coll.* Warden, Sheppey.

Erythropalum jenkinsi n. sp.

Plate 15, figs. 16, 17

DIAGNOSIS. Endocarp ovoid, coarse fibres of the internal surface most conspicuous at the lower end. Length of locule-cast about 14.5 mm.; diameter about 11 mm.

HOLOTYPE. V.29820.

DESCRIPTION. *Endocarp*: One-loculed, one-seeded, ovoid, with small projecting terminal scar (of attachment?). Carpel wall abraded, represented only by small pyritized adherent patches on the surface of the locule-cast formed of flattened equiaxial cells 0.025 to 0.03 mm. in diameter. Surface of locule having a coarse network of flat fibro-vascular strands which diverge from one end and converge to the other. These strands branch and anastomose so as to produce conspicuous long parallel-sided meshes on the lower part of the fruit, and longer less conspicuous meshes on the upper part. Extreme apex broken. Length of locule-cast, 14.5 mm.; diameter, 11 mm.

Seed: Conforming to the locule in shape. Testa (exposed only in one crumpled shrunken patch) of small equiaxial flat-topped cells about 0.025 to 0.03 mm. in diameter.

REMARKS. One specimen broken on one side towards the apex, with a small patch of the locule-cast chipped away near the base, thus exposing the shrivelled seed. A second specimen represents the basal half only of a locule-cast. They closely resemble in general structure, form and arrangement, the endocarp of *Erythropalum europaeum* (p. 147) but are considerably larger, while the network of fibres lining the locule is less conspicuous at the apical end than in that species. *E. jenkinsi* is somewhat larger than the living *E. scandens* Blume.

V.29820 Holotype, figured Pl. 15, figs. 16, 17. A locule-cast (incomplete towards the apex on one side). A small patch of cast has flaked away and shows the shrivelled seed-cast within. East Cliff shore.

V.29821 The basal end of a locule-cast. Hampton shore.
Both *D. J. Jenkins Coll.* Herne Bay, Kent.

Family MENISPERMACEAE

It is remarkable that a small living family like the Menispermaceae should be so well represented in the London Clay. Eighteen distinct species distributed among fourteen genera (including one form-genus *Menispermicarpum*) have now been described. Of these species, two are known from numerous individual specimens; five from several specimens, and the rest from one or two specimens only. The rich representation of this family cannot be wholly due to the striking appearance of the peculiar curved and often ornamental endocarp so that they are seen fairly easily in collecting and when found are recognized without great difficulty. Reid & Chandler (1933: 158) pointed out that four of the five genera at that time determined had proved to be extinct; an additional six extinct genera are now known, making ten in all. One genus, newly described, can be identified with considerable confidence with No. 656 in Crow's manuscript-catalogue 1810 (Reid & Chandler, 1933: 157, 158). It is here referred to the living genus, *Diploclisia*. The family occurs in the Sheppey, Herne Bay, Nursling and Bognor floras.

Section FIBRAUREAE

Genus TINOMISCOIDEA Reid & Chandler, 1933:162

Tinomiscoidea scaphiformis Reid & Chandler

1933 *Tinomiscoidea scaphiformis* Reid & Chandler, p. 162, pl. 4, figs. 1-4.

V.29822 A locule-cast. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.

Genus TINOMISCIUM Miers

Tinomiscium taylori n. sp.

Plate 15, figs. 18-21; Text-fig. 17

DIAGNOSIS. Endocarp straight, bisymmetric, scarcely boat-shaped, without internal condyle or plate on the ventral surface; shallow ventral concavity delimited by rounded margins and divided by a marked longitudinal ridge on both sides of which are conspicuous elongate tubercles. Dorsal surface with a median ridge flanked on each side by transversely elongate and aligned tubercles, sometimes connected with one another by short branches. Placenta median, ventral, sub-apical. Locule wall smooth, as seen in transverse section. Length of endocarp, 9.5 mm.; breadth, 4.5 to 5 mm.; thickness, 2 to 3.5 mm.

HOLOTYPE. V.30574.

DESCRIPTION. *Endocarp*: Straight, bisymmetric, elongate-ovate in outline, shallow boat-shaped, scarcely hollowed on the ventral side, without a ventral internal condyle or plate, with a longitudinal ridge in the plane of symmetry on both surfaces, but especially sharp and conspicuous on the ventral surface within the ventral hollow. Placenta on the ventral ridge about 2 mm. from the apex. Surface ornamented with a series of ridges, or transversely elongate

tubercles, transversely aligned on the dorsal side, converging towards the ventral concavity at the lower end on the ventral side, occasionally united by branches given off at right angles, especially on the dorsal side, tending to die out on the lateral margins where one or two longitudinally aligned ridges may occur. Walls thick, fibrous, surface cells obscured by abrasion. In section a longitudinal fibro-vascular bundle is seen within the ventral ridge. Length of endocarp, 9.5 mm.; breadth, 4.5 to 5 mm.; thickness, 2 to 3.5 mm.

Seed: Solitary, dorsiventrally compressed (as seen in transverse section), slightly hollowed on the ventral face with a marked median longitudinal ridge within the hollow, which may indicate the position of the raphe (Text-fig. 17). Testa (seen on the seed-cast) formed of equiaxial cells, 0.016 to 0.025 mm. in diameter.

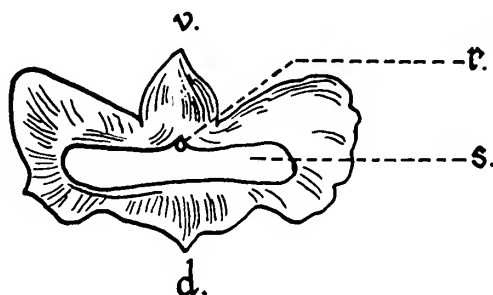


Fig. 17. *Tinomiscium taylori* n. sp. Diagrammatic transverse section of endocarp and seed. *d*, dorsal ridge; *r*, raphe; *s*, seed; *v*, ventral ridge.

REMARKS AND AFFINITIES. Two endocarps, one with an adherent mass of pyrites on the ventral surface which obscures its form and structure. The general form and symmetry, the slight hollowing of the ventral surface, the position of the placenta indicated by a broadening of the ridge and a small scar, and the fibrous endocarp, all indicate relationship with Menispermaceae (Section Fibraureae). There is a very close resemblance to *Tinomiscium* Miers, but no such small species of that genus is known among Recent forms. *T. petiolare* (Wall.) is 26 mm. long. It has a similar but less coarse and less upstanding pattern of ridges or elongate tubercles which may merge into one another. Also the external longitudinal median ridge is a much less marked feature.

There appears to be no adequate grounds for separating this small species from the living genus. It has therefore been described as *Tinomiscium taylori* after the finder of the holotype, Mr. H. E. Taylor. There is some resemblance in form and size to *Microtinomiscium foveolatum* Reid & Chandler (1933: 164, pl. 4, figs. 5, 6), but the transverse section of *Tinomiscium taylori* shows no evidence of a coarsely and conspicuously foveolate locule-cast. The two must therefore be regarded as distinct unless future material should display their identity in an unmistakable way.

Tinomiscium is confined to tropical Asia, occurring from Yunnan to Sumatra and New Guinea, also in the Philippines.

V.30574 Holotype, figured Pl. 15, fig. 18. An endocarp. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.

V.29823 Figured Pl. 15, figs. 19-21; Text-fig. 17. An endocarp, fractured transversely to show the seed and structure of the carpel. *D. J. Jenkins Coll.* Herne Bay, Kent.

Section FIBRAUREAE or TINOSPOREAE?

Genus MENISPERMICARPUM Chesters, 1957:42

Menispermicarpum venablesi n. sp.

Plate 15, figs. 22-28; Text-fig. 18

DIAGNOSIS. Endocarp bisymmetric, almost straight, oval or sub-oval in outline, slightly hollowed on the ventral surface, convex on the dorsal surface, both having a median longitudinal ridge. Ventral surface with two short hollow longitudinal ridges, one at each side, which open (?) by long narrow slits at their extremities. Dorsal surface with two or three irregular rows of conical tubercles on each side of the median ridge. Locule wall with corresponding rows of low rounded prominences (hollows on the locule-cast). Length of endocarp, 4.5 to 7.5 mm.; breadth, 4.25 to 5.5 mm.; thickness, 2 to 3.5 mm.

HOLOTYPE. V.30575.

DESCRIPTION. *Endocarp*: Bisymmetric, almost straight, oval or sub-oval in outline, somewhat dorsiventrally compressed, slightly hollowed on the ventral surface, convex on the dorsal surface. Ventral surface with a marked median longitudinal ridge flanked by two shorter, broader, but even more marked longitudinal ridges, one on each side near the margins of the endocarp. These ventrilateral ridges appear to be hollow and to open to the exterior by long narrow slits (Pl. 15, figs. 23, 26, 27; Text-fig. 18). Dorsal surface with a median longitudinal ridge flanked by about three irregular rows of conical tubercles on each side. The tubercles form a conspicuous crest, as seen in profile, along each margin of the endocarp, their points being reflexed towards its base (Pl. 15, figs. 22, 23). In one specimen the tubercles are seen embedded in pyrites in transverse section (V.29824). In the better preserved material (V.30575) they are seen in surface view.

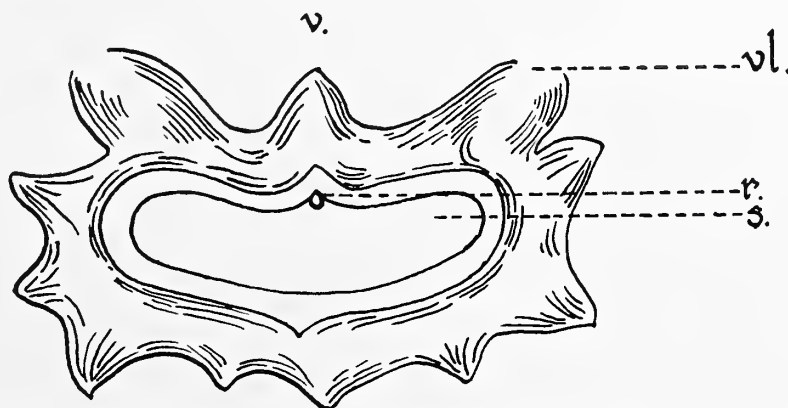


Fig. 18. *Menispermicarpum venablesi* n. sp. Transverse section (diagrammatic) of endocarp and seed. *r*, raphe; *s*, seed; *v*, ventral ridge; *vl*, ventrilateral hollow ridges.

Apex of endocarp with a slight recurved styler beak on the ventral side (Pl. 15, fig. 24). On the dorsal surface of the locule-cast the median ridge almost disappears just below the apex. This surface shows shallow rounded pits in rows corresponding with the external tubercles

of the endocarp (Pl. 15, fig. 25) which evidently form low rounded nodules on the locule wall. Carpel wall fibrous, much thicker on the ventral than on the dorsal side. Agglomerated radially aligned fine fibre masses form the ventrilateral ridges and tubercles. Inner layers of carpel formed of transversely aligned fibres, the innermost layers often criss-cross, producing a smooth glistening surface. The lining of the locule, where preserved, appears to be formed of elongate longitudinally aligned cells, seen in patches on the surface of the locule-cast. Length of endocarp, 7 mm.; breadth, 5 mm.; thickness about 3.5 mm. Length of a second, 5 mm.; breadth, 4.25 mm.; thickness, 2.5 mm. Minimum length seen, 4.5 mm.; maximum length, 7.5 mm. Minimum breadth, 4 mm.; maximum breadth, 5.5 mm.; minimum thickness, 2 mm.

Seed: Exposed only in patches where the film of locule-cast and the locule-lining are chipped away. Agreeing with the locule in shape. Testa of equiaxial cells, somewhat obscure owing to fine crumpling of the surface, possibly with slightly sinuous outlines.

REMARKS AND AFFINITIES. The symmetry, form and cell-structure indicate relationship with Menispermaceae, either with the Fibraureae or with the Tinosporeae (those in which the condyle is obsolete). There is a resemblance to *Tinomiscium taylori* (described on p. 149, Pl. 15, figs. 18–21) which also has a scarcely hollowed ventral surface, but is distinguished by its conspicuous transverse ridges, the absence of conspicuous hollow longitudinal ventrilateral ridges on the ventral surface, and greater size. A somewhat comparable appearance is seen in the living *Disciphania*, a genus with a simpler series of ridges. No exactly comparable living form has been seen, so the species has been referred to the form-genus *Menispermicarpum*, with the specific name *venablesi*, after Mr. E. M. Venables, the finder of the holotype.

- V.30575 Holotype, figured Pl. 15, figs. 22–24. A well-preserved endocarp showing the dorsal tubercles and ventrilateral hollow ridges. Part of the carpel wall is broken away on the dorsal side near the apex exposing the locule-cast. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30576 Figured Pl. 15, figs. 25–27. Another endocarp which has lost the whole of the dorsal wall exposing the pitted surface of the locule-cast. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.
- V.29824 Figured Pl. 15, fig. 28; Text-fig. 18. An endocarp, now fractured transversely. The dorsal wall has chipped away thus exposing the locule-cast and part of the seed-cast. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30577 Another endocarp encrusted with pyrites all over both surfaces. This is the largest specimen yet seen. Length, 7.5 mm.; breadth, 5.5 mm.; thickness, 3 mm. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.

Section TINOSPOREAE

Genus TINOSPORA Miers

Tinospora excavata Reid & Chandler

Plate 15, figs. 29–32

1933 *Tinospora excavata* Reid & Chandler, p. 165, pl. 4, figs. 7–10; text-figs. 3, 4.

AMENDED DIAGNOSIS. Endocarp finely and conspicuously tubercled externally, with a conspicuous sharp median ridge on the dorsal surface, and small ventral aperture about 1.3 by 1.1 mm. in diameter. Locule-cast smooth, with inconspicuous ridge on the dorsal surface, and fairly sharp ridge on the ventral surface, the aperture to the ventral hollow being about 2.5 mm. in diameter. Length of endocarp about 5 to 7 mm.; breadth, 4 to 6 mm.; thickness, 3.3 to 5 mm.

NEOTYPE. V.29825.

DESCRIPTION. *Endocarp*: Hemispherical or gibbous, with a conspicuous median dorsal ridge, deeply depressed ventrally to form a large gibbous or hemispherical hollow from one to three times as deep as the thickness of the locule; bisymmetric about the median dorso-ventral plane; ornamented externally with conspicuous, close-set, elongate tubercles, radially arranged around the ventral aperture (Pl. 15, fig. 29). Walls woody, smooth internally so that the locule-cast is smooth, 0.25 mm. thick, formed of criss-cross fibres, the innermost layers constituting the locule-lining being finer than those outside. Placenta sub-apical on the ventral face, just within the ventral hollow (Reid & Chandler, 1933: 165, text-fig. 3). Locule similar to the endocarp in shape. Length of endocarp about 5 to 7 mm.; breadth, 4 to 6 mm.; thickness, 3.5 to 5 mm. Length of locule-cast, 5.2 to 7 mm.; breadth about 4.3 to 6 mm.; thickness, 3.3 to 5 mm.

Seed: Deeply cup-shaped, ruminant on the ventral (concave) side, pendulous, anatropous with median ventral raphe; testa thin, formed of polygonal cells (about 0.05 to 0.07 mm. in diameter) which show a tendency to become equiaxial over the main body of the seed, but are radially elongate around the ventral margin.

REMARKS AND AFFINITIES. The discovery of new material both *in situ* and dislodged in an unabraded condition, shows clearly that the external surface was conspicuously tubercled. The subsequent flaking away of the carbonaceous endocarp has exposed the smooth locule-cast within (Pl. 15, fig. 31), showing that the tubercled endocarp is indistinguishable from *T. excavata*. The apparent smoothness of the endocarp in *T. excavata*, as originally described, was due to abrasion of the surface even where a film of carbonaceous substance was preserved. The diagnosis and description have therefore been amended in accordance with the more recent evidence. Many living species of *Tinospora* have tubercled endocarps. The largest specimens seen were locule-casts only, therefore the range in size of the species with endocarp preserved must be greater than is indicated by the measurements given above. {

- V.29825 Neotype, figured Pl. 15, fig. 29. A perfect unabraded endocarp showing tubercles. *G. F. Elliott Coll.* Warden Point, Sheppey.
- V.29826 Figured Pl. 15, fig. 30. An endocarp showing tubercles in a more abraded condition. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.
- V.29827 Figured Pl. 15, fig. 31. A locule-cast.
- V.29828 Figured Pl. 15, fig. 32. A somewhat abraded endocarp showing worn tubercles. The carpel wall where chipped away in places exposed the smooth locule-cast. Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29829 A worn endocarp, showing traces of tubercles, broken on one side towards the base. *In situ*.
- V.29830 A specimen in which only the outer layers of the endocarp have chipped away. The bulk of the carpel has become impregnated with pyrites, hence the apparent cast revealed by the chipping shows tubercles and is not a true locule-cast. *In situ*.
- V.29831 A well-preserved tubercled endocarp from which the carpel wall has been largely chipped away so as to show the smooth locule-cast. The above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29832 A well-preserved endocarp showing tubercles. The carpel has chipped away on one side showing the smooth locule-cast. Also part of a second imperfect specimen.
- V.29833 A small but well-preserved endocarp showing tubercles. Both the above *G. F. Elliott Coll.* Sheppey.
- V.29834 A small endocarp with pattern obscure owing to abrasion. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Tinospora wilkinsoni n. sp.

Plate 32, fig. 40

DIAGNOSIS. Endocarp beset with conical spines, having a fairly conspicuous median dorsal ridge, and lateral angles in the upper half only, semi-ovoid. Length, 8 mm.; breadth, 5.75 mm.; thickness, 4 mm.

HOLOTYPE. V.30587.

DESCRIPTION. *Endocarp*: Semi-ovoid, or sub-hemispherical, with fairly conspicuous median dorsal ridge, and, in the upper half only, having lateral angles which die out at about the middle. Convex on the dorsal surface, deeply depressed on the ventral surface to form a hollow whose depth cannot be ascertained in this one specimen. The locule is thus deeply boat-shaped. Style terminal, conspicuous, spine-like. External surface beset with short conical spines (most of whose tips have been broken in fossilization). Carpel wall finely striate and fluted radially around the ventral hollow, radially striate also around the base of each tubercle.

Locule and seed not seen. Placenta ventral at the apical margin of the ventral hollow. Attachment basal where the endocarp is most inflated.

Length, 8 mm.; breadth, 5.75 mm.; thickness, 4 mm.

REMARKS. One endocarp with beautifully preserved surface. The deeply boat-shaped form indicates the genus *Tinospora*. The specimen is larger than *T. excavata*, more elongate in outline and differs also in its lateral angles and in the more widely spaced longer spines.

It has been named *Tinospora wilkinsoni*, after Miss H. P. Wilkinson, the finder.

V.30587 Holotype, figured Pl. 32, fig. 40. An endocarp. *H. P. Wilkinson Coll.* East Cliff shore, Herne Bay, Kent.

Genus CALYCOCARPUM Nutt.

Calyccarpum? jenkinsi n. sp.

Plate 15, figs. 33, 34

DIAGNOSIS. A boat-shaped endocarp shallower than *Tinospora excavata*, either with ventral aperture closed by a pair of plates (?) or sub-divided by a median septum (?). Length of locule-cast, 8.25 mm.; breadth, 5.25 mm.; thickness, 3 mm.; ventral aperture, 5 by 4 mm.

HOLOTYPE. V.29835.

DESCRIPTION. *Endocarp*: Ovate in outline, sub-hemispherical, as seen sideways, bisymmetric about a median dorsiventral plane which passes through the style, having an inconspicuous median dorsal ridge continued over the apex on to the ventral side, depressed ventrally to form a shallow ventral hollow closed by a pair of longitudinal plates (?) as in *Calyccarpum*, or divided by a median partition; locule-cast smooth externally. Walls woody, where preserved around the ventral hollow 1 mm. thick, structure obscure. External surface not known. Length of locule-cast in plane of symmetry, 8.25 mm.; breadth, 5.25 mm.; thickness, 3 mm. Length of aperture of ventral hollow, 5 mm.; breadth, 4 mm.

REMARKS AND AFFINITIES. The boat-shaped form places this specimen in the section *Tinosporeae* of the family *Menispermaceae*. The locule-cast is longer in proportion to its depth than *Tinospora excavata* and the aperture of the ventral hollow is much larger. It may be

closed by a pair of longitudinal plates, not seen in *Tinospora*, impressed upon the pyrites within the hollow. An alternative interpretation of the specimen is that there may be a thick median septum, fusiform in surface view, dividing the pyrites-filled ventral hollow longitudinally. If the first interpretation is correct the specimen most resembles *Calyccarpum*, although it is smaller than the only living species, *C. lyoni*, also its boat-shaped curve is shallower. If the second interpretation is correct it is impossible at present to place the fossil in a living genus for the median septum must have been abnormally thick and spindle-shaped (Pl. 15, fig. 33). The specimen is therefore referred doubtfully to *Calyccarpum*. The living *Calyccarpum* occurs in Atlantic North America.

V.29835 Holotype, figured Pl. 15, figs. 33, 34. An endocarp. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus FRINTONIA nov.

DIAGNOSIS. Endocarp hemispherical with shallow ventral hollow sub-divided by a median longitudinal plate; ornamented on the dorsal surface with four longitudinal rows of stiff fibres or spines. Thickness of the wall with compacted masses and plates of radial fibres and intervening spaces, 2.8 mm. Placenta sub-apical. Surface of seed with a few rounded depressions. Length of carpel, 9.5 mm.; breadth, 8.5 mm.; thickness, 5.55 mm. Length of seed, 9 mm.; breadth, 4 mm.; thickness about 2.8 mm.

TYPE SPECIES. *Frintonia ornata* n. sp.

Frintonia ornata n. sp.

Plate 16, figs. 1-4; Text-fig. 19

DIAGNOSIS. That of the genus.

HOLOTYPE. V.29836.

DESCRIPTION. *Endocarp*: Hemispherical, with a rounded median longitudinal dorsal rib (Pl. 16, fig. 1), approximately boat-shaped being depressed ventrally to form a large shallow hollow occupying about one-third of the thickness of the specimen, the hollow, filled with pyrites, sub-divided longitudinally by a median plate extending throughout its whole length and depth (Pl. 16, fig. 2). Original aspect of the surface not known with certainty owing to abrasion and adherent pyrites. There appear to have been four longitudinal rows of stiff fibres or hollow spines on the dorsal side, one row lying on each side of the median rib, the fibres in these two rows arising at the same distance from the apex, and one row lying between these median rows and the lateral margins, the fibres in these lateral rows alternating with those of the median rows (Pl. 16, fig. 1). The fibre ends are now abraded, their former presence being indicated by canals or depressions within which the hollow hair-bases, now filled with pyrites, can be seen especially in sections of the wall (Pl. 16, figs. 3, 4). Cells of the surface (as preserved) equiaxial about 0.012 to 0.016 mm. in diameter. Walls as seen in section, 2.8 mm. thick on the dorsal surface, fibrous, formed of radially aligned cells or fibres sometimes arranged in compacted masses or plates with interspaces now filled with amorphous pyrites. Whether some of these interspaces originally appeared as hollows on the surface cannot be ascertained. Locule-lining smooth, formed of criss-cross fibres. Placenta sub-apical median ventral at the margin of the ventral hollow (Pl. 16, figs. 3, 4; Text-fig. 19B, E). Locule-cast similar in its

general form to the endocarp but relatively longer and narrower, pointed at the apex, convex dorsally, concave ventrally with a median longitudinal ventral ridge having a sub-apical projection marking the placenta (Pl. 16, figs. 3, 4; Text-fig. 19C, E). Surface of cast showing large circular shallow depressions rather like those of *Microtinomiscium foveolatum* (Reid & Chandler, 1933: 164, pl. 4, figs. 5, 6). Seed solitary, pendulous, conforming to the locule in shape, testa not seen, raphe median ventral. Length of carpel, 9.5 mm.; breadth, 8.5 mm.; thickness, 5.55

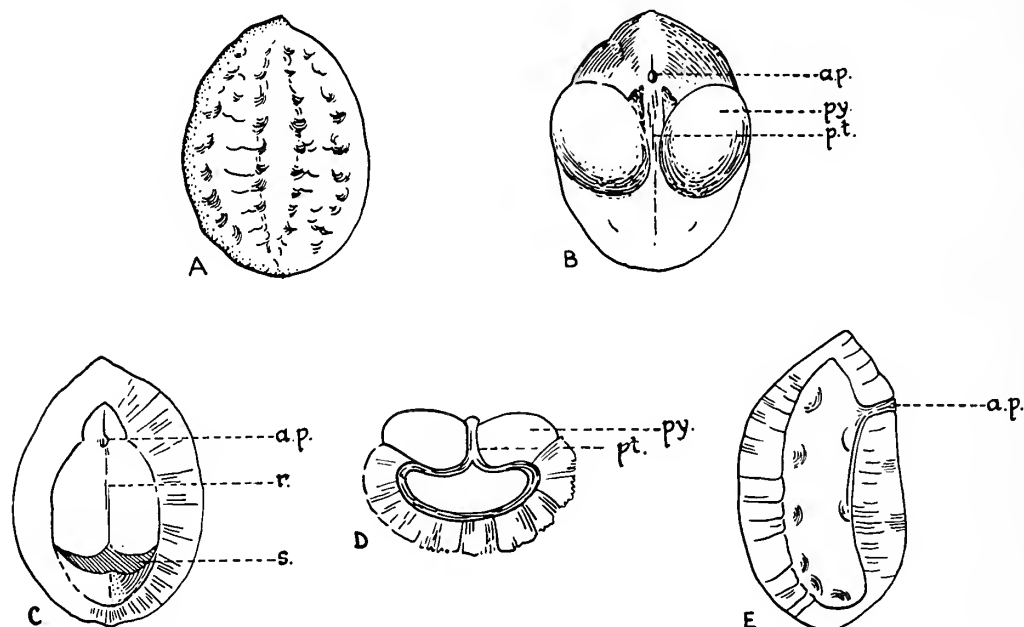


Fig. 19. *Frintonia ornata* n. sp. A, B, diagrammatic drawings of dorsal and ventral views of endocarp. The small depressions in A represent spine bases. C, tangential longitudinal section from side to side. D, transverse section showing pyrites filling ventral hollow. E, dorsiventral longitudinal section, ventral side on the right. *ap*, attachment and placenta; *pt*, plate of tissue; *py*, pyrites; *r*, ridge; *s*, thickness of seed in section.

mm. Length of locule-cast (virtually of seed), 9 mm.; breadth, 4 mm.; thickness about 2.8 mm.

REMARKS AND AFFINITIES. A single endocarp. The erect boat-shaped carpel with ventral condyle and sub-apical placenta at the edge of the ventral infold relates the fossil to the section *Tinosporeae* or some closely allied group of *Menispermaceae*. It is distinguished from other genera and species described by the shallowness of the ventral hollow and condyle, and the sub-division of the hollow into two compartments (now filled with pyrites) by the median plate (cf. Text-fig. 19D), by the spines and their canals, and other cavities within the walls between the radial fibre-masses or plates of tissue.

The specimen has been named *Frintonia ornata*, the generic name indicating the locality where it was found. No identical living genus has yet been seen.

The living monotypic genus *Rhigiocarya* Miers from tropical West Africa shows a comparable cavernous structure of the endocarp, the inner and outer surfaces being connected by radial fibres and plates of tissue with interspaces separating them. But this genus has no

median plate sub-dividing its ventral cavity, which is completely covered in superficially by out-growths from the wall which unite along a median suture. Whether the ventral cavity of *Frintonia* was originally covered in cannot now be decided; all evidence of such a covering, if it ever existed, has been removed by abrasion. The South American genus *Disciphania* Eichl. has also a similar cavernous structure of endocarp, but appears to lack the pair of deep ventral hollows. A pair of ventral hollows with distinct orifices are seen in *Anamirta* Colebr., a smooth-walled deeply curved endocarp which shows no cavernous structure.

Odontocarya Miers has a median plate which sub-divides its ventral cavity, but it does not show two quite distinctly separated orifices as do the fossil and *Anamirta*.

The form of the locule-cast and its dimpled surface recalls *Microtinomiscium*, a genus represented by one locule-cast only which was not sectioned; a film of endocarp (or the impression of its cells) was seen on the surface of the cast. In 1933, in the absence of any evidence to the contrary, this cast was regarded as indicating an endocarp like that of *Tinomiscium* (section *Fibraureae*), a type that is scarcely hollowed on the ventral surface and without a ventral condyle. But the appearance and preservation of the imperfectly exposed locule-cast in the specimen from Frinton raises the question whether *Microtinomiscium* could have been a somewhat similar locule-cast from which a thick and perhaps cavernous endocarp had been abraded, leaving no trace of an original ventral condyle. If so, its relationship must have been with *Tinosporeae* and not with *Fibraureae*, but this appears to be improbable. On the present evidence the locule-cast of *Frintonia*, so far as it can be seen, appears to be more deeply hollowed on the ventral side; it is impossible to see whether the dorsal pits have the regular alignment in four rows as in *Microtinomiscium*.

V.29836 Holotype, figured Pl. 16, figs. 1-4; Text-fig. 19. An endocarp, fractured to show the structure. *A. G. Davis Coll.* Frinton Cliffs between Frinton and Walton-on-Naze, Essex.

Subsection COCCULINAE

Genus DAVISICARPUM nov.

DIAGNOSIS. Endocarp bisymmetric and curved, as in *Cocculinae*, but having a conspicuous gibbous median area between the limbs which produces an obliquely gibbous ventral margin, flanked at each end by a narrow straight rim which passes into the dorsal marginal rim. Diameter along and at right angles to the axis, 7.5 mm.; thickness, 3 mm.

TYPE SPECIES. *Davisicarpum gibbosum* n. sp.

Davisicarpum gibbosum n. sp.

Plate 16, figs. 5-7

DIAGNOSIS. That of the genus.

HOLOTYPE. V.29837.

DESCRIPTION. *Endocarp*: Approximately bisymmetric about a plane in which the margin lies, but one side is somewhat more convex than the other (accidentally?), laterally compressed, curved obliquely, sub-gibbous in outline, the dorsal margin semi-circular, the ventral margin having a broad oblique gibbosity flanked by a straight marginal rim, about 1 mm. broad, on

each side. The continuation of the rim forms the dorsal margin which may be slightly incomplete at the cotyledonary end. The two faces meet at an angle of rather more than 45° . As seen in surface view, the rim is semi-circular, considerably inflated with a semi-circular median angle; between this angle and the margin it is neither rounded nor noticeably concave (Pl. 16, fig. 7). It is delimited by a semi-circular angular groove from the convex central part of the endocarp. The whole surface of the rim is closely and finely ribbed or striate radially. The convex central part of the endocarp is continued to the ventral margin of the gibbosity, its surface being ornamented with a few branched furrows oriented parallel with the oblique axis of curvature of the specimen. A particularly deep oblique furrow, curved at the distal extremity, probably indicates the extent of the internal condyle between the limbs, but this furrow is clearly seen on one face only (Pl. 16, fig. 5). The remains of the carpel wall show fine radiating striae. The foramen is not clear, but may be indicated by a deep pit seen on one surface near the extremity of the gibbosity (Pl. 16, fig. 6). The internal structure has not been seen. Maximum diameter, 7.5 mm.; diameter along the axis of curvature, 7.5 mm.; maximum thickness (central area), 3 mm.

REMARKS AND AFFINITIES. One endocarp, originally with much of the carbonaceous coat now rapidly flaking away and exposing a pyrites cast. The form and curvature make the relationship with the Cocculinae clear, but no living genus has been seen with a comparable gibbous central area giving an obliquely gibbous ventral margin. The specimen has been named *Daviscarpum* after the finder.

V.29837 Holotype, figured Pl. 16, figs. 5-7. An endocarp. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus WARDENIA nov.

DIAGNOSIS. Endocarp referable to one of the Cocculinae, in which the curvature of the limbs and horse-shoe shaped sculpture are almost symmetrical, with wide marginal flange coarsely ribbed, raised rounded horse-shoe shaped ridge with shallow inconspicuous furrow embracing a concave lateral area, straight or concave ventral margin, elongate foramen nearer to the stylar than to the other limb.

TYPE SPECIES. *Wardenia davisii* n. sp.

Wardenia davisii n. sp.

Plate 16, fig. 8

DIAGNOSIS. Endocarp about 5 by 4 mm. in diameter. Ventral margin short, slightly concave, marginal flange coarsely fluted with about twenty simple radial ridges. Horse-shoe shaped ridge broad, rounded, grooved along the crest. Foramen elongate close to the ventral margin and stylar limb.

HOLOTYPE. V.29838.

DESCRIPTION. *Endocarp*: Bisymmetric about a plane in which the margin lies, laterally flattened, reniform in outline, the dorsal margin gibbous, the ventral short, slightly concave, curved, having an inflated marginal part sharply delimited by a grooved, horse-shoe shaped ridge from a flat, or slightly concave, central part. The ridge arises almost at right angles to the central area, but slopes uniformly to the outer margin of the endocarp. The marginal part

is coarsely fluted with about nineteen or twenty simple radial ridges. As seen in transverse section the two faces of the endocarp from the horse-shoe shaped ridge to the outer margin meet at a rounded angle of about 45° , this marginal part being neither concave nor rounded. Both faces show the characteristic foramen between the limbs of the horse-shoe; it is unusually large (0.45 by 0.75 mm.) in relation to the size of the endocarp, elongate, and very close to the ventral margin. Longest diameter of endocarp (across the two limbs), 5 mm.; diameter at right angles to this, 4 mm.; thickness, 1.25 mm.

REMARKS AND AFFINITIES. One endocarp with adherent fragmentary carbonaceous remains. Form and sculpture relate it to the sub-section Cocculinae. Of the genera within that sub-section the resemblance is closest to *Sinomenium* Diels and *Menispermum* (Tourn.). But in both these living genera the foramen is sub-circular rather than elongate, the fluting of the marginal area is much more elaborate and sharper, the horse-shoe shaped ridges rise at right angles to the surface both from the central area and from the fluted margin. In size and shape, and in the size of the foramen and its position so close to the ventral margin, the fossil most resembles *Sinomenium*, but in this genus the marginal fluting is more elaborate. In *Menispermum* the marginal fluting is more like that of the fossil, but the central area is relatively larger. In the thickness of its dorsal margin the fossil approaches the endocarp of *Cocculus* DC., although in other respects there is no close resemblance to this genus.

The genus *Wardenia* is represented by a species from the Bournemouth Marine Beds to be described in a later volume, as well as by *W. davisii* from the London Clay. *W. davisii* is taken as the type species.

V.29838 Holotype, figured Pl. 16, fig. 8. An endocarp. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus PALAEOSINOMENIUM nov.

DIAGNOSIS. Endocarps belonging to the Cocculinae closely comparable with *Sinomenium* and *Menispermum*, but with more oblique endocarp and elongate foramen. Basal margin concave to convex. Marginal flange ribbed or fluted.

TYPE SPECIES. *Palaeosinomenium venablesi* n. sp.

Palaeosinomenium venablesi n. sp.

Plate 16, figs. 9-13

DIAGNOSIS. Endocarp curved obliquely, horse-shoe shaped; ventral margin somewhat concave. Surface with radially aligned prominences on the outer and inner sides of the horse-shoe shaped ridge, those on the outside terminating rather abruptly about half-way across the marginal flange. Area between limbs slightly concave. Foramen between the limbs elongate, oblique, its lower end well above a line drawn between the extremities of the two limbs of the endocarp. Diameter of endocarp, 4 by 4.75 mm.

HOLOTYPE. V.29839.

DESCRIPTION. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate on germination in the plane of symmetry. Sub-gibbous in outline, somewhat oblique, slightly concave along the ventral margin, rounded and gibbous dorsally. A broad marginal horse-shoe shaped flange (about 1.0 mm. broad in the widest part) narrows slightly

towards its extremities at the base of the endocarp. The flange is delimited along its inner edge by an upstanding horse-shoe shaped ridge conspicuously grooved along the crest. On the outer side of the ridge are prominent blunt-ended radially aligned ridges separated by furrows. They terminate somewhat abruptly about half-way across the flange, beyond them are less conspicuous slight flutings of the marginal area. The inner side of the horse-shoe shaped ridge also bears blunt-ended ridges alternating with furrows, rather shorter and less conspicuous than those on the outer side. The large area between the limbs of the horse-shoe is slightly concave. It is pierced near the base by a long narrow oblique foramen, about 1 mm. long, which lies nearer to the stylar than to the other limb and about half-way between the stylar limb and a median canal for the funicle. Its lower end is well above a line drawn between the extremities of the two limbs of the horse-shoe.

The surface of the endocarp is formed of fibres or long narrow cells which diverge from the middle of the concave area. There is a short triangular condyle internally between the middle of the ventral margin and the stylar end of the horse-shoe shaped flange. Length of endocarp along the axis between the limbs about 4 mm.; breadth measured across the two limbs, 4.75 mm.; thickness at right angles to plane of symmetry about 1.5 mm. Length of smallest specimen seen, 2 mm.; breadth, 2.75 mm.

Seed: (Pl. 16, fig. 11). Somewhat flattened, curved, with broad, rather rounded cotyledonary limb, and narrow pointed micropylar limb, conforming in general to the shape of the endocarp, but more excavated on the ventral side where it embraced the internal condyle. There is a low, rounded, curved ridge on each broad surface corresponding in position and form with the horse-shoe shaped ridge of the endocarp, and the marginal area beyond is radially ridged, the ridges being broader and less sharply defined than on the endocarp. The hilum and chalaza are indicated by a scar lying near the inner end of the hollow between the limbs, but closer to the cotyledonary than to the micropylar limb. The testa is formed of equiaxial cells about 0.016 mm. in diameter.

REMARKS AND AFFINITIES. Eight specimens. More than one originally showed the well-preserved carbonaceous endocarp (Pl. 16, figs. 9, 10) which rapidly cracked on drying and flaked away exposing an internal cast in pyrites. The appearance of this cast differs somewhat from that of the carbonaceous endocarp, the ridges on its marginal flange being represented by shorter projections separated by much broader more marked furrows than those of the carpel itself. In places the seed-cast is exposed. A second abraded cast shows the ribs on the inner side of the horse-shoe shaped ridge much less clearly and owing to its worn condition the horse-shoe shaped ridge itself is much less conspicuous. The short triangular condyle is represented on this specimen by a triangular depression; the thinness of the film of pyrites in this region has caused it to collapse partially leaving a large foramen at its centre (Pl. 16, figs. 12, 13).

The relationship is clearly with the section Cocculineae of the Menispermaceae. It most closely resembles *Sinomenium* and *Menispermum*, but is more oblique than either. Moreover, they are distinguished from the fossil by their shorter, rounder foramina. *Cocculus* is distinguished in some species by the incurling of the cotyledonary end of the horse-shoe ornamentation, and in all by the degree of rounding and inflation of that part of the endocarp which encloses the locule. The genus *Palaeosinomenium* occurs in some of the later Eocene Beds of Hampshire and Dorset and another species will be described later. The London Clay species has been named *Palaeosinomenium venablesi*, after the finder. Hitherto it has only

been recorded from Bognor and Nursling. The related genus *Wardenia* from Sheppey has a less obliquely curved endocarp with more equal limbs. It also has somewhat similar coarse ribs on the marginal flange.

- V.29839 Holotype, figured Pl. 16, figs. 9–11. An endocarp now represented largely by a cast of the locule and seed (exposed in parts), originally covered by a carbonaceous endocarp now decayed.
- V.29840 Figured Pl. 16, figs. 12, 13. A much abraded locule-cast with an adherent film of the actual endocarp over the central concave area.
Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30578 An abnormally small endocarp with part of the carbonaceous wall preserved. Also two larger specimens one with part of the wall preserved. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30579 Two endocarps with wall preserved, and part of a third. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.

Genus DIPLOCLISIA Miers

Diploclisia bognorensis n. sp.

Plate 16, figs. 14–17

DIAGNOSIS. Endocarp as in Cocculinae, narrow oboval in outline. Length (not quite perfect), 6.6 to 9 mm.; breadth, 5.5 to 6.75 mm.; thickness, 1.25 to 1.6 mm. Surface with radially aligned ribs alternating with rounded pits or grooves on the outer side only of the horse-shoe shaped ridge. Slit between limbs elongate, oblique, near the ventral margin closer to the longer (stylar) limb than to the other. Foramen rounded median.

HOLOTYPE. V.30580.

DESCRIPTION. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate on germination in the plane of symmetry. Narrowly oboval in outline, slightly oblique, with narrow basal margin. A broad marginal horse-shoe shaped area (1.25 mm. broad in the widest part) narrows at the two extremities towards the base of the endocarp. The area is delimited along its inner edge by an upstanding horse-shoe shaped ridge, originally grooved faintly along its crest, groove now almost obliterated by abrasion. The ridge has conspicuous nodular prominences on its outer side separated by depressions, the prominences are continued on to the flange as radial ridges which usually merge laterally into one another so as to enclose a row of deep sub-circular pits formed by the abrupt ending of the depressions (Pl. 16, fig. 16), but the surface is much abraded, and its original appearance may have been modified to some slight extent as a result. The inner margin of the horse-shoe shaped ridge bears small nodules, which are not continued on to the concave area between the arms of the ridge. There is a long, narrow, slightly oblique slit close to the ventral margin, midway between the two limbs, prolonged as a curved slight ridge at least as far as the middle of the endocarp. Where it ends there is a rounded foramen which penetrates through both sides of the endocarp. It lies on the opposite side of the ridge to the stylar limb. The limb adjacent to it has a very slight sigmoidal curve and contains the cotyledons. Walls of endocarp woody, fibrous. Locule-lining of criss-cross fibres. Dimensions of endocarps: (1) Length, 7 mm.; breadth, 6 mm.; thickness, 1.6 mm. (2) Length, 6.6 mm.; breadth, 5.5 mm.; thickness, 1.25 mm. (3) Length, 9 mm.; breadth, 6.5 mm.; thickness, 1.3 mm. (4) Length, 8 mm.; breadth, 5.5 mm.; thickness, 1.25 mm. (5) Length, 7.5 mm.; breadth, 6.75 mm.; thickness, 1.5 mm.

Seed (Pl. 16, fig. 17): Represented by an imperfect horse-shoe shaped cast, enclosed

beneath the raised horse-shoe shaped ridge and thickest adjacent parts of the endocarp, four-angled in cross section, with radial ridges along its outer sides corresponding with the ridges of the marginal area of the endocarp, the ridges separated by deep depressions which correspond with the ring of pits on the surface of the endocarp; there is also a ridge or angle in the plane of symmetry on the dorsal side. The seed tapers towards the micropylar end (slightly imperfect at the tip). Testa, as represented by its impression on the cast, formed of equiaxial cells 0.012 to 0.016 mm. in diameter.

REMARKS AND AFFINITIES. Seven specimens. One an incomplete seed-cast with remains of locule-cast and a film of endocarp still adhering and obscuring its outline. The cotyledonary end of the seed-cast is broken. The curved compressed endocarp and curved seed place the fossil in the sub-section Cocculinae of the family Menispermaceae. The narrow and obovoid outline distinguishes it from any other fossil species described, but suggests that it is the same as No. 656 illustrated in Crow's manuscript catalogue (see Reid & Chandler, 1933: 6) where it is recorded from Sheppey.

The form and structure are so closely comparable with the living *Diploclisia* that there can be no doubt of the relationship. *Diploclisia* is an East Asiatic genus of climbers represented by about four species, ranging from China and Burma to India and the Malay Peninsula and Islands. Some living species have a large area between the limbs as in the fossil, e.g. *D. affinis* Diels and *D. chinensis* Merrill. Others have only a narrow one. *D. affinis* Diels agrees closely with the fossil in size (length, 7 mm.; breadth, 6 mm.; thickness, 1.4 mm.). It also has a long narrow slit near the ventral margin and the stylar limb and a median circular foramen. *D. chinensis* is similar in size and character. Both are Chinese species. In both the internal condyle extends beyond the middle of the endocarp and is indicated superficially by a curved groove, whereas in the fossil a slight ridge has been seen in the one specimen where the central area is not obscured by pyrites. The ridge is probably due to infiltrated hard pyrites which remains when the softer endocarp surrounding it has been slightly abraded.

- V.30580 Holotype, figured Pl. 16, figs. 14, 15. An endocarp, more or less perfect but the marginal flange is partly obscured by adherent pyrites. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.
- V.29841 Figured Pl. 16, fig. 16. An endocarp abraded and imperfect at the base. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29842 Figured Pl. 16, fig. 17. An incomplete seed-cast with adherent remains of endocarp. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30581 Another endocarp showing the groove and nodules on the horse-shoe shaped ridge. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30582 Two endocarps. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30583 A much abraded endocarp. *H. E. Taylor Coll.* 'Beetle Bed': Bognor, Sussex.

Family MAGNOLIACEAE

Genus MAGNOLIA Linnaeus

The general characters and the variation in form of the living genus *Magnolia* were discussed by Reid & Chandler (1933: 171, 172), where it is pointed out that the discrimination of one species from another is not an easy task. Examination of living seeds reveals considerable variation of shape within a single species, especially as a result of distortion due to mutual pressure of the two seeds in a pod during growth. Thus in *M. wilsonii*, seeds are occasionally

broader than long, but are usually equal in length and breadth and faceted. In *M. tripetala* L. the seeds may be slightly broader than long but are usually longer than broad and faceted. Variations such as this are found in the fossil species *M. crassa*. For convenience of description and classification, fossil forms which differ conspicuously from one another are separated as distinct species, but in some cases the differences may ultimately prove to be individual variations, not of true specific rank, so that some of the less marked varieties may ultimately have to be united.

Magnolia lobata (Bowerbank) Reid & Chandler

Plate 16, fig. 18

1933. *Magnolia lobata* (Bowerbank) Reid & Chandler, p. 174, pl. 9, figs. 25-27.

- V.29843 Figured Pl. 16, fig. 18. A seed of the size and type of *M. reniformis* (Bowerb.), length, 4.75 mm.; breadth, 6 mm. It shows the concavity on one side. Probably referable to *M. lobata*.
 V.29844 A second seed.
 Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.29845 A seed with remains of testa chipping away. It has the broad deeply grooved form of *M. lobata*, but the hilar scar is exceptionally large and long. Probably referable to this species.
 V.29846 A small seed with remains of testa scaling away, probably referable to this species.
 Both the above *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.
 V.29847 A small seed-cast of the type *M. reniformis*, probably referable to *M. lobata*. *G. F. Elliott Coll.* Warden Point, Sheppey.

Magnolia subquadrangularis (Bowerbank) Reid & Chandler

Plate 16, fig. 19

1933 *Magnolia subquadrangularis* (Bowerbank) Reid & Chandler, p. 175, pl. 4, figs. 28, 29.

- V.29848 Figured Pl. 16, fig. 19. A seed-cast about 7 mm. in transverse diameter, and 5 mm. in longitudinal diameter.
 V.29849 A second seed-cast, possibly referable to this species.
 Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.29850 A seed with remains of testa. Length, 6.5 mm.; breadth, 7.5 mm.; thickness, 3 mm. *In situ*.
 V.29851 A seed, possibly of this species. Length, 5.75 mm.; breadth, 7.5 mm.; thickness, 3 mm.
 Both *A. G. Davis Coll.* Warden Point, Sheppey.

Magnolia crassa Reid & Chandler

Plate 16, figs. 20-22

1933 *Magnolia crassa* Reid & Chandler, p. 176, pl. 5, figs. 1, 2.

- V.29852 Figured Pl. 16, fig. 20. A typical seed about 8 mm. long, 6.5 mm. broad, 2.75 mm. thick. It has an asymmetric obovate outline, truncate chalazal end and convex surfaces. One surface is faceted. The woody coat is rugose externally. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.29853 Figured Pl. 16, figs. 21, 22. A much crushed seed (now broken) 9 mm. long, 7.5 mm. broad, 3 mm. thick, possibly referable to this species. One face is slightly convex, the other longitudinally faceted, the faceting may have been sharpened by crushing.
 V.29854 Three seeds, possibly of this species; one is obliquely distorted, all are rather small (length, 7, 7.25, and 6.5 mm.; breadth, 6.25, 7.25, and 7 mm.; thickness, 3, 3.5, and 3 mm.).
 The above *A. G. Davis Coll.* Warden Point, Sheppey.
 V.29855 A seed-cast as broad as long with remains of testa perhaps referable to this species but poorly preserved and much encrusted with pyrites. Length, 7.5 mm.; breadth, 7.5 mm.; thickness, 3 mm.

- V.29856 A seed with decayed remains of testa. Length, 7.75 mm.; breadth, 7 mm. East Cliff shore. The above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.29857 A seed 8 mm. long, 6 mm. broad, 3 mm. thick.
- V.29858 Three seeds about 7 mm. long by 6 mm. broad, two are much obscured by pyrites but possibly referable to this species. One seed is rather more pointed at the micropylar end than the majority of specimens. The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Magnolia subtriangularis Reid & Chandler

1933 *Magnolia subtriangularis* Reid & Chandler, p. 177, pl. 5, figs. 3-5.

- V.29859 A roundly subtriangular seed, faceted along one margin by pressure of a second seed during growth as in the specimen figured by Reid & Chandler (1933, pl. 5, fig. 3). Length, 7 mm.; breadth, 8 mm.; thickness, 4.5 mm. *G. F. Elliott Coll.* Warden Point, Sheppey.
- V.29860 A seed with testa abraded showing a median hollow on one side and hints of faceting. Length, 6.5 mm.; breadth, 8 mm.; thickness, 3.25 mm. *A. G. Davis Coll.* Warden Point, Sheppey.

Magnolia angusta Reid & Chandler

Plate 17, figs. 3, 4

1933 *Magnolia angusta* Reid & Chandler, p. 177, pl. 5, figs. 6-8.

- V.29861 Figured Pl. 17, fig. 3. A seed with internal cast partially exposed along one margin by the breaking of the testa.
- V.29862 Figured Pl. 17, fig. 4. A seed-cast, slightly imperfect near the chalazal end, 7.5 mm. long, 4 mm. broad.
- V.29863 Two seeds possibly referable to this species. One seed splitting marginally may, however, be *M. subcircularis*.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29864 Two seeds rather more inflated than most of the seeds of this species. Also a small doubtful specimen of this species. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29865 A typical seed-cast, oboval in outline, flat on one face, convex and faceted on the other. Length, 8 mm.; breadth, 5.75 mm.; thickness, 2.5 mm. *J. G. Turner Coll.* Sheppey.
- V.29866 A small seed, possibly referable to this species but possibly to *M. subcircularis*. Length, 5.5 mm.; breadth, 4 mm. *G. F. Elliott Coll.* Warden Point, Sheppey.
- V.29867 A seed-cast with remains of testa probably referable to this species or to *M. subcircularis*. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29868 A seed-cast with decayed remains of testa, 8 mm. long, 5.25 mm. broad, perhaps referable to this species as it is relatively narrower than any other species described. *J. E. Cooper Coll.* Herne Bay, Kent.

Magnolia subcircularis Reid & Chandler

Plate 17, figs. 5-9

1933 *Magnolia subcircularis* Reid & Chandler, p. 179, pl. 5, figs. 11, 12.

AMENDED DIAGNOSIS. Seed symmetrically or asymmetrically obovate, sub-circular, or roundly triangular in outline, usually about as long as broad, convex on both faces, one surface being more markedly convex than the other, the more convex surface being faceted in some specimens. Length of seed about 4 to 6 mm., commonly about 5 or 5.5 mm.; breadth, 4 to 6 mm.; thickness, 1.75 to 2.5 mm.

HOLOTYPE. V.22213.

DESCRIPTION. The original description calls for slight amendment following upon the discovery of further material both at Bognor and Sheppey. The seed may be symmetrically

or asymmetrically obovate or roundly triangular as well as sub-circular in outline, truncate at the chalazal end, more or less pointed or rounded at the micropylar end. Both surfaces are more or less convex, one surface being usually more convex than the other, while the surface which bears the raphe is often slightly hollowed near the chalaza. The more convex face is sometimes angled and faceted. Chalaza, testa and tegmen as in the genus. The external chalazal scar is small, circular, deep, the internal scar is large and oval. Testa thin with cells arranged in a columnar manner, 0.016 to 0.025 mm. in diameter. Elongate cells of tegmen, 0.012 to 0.016 mm. broad.

The dimensions of specimens from Bognor are as follows: (1) Length, 4.75 mm.; breadth, 4.25 mm.; thickness, 2 mm. (2) Length, 5 mm.; breadth, 4.5 mm.; thickness, 2 mm. (3) Length, 5.5 mm.; breadth, 4.5 mm.; thickness, 2.5 mm. (4) Length, 5.25 mm.; breadth, 5.5 mm.; thickness, 2.25 mm. (5) Length, 4.5 mm.; breadth, 4 mm.; thickness, 1.75 mm. Other seeds from Sheppey may be 5 to 6 mm. long, 5.2 to 6 mm. broad.

REMARKS AND AFFINITIES. More than twenty seeds distinguished by their small size and more or less equal diameters. They are frequently sub-circular but show slight variation of outline and form, a few being faceted. One or two are obovate rather than sub-circular in outline. An attempt was made at first to separate as a distinct type the less sub-circular and those showing a greater degree of inflation, and more marked faceting, but careful comparisons subsequently showed no clear line of demarcation between the two types. Hence all have been united under the name *M. subcircularis*.

- V.29869 Figured Pl. 17, fig. 5. A faceted seed, with testa largely abraded.
- V.29870 Figured Pl. 17, figs. 6-8. Three seeds with remains of testa.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29871 Figured Pl. 17, fig. 9. A much compressed seed with thin remains of abraded testa. Length, 4.6 mm.; breadth, 5.3 mm.; thickness, 1.75 mm. The breadth is unusual. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29872 A seed-cast. *J. G. Turner Coll.* Sheppey.
- V.29873 A seed-cast with testa originally perfect, now rapidly flaking off. *In situ*.
- V.29874 A seed with testa preserved on one side except where it is chipped away over the chalaza. Probably referable to this species.
- V.29875 A seed-cast with film of testa.
The above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29876 The cast of a seed which has split marginally. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29877 A seed-cast with remains of testa. *G. F. Elliott Coll.* Warden Point, Sheppey.
- V.29878 A seed-cast with a film of testa.
- V.29879 Two obovoid seeds, one imperfect and fractured longitudinally, the other 5.5 mm. long, 4.75 mm. broad, 2.5 mm. thick.
- V.29880 A small faceted seed, subtriangular in outline. *In situ*.
The above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29881 Two seeds, one transversely oval and biconvex, length, 4.75 mm.; breadth, 5.5 mm.; thickness, 3 mm. The other roundly triangular, markedly faceted on one face, slightly convex on the other, length, 6.25 mm.; breadth, 5.75 mm.; thickness, 3 mm.
- V.29882 A small sub-circular biconvex seed.
The above *G. F. Elliott Coll.* Sheppey.
- V.29883 Two well-preserved seeds with testa.
- V.29884 A small seed, probably of this species.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29885 Two seeds. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29886 Three seeds showing variation of form. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.

? Magnolia enormis (Bowerbank) Reid & Chandler

Plate 17, fig. 10

1840 *Leguminosites enormis* Bowerbank, p. 129, pl. 17, figs. 14, 15.1933 *Magnolia enormis* (Bowerbank) Reid & Chandler, p. 180.

DESCRIPTION. *Seed*: Rounded-triangular, rounded at the micropyle, straight along the chalazal margin, having one face convex, the other with a shallow median furrow; external chalaza small, deep. Testa as in the genus (Reid & Chandler, 1933: 171). Length of seed, 9 mm.; breadth, 9.5 mm.; thickness, 4 mm. Length of a second specimen, 7.25 mm.; breadth, 7.5 mm.; thickness, 3.5 mm.

REMARKS. Three seeds, possibly referable to this species, as they closely resemble Bowerbank's figures (1840, pl. 17, figs. 14, 15), although they appear to be more inflated, and more hollowed medianly on one face. They are considerably larger than either *M. lobata*, *M. subtriangularis* (Reid & Chandler, 1933: 174, pl. 4, figs. 25-27; 177, pl. 5, figs. 3-5) or *M. symmetrica* (see p. 168).

V.29887 Figured Pl. 17, fig. 10. A seed with testa preserved.

V.29888 A somewhat thinner seed, with scarcely perceptible median hollow. *In situ*.

V.29889 A typical inflated seed with well-marked median hollow on one face.

All *A. G. Davis Coll.* Warden Point, Sheppey.*Magnolia gigantea* n. sp.

Plate 17, fig. 11

DIAGNOSIS. Seed reniform, length, 9.5 mm.; breadth, 15 mm.; thickness, 7 mm. Differing from *M. longissima* (Reid & Chandler, 1933: pl. 4, figs. 22-24) in the greater length relative to the breadth, and in the much greater degree of inflation.

HOLOTYPE. V.29890

DESCRIPTION. *Seed*: Reniform, broader than long, slightly hollowed over the chalazal region and pointed at the micropyle, with a scarcely perceptible median depression on one surface. Length, 9.5 mm.; breadth, 15 mm.; thickness, 7 mm.

REMARKS AND AFFINITIES. One complete seed. The testa, although superficially abraded, is otherwise complete and is therefore seen nowhere in section. Its presence obscures the chalazal scar, but the micropylar aperture is apparent at the pointed end. The species is only comparable in size with *M. longissima* among fossil forms, but its proportionate breadth to length is less and its thickness is actually much greater than in that species giving a more truly reniform shape. It has therefore been described as a distinct species under the name *Magnolia gigantea*.

V.29890 Holotype, figured Pl. 17, fig. 11. A seed. *A. G. Davis Coll.* Warden Point, Sheppey.*Magnolia davisi* n. sp.

Plate 17, figs. 12, 13

DIAGNOSIS. Seed broadly reniform with a very slight median depression on one face. Length about 7.5 mm.; breadth about 11 mm.; thickness, 3.5 to 4.5 mm.

HOLOTYPE. V.29891.

DESCRIPTION. *Seed*: Somewhat broadly reniform in outline with a very slight median depression on one face. Testa fairly thick, structure as in *Magnolia*. Length, 7.5 mm.; breadth, 11 mm.; thickness, 3.5 to 4.5 mm.

REMARKS AND AFFINITIES. Two complete seeds and one half seed (broken longitudinally). They strongly recall *Leguminosites gracilis* Bowerbank (1840, pl. 17, figs. 12, 13) in size and outline, a species tentatively referred to *Magnolia longissima* (Bowerbank) by Reid & Chandler (1933: 173), but which might perhaps more wisely have been retained as a distinct species. The seeds described above as *M. davisii* differ from *L. gracilis* Bowerbank in their more inflated, less curved form, and in their less conspicuous median depression.

V.29891 Holotype, figured Pl. 17, fig. 12. A seed.

V.29892 Figured Pl. 17, fig. 13. A second seed (figured) and half of a third specimen. *A. G. Davis Coll.* Warden Point, Sheppey.

Magnolia lata n. sp.

Plate 17, fig. 14

DIAGNOSIS. Seed nearly twice as broad as long, compressed, convex on one face, with a broad, shallow, median longitudinal concavity on the other. Length, 4 mm.; breadth, 6.75 mm.; thickness, 2 mm.

HOLOTYPE. V.29893.

DESCRIPTION. *Seed*: Transversely oval in outline, nearly twice as broad as long, compressed, convex on one face, with a broad, shallow, median longitudinal concavity on the other. Testa relatively thin, surface much decayed and abraded, structure obscure. Scar of external chalaza small, deep. Length of seed, 4 mm.; breadth, 6.75 mm.; thickness, 2 mm.

REMARKS. One seed distinguished by its short broad form. It is much smaller and relatively narrower than *M. longissima* (Bowerbank) Reid & Chandler (1933: 173) or *M. oblonga* from Sheppey described below.

V.29893 Holotype, figured Pl. 17, fig. 14. A seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Magnolia oblonga n. sp.

Plate 17, figs. 15-18

DIAGNOSIS. Seed transversely-oblong or sub-oval in outline, very slightly hollowed on one face, chalaza margin straight. Length, 5.5 to 6.25 mm.; breadth, 7.25 to 9.25 mm.; thickness, 2 to 2.5 mm.

HOLOTYPE. V.29894.

DESCRIPTION. *Seed*: Transversely-oblong or sub-oval in outline, markedly broader than long, convex on one face, scarcely hollowed on the other, straight on the chalazal margin, convex on the micropylar margin, the micropyle being marked by an obtuse angle. Chalaza long and narrow, about 5 mm. long. Elongate cells lining the testa (seen on the internal cast) about 0.025 mm. broad, arranged so as to produce slightly wavy longitudinal lines. Coat within formed of equiaxial cells 0.03 mm. in diameter. Length of seeds, 5 to 6.25 mm.; breadth, 7.25 to 9.25 mm.; thickness, 2 to 2.5 mm.

REMARKS AND AFFINITIES. Nine specimens with testa showing varying degrees of abrasion and one crushed doubtful seed (Pl. 17, fig. 18). The species is distinguished by its proportions, viz.: great breadth relative to its length combined with slight thickness (only 2–2.5 mm.). It is much larger than *M. lata* from Bognor and smaller than *M. longissima* (Reid & Chandler, 1933: 173) or *M. davisii* from Sheppey.

- V.29894 Holotype, figured Pl. 17, fig. 15. A seed-cast. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.29895 Figured Pl. 17, figs. 16, 17. Two seed-casts with remains of testa. Successive integuments are well preserved as impressions on films of pyrites in one specimen.
 V.29896 Figured Pl. 17, fig. 18. A seed which has been crushed; it is broader than long but its length (probably exaggerated by crushing) is greater than is usual in this species, hence the determination is regarded as doubtful. Length, 7.75 mm.; breadth, 9.5 mm.; thickness, 2.5 mm. *In situ*.
 V.29897 Six seeds, one split longitudinally in the plane of symmetry, another represented by one half only. The above *A. G. Davis Coll.* Warden Point, Sheppey.
 V.29898 A seed, much encrusted with pyrites, about 6.5 mm. long and some 9 or 10 mm. broad, probably referable to this species. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.29899 Another similar but uncrushed seed 7.25 mm. long, 9.5 mm. broad, may belong to this species although it is relatively longer in proportion to its breadth than the majority of specimens so far examined. *D. J. Jenkins Coll.* Herne Bay, Kent.

Magnolia pygmaea n. sp.

Plate 17, fig. 19

DIAGNOSIS. Seed sub-circular in outline, inflated. Length of cast, 3.25 mm.; breadth, 3.5 mm.; thickness, 2.25 mm.

HOLOTYPE. V.29900.

DESCRIPTION. *Seed*: Sub-circular, considerably inflated, both surfaces convex, one much more so than the other. Chalaza relatively broad, 1.5 mm. by 1 mm. in diameter. Testa abraded, internal cast longitudinally striate, the striations due to narrow elongate cells about 0.016 mm. broad. Within is a thin coat, one cell thick only, of equiaxial cells 0.05 mm. in diameter. Length of cast, 3.25 mm.; breadth, 3.5 mm.; thickness, 2.25 mm.

REMARKS AND AFFINITIES. One seed distinguished by its unusually small size. That it is mature is probable from its unshrunk inflated condition. Even if the testa were preserved, the specimen would still be much smaller than any fossil species seen, the nearest being a small seed of *M. subcircularis*. No comparable small living seed has been found.

- V.29900 Holotype, figured Pl. 17, fig. 19. A seed-cast. *D. J. Jenkins Coll.* Warden Point, Sheppey.

Magnolia symmetrica n. sp.

Plate 17, figs. 20–22

DIAGNOSIS. Seeds rounded-triangular to sub-circular, more or less equal-sided, straight along the chalazal margin, pointed at the micropyle, sometimes hollowed on one surface. Surface sometimes slightly rugose. Length and breadth of seed about 7 mm.; thickness about 3 mm.

HOLOTYPE. V.29901.

DESCRIPTION. *Seed*: Rounded-triangular to sub-circular, usually as broad as long, sometimes slightly longer than broad, straight along the chalazal margin, pointed at the micropyle,

sometimes, but not invariably, hollowed on the raphe side, convex on the opposite side. The convex surface is occasionally very slightly faceted. Micropyle, chalaza and hilum as in the genus. Surface of testa smooth or somewhat rugose; thickness of testa, 0.2 mm., the ends of the columns forming the thickness of the testa are about 0.016 to 0.025 mm. in diameter where impressed on a film of pyrites. Elongate cells lining the testa, 0.012 to 0.016 broad. Equiaxial cells of the inner integument, 0.03 mm. in diameter. Length of seeds about 7 mm.; breadth about 7 mm.; thickness, 3 to 3.5 mm.

REMARKS AND AFFINITIES. Three seeds probably belonging to a distinct species characterized among other features by its symmetrical equilateral form. The narrowness of these seeds appears to be an original character not caused to any appreciable extent by the faceting during growth in a two-seeded fruit of an originally broader than long seed as in the Recent *Magnolia wilsonii*.

- V.29901 Holotype, figured Pl. 17, fig. 20. A seed with somewhat rugose testa now flaking away. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.
- V.29902 Figured Pl. 17, fig. 21. A seed-cast with testa preserved over the chalaza and most of the surface.
- V.29903 Figured Pl. 17, fig. 22. A seed with most of the testa flaked away showing the structure of the inner integuments.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29904 A seed with somewhat rugose testa preserved. Length, 6.75 mm.; breadth about 6 mm. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.

Magnolia rugosa n. sp.

Plate 17, figs. 23, 24

DIAGNOSIS. Seeds similar in form to those of *M. symmetrica*, but smaller. Surface markedly rugose when unworn. Length of seed about 6 mm.; breadth, 5 to 6.25 mm.; thickness, 2.5 to 3 mm.

HOLOTYPE. V.29905

DESCRIPTION. Seed similar in form to *M. symmetrica* but smaller and more slender. Surface of testa where unabraded conspicuously rugose with interrupted longitudinal ridges. The more convex of the two surfaces may show distinct faceting. Length of seed about 6 mm.; breadth, 5 to 6.25 mm.; thickness, 2.5 to 3 mm.

REMARKS. Two well characterized seeds, and one worn and more doubtful specimen. In general appearance these seeds resemble the narrower more symmetric specimens of the Recent *M. parviflora*.

- V.29905 Holotype, figured Pl. 17, figs. 23, 24. A seed with rugose testa preserved. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29906 Another seed. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.
- V.29907 A worn seed. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Family ANONACEAE

Genus ANONASPERMUM Ball emend. Reid & Chandler, 1933:184

Anonaspermum commune Reid & Chandler

Plate 17, fig. 25

1933 *Anonaspermum commune* Reid & Chandler, p. 184, pl. 5, figs. 14-17.

V.29908 Figured Pl. 17, fig. 25. Two closely appressed seeds with testa partly abraded showing the mode of growth in the fruit.

V.29909 Three seed-casts.
The above *A. G. Davis Coll.* Warden Point, Sheppey.? *Anonaspermum pulchrum* Reid & Chandler

Plate 17, fig. 26

1933 *Anonaspermum pulchrum* Reid & Chandler, p. 187, pl. 5, figs. 25-27.V.29910 Figured Pl. 17, fig. 26. A seed with adherent inner layers of testa which obscure the ruminations and make specific determination doubtful. Such evidence as can be seen suggests relationship with *A. pulchrum*, but *A. rugosum* might have a somewhat similar appearance, although it is generally larger. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.**Anonaspermum minimum* Reid & Chandler

Plate 17, fig. 27

1933 *Anonaspermum minimum* Reid & Chandler, p. 188, pl. 5, fig. 28.

Two small anonaceous seeds, one with part of the testa preserved, are referred to *Anonaspermum minimum* on account of their small size and coarse ruminations, some of which pass from margin to margin, others ending near the middle. Length of seeds, 4.25 to 4.5 mm.; breadth, 3.75 to 4 mm.; thickness, 2 mm.

V.29911 Figured Pl. 17, fig. 27. A seed-cast with a mere film of testa over part of one surface.

V.29912 A seed with part of testa preserved.
Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.*Anonaspermum ovale* Reid & Chandler

Plate 17, fig. 28

1933 *Anonaspermum ovale* Reid & Chandler, p. 190, pl. 5, figs. 31-33.V.29913 Figured Pl. 17, fig. 28. A seed with testa partly preserved so that the albumen is not fully exposed. Length, 6.75 mm.; breadth, 4.75 mm.; thickness, 2.25 mm. The specimen, which resembles *A. ovale*, is, however, smaller than the Sheppey specimens and is therefore referred doubtfully to this species. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.V.29914 A small seed, 7.5 mm. long, 5.5 mm. broad, probably referable to this species. Also a fragment of a second seed. Both with testa abraded. *A. G. Davis Coll.* Warden Point, Sheppey.V.29915 A sub-circular seed-cast probably referable to this species. *J. G. Turner Coll.* Sheppey.

Anonaspermum complanatum Reid & Chandler

Plate 17, figs. 29, 30

1933 *Anonaspermum complanatum* Reid & Chandler, p. 191, pl. 5, figs. 34, 35.

- V.29916** Figured Pl. 17, fig. 29. A well-preserved seed-cast less abraded than specimens formerly figured. The complete removal of the testa shows the character of the albumen particularly clearly. The ruminations appear to be finer, as well as more definitely radially arranged, than those of *A. ovale*. *J. G. Turner Coll. Sheppey.*
- V.29917** Figured Pl. 17, fig. 30. A seed-cast broken along one side but with hilum and chalaza preserved. Originally sub-circular in outline it is a broader seed than other specimens referred to *A. complanatum*. The ridges of the albumen are short and radially arranged around the margin. They quickly branch and anastomose over the greater part of the surface, thereby forming an irregular series of pits. Occasionally shorter radial ridges are interpolated between the longer marginal ones. Length of seed, 7.5 mm.; breadth, incomplete; thickness, 2 mm. Referred doubtfully to this species. *A. G. Davis Coll. Warden Point, Sheppey.*

Anonaspermum anoniforme Reid & Chandler

Plate 17, fig. 31; Pl. 18, fig. 1

1933 *Anonaspermum anoniforme* Reid & Chandler, p. 192, pl. 5, fig. 37.

- V.29918** Figured Pl. 17, fig. 31. Seed-cast elongate-oval in outline, 9 mm. long, 4.75 mm. broad, 3.25 mm. thick. Both faces are convex and show ruminations comparable with those of *A. anoniforme*. They are mostly directed transversely, sometimes continued in a sinuous course across the middle, sometimes anastomosing with those of the opposite margin or bending back or forking so as to produce nodules. There is a marked development of short ridges at the margin interpolated between the longer ones. The testa, now flaked away, was originally preserved over the whole surface of the cast. The specimen is somewhat smaller than the holotype and less abraded. *A. G. Davis Coll. Warden Point, Sheppey.*
- V.29919** Figured Pl. 18, fig. 1. An elongate-oval seed with well-preserved testa and hilum. At the opposite end the testa has flaked away showing the ruminations elsewhere obscured. An incrustation of pyrites on the surface of the seed prevents the complete removal of the testa. Length of seed (including testa), 14 mm.; breadth (with testa) about 8 mm.; breadth of seed-cast, 6 mm.; thickness of seed with testa, 5.5 mm. *G. F. Elliott Coll. Warden Point, Sheppey.*

Anonaspermum complicatum n. sp.

Plate 18, fig. 2

DIAGNOSIS. Seed-cast elongate-oval in outline with convex faces, rumination ridges tortuous and complicated, branching and anastomosing all over the surface.

HOLOTYPE. V.29920.

DESCRIPTION. *Seed*: Elongate-oval in outline, somewhat inflated so that both faces are convex. Endosperm without marginal groove, ruminations tortuous and complicated, branching, bending and anastomosing so as to give rise all over the surface to a system of sinuous nodules and pits which distinguish this seed from any other described. The smooth testa was originally preserved, but is now rapidly flaking away. Length of seed, 8.5 mm.; breadth, 4.5 mm.; thickness, 4 mm.

- V.29920** Holotype, figured Pl. 18, fig. 2. A seed with testa partly preserved. *G. F. Elliott Coll. Warden Point, Sheppey.*

Anonaspermum sp.

Plate 18, fig. 3

DESCRIPTION. *Seed*: Sub-circular in outline, lenticular in section, both surfaces convex; anatropous with terminal hilum and flat marginal raphe; albuminous with ruminant albumen largely obscured by adherent patches of thick testa formed of criss-cross fibres. The ruminations, where visible, are radially arranged round the margin, occasionally bifurcating towards the margin, branching and anastomosing within so as to form a series of elongate irregular pits over the central part of the surface. Length of seed as preserved, 5.75 mm.; breadth, 5.25 mm.; thickness, 6 mm.

REMARKS AND AFFINITIES. One seed approximately the size and shape of *Anonaspermum minimum* and *A. subcompressum*. *A. minimum* differs in the marked transverse arrangement of the ruminations and *A. subcompressum* has a less simple arrangement of its ruminations. The incompleteness of the evidence, based on one specimen only, in which the albumen is partially obscured by testa makes specific determination uncertain.

V.29921 Figured Pl. 18, fig. 3. A seed with part of the testa abraded. *A. G. Davis Coll.* Warden Point, Sheppey.

Anonaspermum sp.

Plate 18, fig. 4

A seed-cast bearing some resemblance to *A. rugosum* Reid & Chandler but somewhat smaller and less grooved around the margin. Moreover the ridges of albumen tend to die out over the middle of the seed which shows a tendency to be punctate as in *A. obscurum* Reid & Chandler (1933: 193, pl. 5, fig. 39). Length of seed, 7 mm.; breadth, 5.5 mm.; thickness, 2.5 mm.

V.29922 *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family LAURACEAE

The difficulty of determining genera and species in this family was pointed out by Reid & Chandler (1933: 195). Frequently identification depends on detailed knowledge of internal cell-structures which may be visible only after destruction of the specimens. On the other hand where the internal structure is revealed by abrasion or fracture in fossilization, the external characters may not have been preserved. Certain well-marked types, represented by abundant material are fairly easy to recognize. But over and beyond these an enormous number of specimens, recognizable as Lauraceae, cannot be more closely identified. They serve to show, however, how richly the family was represented in London Clay times and their presence emphasizes 'the extremely warm humid climate in which the London Clay flora must have flourished' (Reid & Chandler, 1933: 198). They may represent a large number of additional genera and species which, without a far longer and more exhaustive study than can at present be given to them, must remain unknown. Most of such specimens have not been catalogued.

Genus CINNAMOMUM Blume

Cinnamomum globulare Reid & Chandler

Plate 18, figs. 5–8

1933 *Cinnamomum globulare* Reid & Chandler, p. 200, pl. 6, figs. 6–11.

- V.29924 Figured Pl. 18, fig. 5. A berry showing attachment scar, embedded in a septarian fragment. *A. G. Davis Coll.* Beach below Warden Post Office, Sheppey. *In situ.*
- V.29925 Figured Pl. 18, figs. 6, 8. Two berries (one abraded so as to expose the endocarp in the lower half). Both agree in size, form and pitted epicarp with *C. globulare*. The perfect berry (Fig. 6) agrees also in its attachment scar.
- V.29926 Figured Pl. 18, fig. 7. A small berry showing epicarp and attachment scar. Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29927 A small berry showing basal attachment scar. *C. E. Hollis Coll.* Swale Cliff, Herne Bay, Kent.
- V.29928 Two berries. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Cinnamomum grande Reid & Chandler

Plate 18, fig. 9

1933 *Cinnamomum grande* Reid & Chandler, p. 202, pl. 6, figs. 12–14.

- V.29929 Figured Pl. 18, fig. 9. A berry, somewhat depressed longitudinally with the basal scar partly abraded round its edges. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29930 Four berries, one with exocarp partly broken away and much rotted. The typical circular scars are seen on the epicarp. Largest diameter about 14 mm. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
- V.29931–33 Two typical large berries, and two immature shrivelled laterally compressed berries. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.
- V.29934 A crushed berry, about 12 mm. long and 12.5 mm. in transverse diameter, probably belonging to this species, although the circular pits of the epicarp are not clearly seen, perhaps owing to the condition of preservation. *G. F. Elliott Coll.* Sheppey.

Cinnamomum ovoideum n. sp.

Plate 18, figs. 10–12

DIAGNOSIS. Berry narrow-ellipsoid or -ovoid. Epicarp with large circular depressions or punctations. Endocarp about 0.05 mm. thick. Length of fruit, 7.5 to 11.5 mm.; breadth about 5 mm. (maximum breadth seen, 6.75 mm.).

HOLOTYPE. V.29935.

DESCRIPTION. *Berry*: One-loculed, one-seeded, narrow-ellipsoid or -ovoid with large circular basal attachment scar 3.5 to 4.5 mm. in diameter. Surface smooth and shining with large circular punctations as in *Cinnamomum grande*. Epicarp thin, leathery, formed of fine equiaxial cells, 0.012 to 0.016 mm. in diameter, which give a finely tessellated or sometimes a longitudinally striate surface. It also shows numerous circular oil ducts 0.1 to 0.15 mm. in diameter (not always preserved). Mesocarp formed of several layers of cells not clearly seen although they are obscurely impressed upon the surface of the testa. They include coarse globular secreting cells. Endocarp about 0.05 mm. thick, columnar in section. Seed pendulous. Length of berry, 7.5 to 11.5 mm.; breadth about 5 mm. (maximum breadth, 6.75 mm.)

Seed: Narrow-ovoid, anatropous with hilum at one end, raphe lateral, chalaza at the opposite end, its limits and size not seen. Testa with a layer of cells having sinuous outlines

and containing a black secretion, very variable in size, from about 0.05 to 0.15 mm. in diameter; within it is a layer of equiaxial cells, about 0.02 to 0.025 mm. in diameter, aligned so as to produce an appearance of transverse striation towards the apex of the fruit. Inside is a coat of thinner-walled cells which produce a smooth shining surface of transversely elongate cells with strongly marked transverse walls.

REMARKS AND AFFINITIES. Fourteen berries in different stages of abrasion. The large basal scar indicates a swollen peduncle. The characters indicate the genus *Cinnamomum*. The species is smaller and more narrowly ovoid than *C. globulare* or *C. grande* and much smaller than the narrow-ovoid species *C. oblongum*; yet it appears to be fully mature and it therefore merits a specific name. It is one of the few species known up to the present from Bognor and Herne Bay but not recorded from Sheppey.

V.29935 Holotype, figured Pl. 18, fig. 10. A berry with epicarp beautifully preserved.

V.29936 Figured Pl. 18, fig. 11. A berry abraded so as partly to expose the seed. The circular punctations of the surface are very conspicuous where the epicarp is preserved.

V.29937 Figured Pl. 18, fig. 12. A typical berry. *J. E. Cooper Coll.* Herne Bay, Kent.

V.29938 Eleven specimens, nine being berries in some cases with the epicarp much abraded; one is a seed obscured by adherent remains of the fruit; one a much compressed berry.

All the above (except V.29937) *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Cinnamomum oblongum n. sp.

Plate 18, figs. 13-18

DIAGNOSIS. Berry narrowly ellipsoid or obovoid. Epicarp with large circular depressions. Endocarp usually about 0.075 mm. thick. Chalaza, occupying rather more than one-sixth of the length of the seed, about 3 mm. broad. Length of fruit, 13 or 14 mm.; breadth, 8 to 9.5 mm.

HOLOTYPE. V.29939.

DESCRIPTION. *Berry*: One-loculed, one-seeded, narrowly obovoid or ellipsoid with basal attachment scar about 4 mm. in diameter. Surface smooth shining with large circular depressions or punctations; epicarp brown, semi-translucent, leathery, formed of small equiaxial cells about 0.016 to 0.02 mm. in diameter, with numerous circular yellowish oil ducts. Mesocarp formed of several layers of coarser cells which, immediately below the epicarp, are about 0.03 mm. in diameter. One much compressed specimen (Pl. 18, fig. 16) probably referable to this species shows, beneath its partly abraded epicarp, thick longitudinal strands of fibres which occasionally branch; they are embedded in a mass of globular cells about 0.05 mm. in diameter. Endocarp columnar in section, 0.075 mm. thick (in one specimen 0.35 mm. thick). Length of berry, 13 to 14 mm. sometimes larger; breadth, 7 to 9.5 mm.

Seed: Ovoid, anatropous with broad lateral raphe, chalaza circular, 3 mm. broad, occupying rather more than one-sixth of the length. Testa, about 0.1 mm. thick, formed of sinuous secreting cells some as large as 0.2 mm. in diameter. Within is a smooth shining coat of angular equiaxial cells which appear longitudinally or transversely aligned according to the lighting of the specimen. Within again is a coat of fine equiaxial cells about 0.006 mm. in diameter. Length of seed, 11.5 mm.; breadth, 7.5 mm.

REMARKS AND AFFINITIES. Fifteen specimens in various stages of abrasion, eleven from Herne Bay, two from Sheppey, one each from Bognor and Frinton. The large basal scar indicates a swollen peduncle; the surface and succession of coats indicate relationship with

Cinnamomum and, like *C. ovoideum*, the species is more elongate than those previously described. It is much larger than *C. ovoideum* from which it also differs in the cell-structure of its coats. It appears to merit a distinct specific name.

- V.29939 Holotype, figured Pl. 18, fig. 13. A berry with part of the leathery epicarp preserved, part removed so that endocarp, testa and seed-cast are exposed. The raphe is clear, and part of the chalaza is seen. Length of berry, 13 mm.; breadth, 8.5 mm.
- V.29940 Figured Pl. 18, fig. 14. A well-developed berry broken at the attachment to show the chalaza on the seed-cast. The epicarp is somewhat worn so that the shining brown surface is not well preserved, but the circular depressions are clear. Length (not quite complete), 14 mm.; breadth, 9.5 mm.
- V.29941 Figured Pl. 18, fig. 15. A seed showing the chalaza. Remains of the berry adhere at the apex, East Cliff shore. All the above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29942 Figured Pl. 18, fig. 16. A somewhat flattened berry with epicarp preserved only in places, elsewhere fibres and cells of mesocarp are exposed. The chalazal end of the seed is visible, the chalaza occupying about one-sixth of the total length. Length of berry, 13.5 mm.; breadth, 8 mm. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*
- V.29943 Figured Pl. 18, fig. 17. A berry with epicarp preserved, but decayed and obscured by pyritization of the mesocarp which has swollen and burst through the epicarp, forming numerous circular excrescences corresponding with the circular depressions seen in other specimens. The apex is also somewhat obscured by encrusting pyrites. The basal scar is clearly seen. *A. G. Davis Coll.* Frinton, Essex.
- V.29944 Figured Pl. 18, fig. 18. A somewhat distorted fruit with scar of attachment broken to expose the chalaza and cotyledons. The epicarp bears circular punctations like those of *C. grande*. Length of berry, 13 mm.; breadth, 13 by 6.5 mm. (compressed). *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29945 An abraded fruit showing fibres and groups of secreting cells in the mesocarp. Endocarp unusually thick (0.325 mm.). Length (incomplete at basal scar), 12 mm.; breadth, 8.5 mm. *F. M. Wonnacott Coll.* Warden Point, Sheppey.
- V.29946 A somewhat abraded but otherwise perfect berry showing the attachment scar 4 mm. in diameter. Length of berry, 13.5 mm.; breadth, 9 mm. Also a berry fractured to show the seed.
- V.29947 Four small berries at various stages of abrasion.
The above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.29948 A fruit with epicarp preserved in one small patch only near the apex. At the base the endocarp is exposed. The specimen has been compressed giving it a rather broader appearance than is normal. It is now fractured longitudinally. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29949 A crushed fruit much abraded. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Genus LITSEA Lamarck

Litsea pyriformis Reid & Chandler

Plate 18, fig. 19

1933 *Litsea pyriformis* Reid & Chandler, p. 204, pl. 6, figs. 15-17.

- V.29950 Figured Pl. 18, fig. 19. A beautifully-preserved obconical cupule. The berry has fallen from the cupule. The surface is shining with a translucent yellow epidermis studded all over the surface with circular depression as in the berries of *Cinnamomum* spp. It is formed of small square or polygonal cells varying in size which diverge around the depression. Its surface is much puckered and appears leathery. Length, with peduncle into which it narrows, 29 mm.; maximum breadth, 14.5 mm. Breadth across the apex of the cupule, 13 mm. *E. M. Venables Coll.* Top of 'Upper Fish Tooth Bed'; Bognor, Sussex. *In situ.*
- V.29951 A berry in an obconical cupule, fractured longitudinally to show the structure. The surface is abraded and the stalk worn away. The cupule is not slightly incurved below the berry, as in the holotype, and the seed and endocarp are somewhat longitudinally elongate and unconstricted at the level of the chalaza. Probably these are individual variations and not of specific rank. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus BEILSCHMIEDIA Nees

Beilschmiedia oviformis (Bowerbank) Reid & Chandler

1933 *Beilschmiedia oviformis* (Bowerb.) Reid & Chandler, p. 205, pl. 6, figs. 18-22.

- V.29952 Four locule- or seed-casts showing the cotyledons and chalaza. *J. E. Cooper Coll.* Herne Bay, Kent.
 V.29953 Two seed-casts showing cotyledons and chalaza, and a third much abraded specimen. *J. E. Cooper Coll.* Herne Bay, Kent.
 V.29954 A crushed seed-cast, with unusually thick and continuous columnar coat representing adherent endocarp. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.29955 A seed-cast showing radicle, chalaza and two cotyledons. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.
 V.29956 Two seed-casts showing radicle, chalaza and two cotyledons. *A. G. Davis Coll.* Warden Point, Sheppey.
 V.29957 An incomplete seed broken at the chalazal end, with small mucro preserved at the other (radicle) end. Columnar coat where seen, 0.15 mm. thick. There is some indication of a groove between the cotyledons and a strap-shaped chalaza at their junction from which striae diverge obliquely or transversely across the cotyledons. Length incomplete; breadth, 7.5 mm. Probably this species. *H. A. Toombs Coll.* Sewer trench 200 yards W. of L.M.S. Rly. Stn., Kenton, nr. Harrow, Middlesex.

Beilschmiedia pyriformis Reid & Chandler

1933 *Beilschmiedia pyriformis* Reid & Chandler, p. 207, pl. 6, figs. 23-25.

- V.29958 A seed-cast with adherent remains of testa and berry. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Beilschmiedia bognorensis n. sp.

Plate 18, figs. 20-22

DIAGNOSIS. Fruit ovoid, about 17 mm. long. Pericarp (as preserved) with a coat of cells arranged in conspicuous stellate groups about 2 mm. in diameter. Seed apiculate-ovate. Testa (about 0.5 mm. thick) with several outer layers of angular equiaxial cells, having a black secretion and inner layers of stellate cells with long narrow rays. Embryo with apiculate radicle and appressed plano-convex cotyledons. Chalaza straight-sided ligulate, extending for more than half the length around the lower end of the seed as it lies in the fruit. Seed about 13 mm. long.

HOLOTYPE. V.29959.

DESCRIPTION. *Fruit*: One-loculed, one-seeded, ovoid. Epicarp abraded, the surface thus exposed formed of conspicuous stellate groups of cells, the groups having sinuous outlines and usually measuring about 2 mm. in diameter; the coat (mesocarp + endocarp?) as preserved is about 0.7 mm. thick. It is broken away except near the apex on one side, elsewhere the seed or seed-cast is exposed. No distinct columnar layer has been detected probably owing to the condition of the specimen. Estimated length of fruit about 17 mm.; estimated breadth about 15 mm. (exaggerated by compression in fossilization).

Seed: Exalbuminous with large plano-convex cotyledons and a small radicle which forms the point of the mucronate-ovoid seed. Testa having a maximum thickness near the base of about 0.5 mm., formed, as regards its outer layers, of coarse angular cells, often about 0.1 mm. in diameter, having a black shining secretion. The innermost layers are of stellate cells, about 0.1 to 0.15 mm. in diameter, with long narrow rays. A layer of these cells can be seen closely

investing the seed and obscuring the tegmen (exposed near the junction of the cotyledons) of thin-walled angular cells varying from 0.05 to 0.1 mm. in diameter. The chalaza scar is long, narrow, straight-sided, it lies along the junction of the cotyledons passing over their distal ends and extending for rather more than half the length of the seed. Length of seed, 13 mm.; breadth, 12 by 8 mm. (compressed in fossilization).

REMARKS AND AFFINITIES. One specimen whose apiculate seed with large cotyledons, strap-shaped chalaza, and stellate cell-groups of the mesocarp, indicate the genus *Beilschmiedia*. The species is considerably larger than *B. oviformis* and smaller than *B. pyriformis*, *B. bowerbanki*, *B. crassicuta*, *B. eocenica* and *B. gigantea* (Reid & Chandler, 1933: 209–212). It is further distinguished from *B. pyriformis*, *B. bowerbanki* and *B. eocenica* by its narrow, straight sided, strap-shaped chalaza. No fibrous layer such as occurs in *B. fibrosa* has been seen, and the testa cells are coarser than in that species. *B. crassicuta* has a characteristic conical seed. In spite of its imperfect condition, the characters that are preserved in this fossil appear sufficiently distinctive to justify specific definition. The name *Beilschmiedia bognorensis* has therefore been given.

V.29959 Holotype, figured Pl. 18, figs. 20–22. A seed with remains of exocarp. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus PROTORAVERSARA Reid & Chandler, 1933:214

Protoravensara sheppeyensis Reid & Chandler

Plate 18, fig. 23

1933 *Protoravensara sheppeyensis* Reid & Chandler, p. 214, pl. 7, figs. 3–5.

To the description already published of this fossil the following details may now be added. The columnar coat (endocarp?) may be 0.15 to 0.2 mm. thick. In one of the grooves of the furrowed locule-cast a mass of tissue was seen formed of thin-walled equiaxial cells 0.03 mm. in diameter. This tissue had ill-defined edges, it gradually faded out. As it lies inside the columnar coat it may represent the raphe of the solitary seed or part of the testa.

V.29960 Figured Pl. 18, fig. 23. A distorted fruit abraded to show the furrowed locule-cast in places. The fruit has been fractured so that the lobed endocarp may be seen in section with its well-defined columnar wall. There is a sunk basal polygonal scar of attachment. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29961 A fruit abraded so as to expose the locule-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

V.29962 A locule-cast. *G. F. Elliott Coll.* Warden Point, Sheppey.

Genus LAUROCALYX Reid & Chandler, 1933:219

Laurocalyx globularis Reid & Chandler

Plate 18, figs. 24, 25

1933 *Laurocalyx globularis* Reid & Chandler, p. 219, pl. 7, figs. 12–15.

A sub-globular cupule 10 mm. long, 11.5 mm. in transverse diameter agrees in such of its characters as are displayed with *Laurocalyx globularis*. The cupule extends almost to the apex

of the berry (Pl. 18, fig. 24). The base is abraded so that the scar of attachment is not clear as in the holotype. The surface also is abraded exposing the substance of irregular parenchyma. Only in a few very small patches can traces be seen of what may have been an original surface of equiaxial, more or less equal sided cells about 0.03 mm. in diameter. At the extreme apex cells and fibres lie parallel with the margin of the cupule, a little further away the abrasion of the epicarp has exposed rather large flattened cells (secreting?) aligned and elongate at right angles to the margin, about 0.05 mm. broad. The extreme apex of the berry, which alone is exposed, shows traces of epicarp formed of small equiaxial cells about 0.016 mm. in diameter. Without fracturing the specimen the characters of seed and endocarp cannot be examined, but there can be little doubt of the relationship of the species. There is also a second specimen incomplete at the base.

V.29963 Figured Pl. 18, figs. 24, 25. A berry enclosed almost to the apex in a cupule. *D. J. Jenkins Coll.* Hampton (Swale Cliff), Herne Bay, Kent.

V.29964 A second cupule broken below so as to expose the seed. *J. E. Cooper Coll.* Herne Bay, Kent.

Genus LAUROCARPUM Reid & Chandler, 1933:225

Laurocarpum paradoxum Reid & Chandler

Plate 18, fig. 28

1933 *Laurocarpum paradoxum* Reid & Chandler, p. 226, pl. 7, figs. 29-34.

V.29965 Figured Pl. 18, fig. 28. A seed with adherent remains of endocarp. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29966 Two seeds, one with remains of the endocarp showing rugosities. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29967 Three seeds, one with remains of endocarp around the hilum only, one very small but with the ridged and puckered endocarp preserved, all showing the curved transverse placental aperture. *J. E. Cooper Coll.* Herne Bay, Kent.

V.29968 A similar seed with remains of endocarp. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Laurocarpum ovoideum Reid & Chandler

Plate 18, figs. 29-32

1933 *Laurocarpum ovoideum* Reid & Chandler, p. 228, pl. 7, figs. 35-38.

Three berries, two from Herne Bay, and one from the new plant locality at Frinton, Essex, are evidently referable to *L. ovoideum*. One of the Herne Bay specimens differs from the holotype in its smooth external surface without any trace of longitudinal ribbing but this may be due to the preservation. In other respects it agrees with *L. ovoideum*.

V.29969 Figured Pl. 18, figs. 29, 30. A sub-ovoid berry fractured longitudinally to expose the seed. Base truncate with fluted aperture, about 2.5 mm. in diameter, marking the attachment to a swollen peduncle and the point of entry of fibro-vascular bundles. Epicarp smooth, surface formed of equiaxial cells, 0.012 to 0.016 mm. in diameter, columnar in section, about 0.1 mm. thick. Mesocarp thick below the seed, formed of elongate cells, becoming very thin over the sides and apex. Endocarp 0.2 mm. thick, columnar in section. Length of berry (slightly imperfect at the base), 13 mm.; breadth, 9.5 mm. The seed is ovoid with a longitudinal angle at the apex probably associated with the raphe, chalaza obscured by testa the cells of which vary in shape and size, sometimes as much as 0.2 mm. in diameter, flattened and secreting. Length of

seed, 10.5 mm.; breadth about 8.5 mm. (partly obscured by exocarp). *D. J. Jenkins Coll.* Herne Bay, Kent.

V.29970 Figured Pl. 18, figs. 31, 32. A berry about 15 mm. long, 10 mm. broad with typical obscure longitudinal ribbing and large fluted basal aperture. *A. G. Davis Coll.* Frinton, Essex.

V.29971 A berry, now fractured. *D. J. Jenkins Coll.* Herne Bay, Kent.

Laurocarpum proteum Reid & Chandler

1933 *Laurocarpum proteum* Reid & Chandler, p. 230, pl. 7, figs. 39-43.

V.29972 A broken fruit, apical end showing the seed-cast within. *D. J. Jenkins Coll.* Herne Bay, Kent.

Laurocarpum minimum Reid & Chandler

Plate 18, figs. 33-35

1933 *Laurocarpum minimum* Reid & Chandler, p. 231, pl. 7, figs. 44, 45.

V.29973 Figured Pl. 18, fig. 33. A perfect berry slightly mucronate at the apex, basal scar of attachment 2.5 mm. in diameter. Epicarp yellow-brown, translucent, formed of equiaxial cells 0.016 to 0.025 mm. in diameter. Mesocarp of equiaxial cells 0.012 mm. in diameter, with coarser cells inside 0.016 to 0.025 mm. in diameter. Length of berry, 7.5 mm.; breadth, 5 mm. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

V.29974 Figured Pl. 18, fig. 34. A berry with conical apex and somewhat puckered base. Epicarp shining formed of equiaxial cells 0.016 mm. in diameter, endocarp 0.06 mm. thick, testa of several layers including a layer of secreting cells. Length as shortened by puckering, 6 mm.; breadth, 4.25 mm. The specimen has been fractured longitudinally to expose the coats. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29975 Figured Pl. 18, fig. 35. A berry with epicarp well preserved. The specimen is broken at one side to show the seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.29976 A seed-cast. *In situ.*

V.29977 A berry fractured transversely at the attachment. Coarse cells of the testa are shown where part of the exocarp and endocarp have come away.

The above *A. G. Davis Coll.* Warden Point, Sheppey.

V.29978 Thirteen berries, some with exocarp, others with endocarp and seed exposed. One encased in pyrites (now broken in pieces) enclosing a broad ovoid seed 5.5 mm. long, 4.5 mm. broad. The endocarp, where seen, is 0.1 mm. thick, columnar in section. *J. E. Cooper Coll.* Herne Bay, Kent.

? *Laurocarpum minimum* Reid & Chandler

Plate 18, fig. 36

Seed: Ovoid, slightly angled in the plane between the cotyledons at the hilar end, rather more pointed at the hilum than at the chalaza. Chalaza large and smooth occupying rather more than a third of the length. Testa or tegmen preserved only as impressions on the seed-cast formed of longitudinally elongate or square cells arranged in slightly sinuous or irregular rows about 0.016 mm. broad. The impressions are seen both on and beyond the limits of the chalaza. No trace of exocarp or endocarp is preserved. Length of seed-cast, 5.5 mm.; transverse diameter, 4 mm.

REMARKS. The seed may possibly be a specimen of *Laurocarpum minimum*, but it is somewhat smaller with a relatively larger chalaza occupying a greater proportion of the length of the seed also rather more pointed at the chalazal end.

V.29979 Figured Pl. 18, fig. 36. A seed-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

Laurocarpum minutissimum Reid & Chandler

Plate 18, figs. 37, 38

- 1933 *Laurocarpum minutissimum* Reid & Chandler, p. 232, pl. 8, figs. 1-3.
- V.29980 Figured Pl. 18, fig. 37. A seed 4.25 mm. long, 4 mm. in diameter, showing the lateral raphe and large basal chalaza (3 mm. in diameter).
- V.29981 Figured Pl. 18, fig. 38. A seed about 3.75 by 3.5 mm. in transverse diameter and 3 mm. long (compressed). The chalaza and part of the seed-cast above it are exposed by abrasion. The chalaza occupies about one-third of the length of the seed and is about 2.5 mm. in diameter. The specimen is smaller than *L. minutissimum*, and the chalaza occupies a greater proportion of the length. It is therefore referred doubtfully to this species.
- V.29982 A compressed endocarp, 4 mm. long as crushed, 5 mm. in diameter, with adherent remains of the berry above.
- V.29983 A typical berry partly fractured so that the large chalaza is exposed. Length and breadth, 5 mm. Chalaza 3.5 mm. in diameter occupying about one-fifth of the length of the seed.
All the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29984 A typical berry now fractured to show the endocarp, seed and seed-cast on which the impressions of the two cotyledons are clearly seen. Length of berry, 5 mm.; diameter, 6 mm.; breadth of attachment scar, 3.5 mm. *J. E. Cooper Coll.* Herne Bay, Kent.

Laurocarpum sheppeyense Reid & Chandler

- 1933 *Laurocarpum sheppeyense* Reid & Chandler, p. 225, pl. 7, figs. 27, 28.
- V.29991 Two seed-casts. Also a seed resembling this species in the large gaping placental aperture, but differing in having a smaller chalaza (about one-quarter of the length of the seed). *J. E. Cooper Coll.* Herne Bay, Kent.

Laurocarpum sp. 16

Plate 18, fig. 39

- 1933 *Laurocarpum* sp. 16, Reid & Chandler, p. 239, pl. 8, fig. 19.
- V.29985 Figured Pl. 18, fig. 39. A small crushed berry. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.29986 A somewhat flattened fruit enclosing a seed. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29987 A somewhat abraded flattened berry with coarse testa cells preserved in depressions. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.29988 An endocarp and a seed. Both much compressed. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.29989 A seed, somewhat compressed, probably referable to this species. It shows the coarse testa cells, and the branching fibres over the chalaza. *D. J. Jenkins Coll.* Sheppey.
- V.29990 Five small, immature, thin-walled much collapsed berries. Possibly referable to this species, but if so, unusually small. *A. G. Davis Coll.* Warden Point, Sheppey.

Laurocarpum sp. 18

Plate 18, figs. 40, 41

- 1933 *Laurocarpum* sp. 18, Reid & Chandler, p. 140, pl. 8, fig. 21.
- V.29992 Figured Pl. 18, figs. 40, 41. A seed with cotyledons exposed at the base. The seed is partly covered by columnar endocarp above within which are a few stout longitudinal strands of fibres lying in a coat (testa?) several cells thick, formed of cells with sinuous walls, about 0.05 mm. in diameter. The seed shows a marked tendency to break up. Length of specimen, 20 mm.; transverse diameter about 13 mm. including remains of endocarp. It agrees in size and form with *Laurocarpum* sp. 18 (Reid & Chandler, 1933, pl. 8, fig. 21), and has the same large plano-convex cotyledons, but the extent of the chalaza cannot be seen owing to adherent testa and endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

Laurocarpum davisi n. sp.

Plate 18, figs. 42, 43

DIAGNOSIS. Berry ovoid, about 19 mm. long, with small scar of attachment. Mesocarp about 2.5 mm. thick, of closely compacted equiaxial cells with small carbonaceous patches perhaps indicating radiating cell-groups. Endocarp ovoid with a longitudinal angle corresponding with the raphe within. Surface with shallow rugosities. Length of endocarp about 10 mm.

HOLOTYPE. V.29993.

DESCRIPTION. *Berry*: Ovoid, with small attachment scar indicating a thin unswollen peduncle and no cupule. Surface smooth and even, without large pits or depressions as preserved. Epicarp of equiaxial cells, 0.006 to 0.008 mm. in diameter (largely worn away). Mesocarp about 2.5 mm. thick, formed of closely compacted equiaxial cells about 0.03 mm. in diameter, with small carbonaceous patches more or less evenly scattered throughout perhaps indicating the positions of radiating cell-groups (now decayed). Length of berry (including short remains of peduncle), 19 mm.; breadth, 13.5 mm.

Endocarp: Ovoid, with a longitudinal angle extending from the placenta to the equator evidently corresponding in position with the raphe of the enclosed seed (not seen). Surface of endocarp uneven with shallow rounded rugosities especially over the lower part (covering the chalazal area of the seed?), formed of small angular or oblong cells about 0.016 mm. in diameter. Length of endocarp, 10 mm.; breadth at right angles to plane of symmetry (with longitudinal angle), 7.5 mm.; breadth in plane of symmetry not exposed.

REMARKS AND AFFINITIES. One berry, and a possible second specimen represented by a fragment with a similar form and thick mesocarp. The relationship to living genera has not been determined.

V.29993 Holotype, figured Pl. 18, figs. 42, 43. A berry now fractured to show the endocarp.

V.29994 A fragment of a second fruit, probably referable to this species.

The above *A. G. Davis Coll.* Warden Point, Sheppey.

Laurocarpum cupuliferum n. sp.

Plate 18, figs. 44, 45

DIAGNOSIS. Berry sub-globular, with large attachment scar extending for less than one-quarter the length of the berry. Mesocarp with numerous groups of radially arranged cells. Endocarp wall thin, intermittently columnar. Testa thick not sharply delimited from the endocarp. Length of berry about 14 mm.; breadth, 14 mm.

HOLOTYPE. V.29995.

DESCRIPTION. *Berry*: Sub-globular, cupulate as evidenced by a large differentiated basal area, or else attached to a large swollen peduncle. The area of attachment is marked by a slight contraction of the surface as seen in profile, the contraction being delimited by an irregular latitudinal line below which there is a roughening of the surface (attachment area). It extends for less than one-quarter of the length of the berry. Epicarp, seen in small patches above the limits of the basal scar, formed of equiaxial cells 0.016 in diameter; immediately underlying it are longitudinally elongate and aligned cells 0.1 mm. long, 0.1 to 0.2 mm. broad. Mesocarp with numerous groups of radially arranged cells as in *Laurocarpum inornatum*.

Endocarp apparently with a thin intermittently columnar wall. Testa thick, coarse celled, not sharply delimited from the endocarp. Length of berry, 14 mm.; breadth, 14 mm.; depth of basal scar, 4 mm. (i.e. from base of berry to margin of scar).

REMARKS. One berry somewhat resembling *Laurocarpum inornatum* but distinguished by the large basal scar, and by the thin intermittently columnar endocarp.

V.29995 Holotype, figured Pl. 18, figs. 44, 45. A berry. *D. J. Jenkins Coll.* Herne Bay, Kent.

Laurocarpum inornatum n. sp.

Plate 18, figs. 46, 47

DIAGNOSIS. Berry sub-globular with small attachment scar. Mesocarp thick, with numerous groups of radially arranged cells. Endocarp clearly defined, columnar, 0.1 to 0.2 mm. thick. Seed conical or sub-globular. Chalaza only slightly convex forming a broad basal area. Length of berry, 13 to 16 mm.; breadth, 12 mm. All diameters of endocarp about 9 mm.

HOLOTYPE. V.29996.

DESCRIPTION. *Berry*: Sub-globular with small inconspicuous scar of attachment, evidently therefore without cupule or swollen peduncle. Epicarp usually obscured by a thin adherent film of pyrites. Mesocarp thick, with numerous groups of radially arranged cells which, when abraded, tend to form pits or depressions at the surface, and with longitudinal fibre strands partly exposed by abrasion. Length of berry, 13 to 16 mm.; breadth, 12 mm.; diameter of an endocarp, 9 mm. in all directions.

Endocarp: With clearly defined surfaces, columnar in section, about 0.1 to 0.2 mm. thick, the columns about 0.2 mm. in diameter.

Seed: Conical or sub-globular with large slightly convex chalaza forming a broad base occupying very little of the length of the endocarp.

REMARKS AND AFFINITIES. Nine specimens. The characters of this species are not very clear and definite. It is distinguished from *Cinnamomum* by the absence of a large basal scar. It is possible that more than one true species is amalgamated under the specific name *Laurocarpum inornatum*, but in order to establish this with certainty a much larger range of material would be needed than is at present available. The external characters are not very distinctive; only when seen in section can the species be distinguished with certainty.

- V.29996 Holotype, figured Pl. 18, figs. 46, 47. A berry, fractured longitudinally to show the seed. The epicarp is abraded, and the radiating cell-clusters of the mesocarp are exposed. Mesocarp 1.4 mm. thick; endocarp 0.1 to 0.2 mm. thick. Length of berry, 13 mm.; breadth, 12 mm. Length and breadth of endocarp, 9 mm. Swale Cliff.
- V.29997 A berry with somewhat coarser mesocarp cells than in the holotype. Length of berry, 13 mm.; breadth, 12 mm. Chalaza broad, slightly convex.
- V.29998 A distorted berry, dorsiventrally compressed, breadth about 12 mm.; chalaza about 8 mm. in diameter. Epicarp obscured by pyrites, mesocarp showing radiating cell-clusters.
- V.29999 A berry 15 mm. long, 12 mm. broad, with thick mesocarp and well-defined endocarp. Seed not seen. Evidence as to attachment obscure. East Cliff shore.
- V.30000 A large berry (now broken) with pyrites obscuring the epicarp. Mesocarp cells fine with typical radiating cell-clusters. Endocarp clearly defined. Swale Cliff.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30001 A large berry, somewhat broken, so that the mesocarp, endocarp, and somewhat shrivelled seed are exposed.

- V.30002 A seed showing slightly convex chalaza with impression of the cotyledons. The fruit has been chipped away.
- V.30003 Two berries, too incomplete for certain determination, but probably referable to this species. The above *ŷ. E. Cooper Coll.* Herne Bay, Kent.

Laurocarpum (? *Endiandra*) sp.

Plate 18, figs. 26, 27

DESCRIPTION. *Endocarp*: Ovoid, with small mucronate apical scar within which fibres can be seen. External part of carpel wall largely abraded, about 0.1 mm. thick, columnar in section, the columns rather broad, about 0.02 to 0.025 mm. in diameter. Impression of the inner surface of this coat with rounded blobs or tubercles. Beneath is a somewhat spongy layer of cells flattened parallel with the surface of the coat, several cells thick, heavily pyritized. Beneath again are equiaxial cells, 0.03 mm. in diameter, and a few broad bands of branching fibres. Length of endocarp, 17 mm.; breadth, 14.5 by 10 mm.

- V.30011 Figured Pl. 18, figs. 26, 27. A crushed and abraded endocarp. *A. G. Davis Coll.* Warden Point, Sheppey.

Laurocarpum sp.

Plate 19, fig. 1

An ellipsoid berry, 12 mm. long, 9 by 5 mm. in transverse diameter (as crushed) is probably referable to Lauraceae. There is a sunk scar at the apex and a large basal scar of attachment, 4 by 5 mm. in diameter, now occupied by the protruding chalaza of the seed. The remains of a thick carbonaceous coat (epicarp?), 0.2 mm. thick, columnar in section, adhere within the apical depression but elsewhere it is abraded. Beneath this coat the surface of the specimen as now exposed is fairly smooth but abraded. It shows longitudinally aligned rectangular cells in places, about 0.025 mm. in diameter, with several layers of somewhat larger longitudinally aligned cells beneath them. These layers probably represent the mesocarp which, near the apex (where best seen), is about 0.5 mm. thick. Inside the mesocarp is a columnar endocarp, 0.2 mm. thick, formed of coarse columnar cells. The seed where exposed is somewhat abraded but shows cells of varying size usually longitudinally aligned, often rounded, and about 0.03 mm. long. The specimen differs in its broad ellipsoid form and sunk apical end from any other species described. In the absence of further material it is referred to the form-genus *Laurocarpum* without specific name.

- V.30004 Figured Pl. 19, fig. 1. A berry, now fractured, showing seed (partly exposed), endocarp, mesocarp and epicarp. *G. F. Elliott Coll.* Sheppey.

Laurocarpum sp.

Plate 19, figs. 2-6

Fruit: Sub-globular, somewhat flattened below, the flattening corresponding with a smooth surface which suggests attachment to a small cupule or swollen peduncle, epicarp abraded, mesocarp formed externally of equiaxial cells, about 0.01 to 0.012 mm. in diameter, surface sometimes showing radially arranged stellate groups of cells. Within are somewhat

larger cells, 0.02 to 0.025 mm. in diameter, also some interspersed elongate cells or fibres. At the base (as preserved) the mesocarp is about 1 mm. thick, near the apex 0.8 mm. thick. Transverse diameter of fruit, 12.5 mm.; height from base to apex about 11 mm. (incomplete).

Endocarp: Sub-globular, walls clearly defined, columnar in section, about 0.1 mm. thick, but with irregularities of the surface due to the break down of the coarse columnar cells of which it is composed. These cells are about 0.05 to 0.1 mm. in diameter.

Seed: Sub-globular, somewhat mucronate at the hilar end, flattened at the chalaza which is about 5 mm. in diameter, with coarse crenulate lateral walls immediately above the chalaza, the crenulations, about 20 in number, extending about 2 to 2.5 mm. up the sides of the seed (Pl. 19, figs. 4, 5). Testa about 0.1 mm. thick near the hilar end, and 0.2 mm. thick near the chalaza, with cells aligned at right angles to the surface. Worn surface of testa exposing the cavities of coarse secreting angular cells, rather irregular in size and shape, 0.1 to 0.2 mm. in diameter, sometimes larger. Inner integument formed of more or less rectangular cells about 0.016 mm. in diameter with thickened lateral walls giving a longitudinally aligned effect in the parts of the seed adjacent to the chalaza, but concentrically aligned around and below the hilum. Surface of chalaza at the level of this coat somewhat rough with equiaxial cells about 0.025 mm. in diameter. Within is a third, shining, thin integument (represented by a pyrites impression) formed of transversely aligned, inflated, square cells, about 0.016 to 0.025 mm. in diameter, with markedly thickened transverse walls. This coat is seen only in one or two places where the succeeding coat has been chipped away. The two integuments are clearly separated by a considerable thickness of infiltrated pyrites. Length and breadth of seed-cast about 6.5 mm. The chalaza occupies only about one-sixth of the length of the seed-cast.

REMARKS. One fruit clearly referable to Lauraceae. It somewhat resembles *Laurocalyx globularis* in size and appearance but so far as present evidence goes is a berry without an enclosing cupule. There is a superficial resemblance to *Laurocarpum inornatum* (p. 182) which is nevertheless distinguished by its smaller attachment scar and less flattened base, as well as by the thinner columns of the endocarp (as seen in section) and its more even surface. The fluted sides of the seed at the junction with the chalaza are peculiar, but may be either a specific feature or a result of shrinkage in fossilization.

V.30005 Figured Pl. 19, figs. 2-6. One fruit, now fractured to expose the seed. *D. J. Jenkins Coll.* Herne Bay, Kent.

Laurocarpum sp.

Plate 19, figs. 7, 8

Fruit: Sub-globular, somewhat depressed, with a small sunk pentangular scar, 1.5 mm. in diameter at the apex at the centre of which the prominent remains of the style can be seen. Epicarp abraded. Five short ridges of pyrites can be seen at the apex, one diverging from each angle of the scar as if pyrites had infiltrated into cracks in the surface and had subsequently hardened. Outer layers of mesocarp of angular longitudinally elongate cells often 0.05 mm. broad and as much as 0.2 mm. long, among them are fine equiaxial cells. Inner layers of mesocarp, where the outer are abraded, formed of irregular or equiaxial angular cells from 0.05 to 0.1 mm. in diameter, many of them being arranged in radiating or stellate clusters with smaller cells at and near the centres of the clusters.

Endocarp: (Seen only in section) columnar, about 0.2 mm. thick. By abrasion of the outer

integument the seed is exposed at the base of the specimen. It has a smooth chalaza, showing fine equiaxial cells, 0.02 to 0.025 mm. in diameter. The full extent of the chalaza cannot be seen. Length of fruit from base to apex, 7.5 mm.; transverse diameter, 8 by 9 mm. The nearer relationship has not been discovered.

V.30006 Figured Pl. 19, figs. 7, 8. An abraded fruit with mesocarp, the section of the endocarp and chalaza of the seed exposed. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Laurocarpum sp.

Plate 19, fig. 9

Fruit: Sub-ovoid, somewhat flattened laterally in fossilization. External surface when preserved obscured by pyrites, but for the most part both exocarp and endocarp have been detached so that the seed-cast is exposed. Eroded remains of mesocarp are preserved at the apex where they show a four-partite splitting indicated by obscure short pyrites ridges due to infiltration of pyrites in solution along incipient cracks. The mesocarp is also seen in section adhering to the base of the seed where its inner layers, 0.9 mm. thick, are formed of coarse, angular, equiaxial or irregular cells, 0.05 to 0.2 mm. in diameter, with a black secretion. Its outer layers are of compact non-secreting tissue, 0.8 mm. thick, many of the cells being about 0.016 mm. in diameter. Length of fruit (incomplete at apex), 14 mm.; breadth, incomplete, 11 mm.

Endocarp: 0.05 to 0.1 mm. thick, columnar in section, the surfaces not very clearly defined, but the columnar coat is apparently more or less continuous, not discontinuous as in species of *Beilschmiedia*.

Seed: Much obscured by mesocarp, structure of testa obscure.

V.30007 Figured Pl. 19, fig. 9. A fruit, partially broken to expose the seed-cast within. *C. E. Hollis Coll.* Herne Bay, Kent.

Laurocarpum sp.

Plate 19, figs. 10, 11

Fruit: Sub-oval, somewhat truncated at the stylar end (apex), irregularly angled below the style in the upper half, rounded at the base. Surface worn and structure rather obscure. Apex with a large circular gaping aperture about 2 mm. broad now occupied by a stylar-placental plug of tissue (Pl. 19, figs. 10, 11). Length of fruit (not quite complete at the base), 11.5 mm.; breadth, 7.5 mm. at least (again broken and possibly not quite complete).

Endocarp: Sub-globular, with clearly defined surfaces, wall columnar in section, 0.1 to 0.15 mm. thick, the columns about 0.014 mm. broad, and equiaxial in surface view. Outer surface of endocarp showing obscure impressions of slightly concave cells about 0.05 to 0.1 mm. in diameter apparently with sinuous walls, but the relationship of this very thin layer to the columnar coat is not clear.

Seed: Sub-globular, pointed at the hilum, rounded over the chalaza, with a lateral, somewhat flattened facet extending from apex to base. Testa cells longitudinally aligned, 0.02 mm. broad; tegmen cells also longitudinally aligned, 0.012 to 0.016 mm. broad, closely comparable

with those of the testa. Raphe lateral, continued over the chalaza as a broad strand of fibres. Exact limits of chalaza not exposed. Length and breadth of seed, 5.5 mm.

V.30008 Figured Pl. 19, figs. 10, 11. A fruit, incomplete at the base, now shattered to expose the endocarp and seed. *G. F. Elliott Coll.* Sheppey.

Laurocarpum sp.

Plate 19, figs. 12, 13

Fruit: Ovoid originally (somewhat compressed) with a small scar at the apex indicated by a pyrites ridge on the cast perhaps representing the placental aperture at the narrower end. One-loculed, one-seeded. Surface smooth, finely pitted, formed of equiaxial cells, 0.012 mm. in diameter, columnar in section, the angular columns about 0.03 to 0.05 mm. broad, the coat rather more than 0.1 mm. thick. This outer coat is preserved in patches only.

Endocarp: Closely conforming to the seed in shape. Wall columnar in section, as much as 0.3 mm. in thickness, the columns about 0.05 mm. broad, each made up of a series of finer columns or cells about 0.01 mm. broad, themselves probably built up of smaller cells arranged end to end. When weathered the endocarp breaks up into fine longitudinal fibres. The internal cast shows longitudinally aligned cells, 0.016 mm. broad and of considerably greater length, producing a longitudinally striate effect. Length of fruit, 9.5 mm.; breadth (crushed), 8 by 4.75 mm. and 8.5 by 4 mm. in two specimens respectively.

Seed: Agreeing with the locule in shape. Testa carbonaceous having an outer coat (rarely preserved) finely striate longitudinally, formed of equiaxial cells 0.012 mm. in diameter, the coat in section obscurely columnar, the columns about 0.012 to 0.016 mm. broad.; within, the testa is formed of rounded equiaxial cells, 0.012 mm. in diameter. One specimen shows slight traces of an outer layer of slightly sinuous cells, 0.05 mm. broad. Tegmen smooth, slightly crumpled as preserved, formed of equiaxial cells about 0.1 mm. in diameter, seen in a small patch over the chalaza where the testa and its internal cast have chipped away.

V.30009 Figured Pl. 19, fig. 12. A fruit. It shows a small patch of chalaza, and parts of the epicarp and endocarp. *G. F. Elliott Coll.* Warden Point, Sheppey.

V.30010 Figured Pl. 19, fig. 13. A second specimen, more crushed but still showing the scar of the placenta. *A. G. Davis Coll.* Warden Point, Sheppey.

Family HAMAMELIDACEAE

Genus CORYLOPSIS Sieb. & Zucc.

Corylopsis venablesi n. sp.

Plate 19, figs. 14, 15

DIAGNOSIS. Seed pointed-ovoid, very slightly compressed. Hilar facet and scar extending from one-quarter to one-half the length of the seed. Facet as broad as long, scar narrow. Surface cells of testa arranged in groups and more or less longitudinally aligned. Thickness of testa formed of sinuous cells. Length of seed, 5.5 mm.; diameter, 2.5 to 3 mm.

HOLOTYPE. V.30012.

DESCRIPTION. *Seed*: Pointed-ovoid, only very slightly compressed, with a median longitudinal groove in one seed caused apparently by splitting as it is not present in a second specimen. A large basilateral scar and facet are associated with the hilum, they lie on opposite sides of the seed athwart the plane of the cotyledons, the facet is as broad as it is long, concave, covered by the shining surface of the testa (Pl. 19, fig. 15), the scar is narrow, sunk, not covered by the shining coat which terminates abruptly against it (Pl. 19, fig. 14), both extend for almost half the length of the seed in one specimen and for a quarter of the length in the other. Testa black, shining, much abraded so that the cell-structure is obscure, but in places narrow elongate cells, about 0.012 mm. broad, are preserved, arranged in groups more or less longitudinally aligned as in seeds of the living *Corylopsis*. Where the surface is chipped away the testa appears to be formed of sinuous cells. The hilar facet has a crumpled surface, the coarse polygonal crumples sometimes measuring as much as 0.2 mm. in length and 0.05 to 0.1 mm. in breadth. Length of seed, 5.5 mm.; breadth, 3 mm.; thickness in the plane of the cotyledons, 2.5 mm.

REMARKS AND AFFINITIES. Two seeds. The form and characteristic hilar scar and facet indicate the family Hamamelidaceae. The peculiar form of this scar and its association with a facet covered by testa point to relationship with *Corylopsis*. The structure of the testa, so far as it can be ascertained, bears out the relationship, as does the size of the seed (*Corylopsis wilmotti* length, 4.75 mm.; diameter, 2.5 mm.; *C. veitchiana* length, 4.5 mm.; diameter, 2.75 by 2.5 mm.). Other genera examined have a rough, sunk, simple or bilobed scar and lack the facet covered by the shining testa.

V.30012 Holotype, figured Pl. 19, figs. 14, 15. A seed.

V.30013 A second seed broken over the hilar facet the extent of which is indicated by curvature of the broken edge. The scar is relatively short, about one-quarter of the length of the seed.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Corylopsis? bognoensis n. sp.

Plate 19, figs. 16, 17

DIAGNOSIS. Seed pointed ellipsoid almost uncompressed. Testa formed externally and within of longitudinally aligned elongate cells. Tegmen cells transversely aligned. Chalaza large, elongate-oval. Hilar facet and scar not seen. Length of seed, 4.5 mm.; diameter, 2 to 2.5 mm.

HOLOTYPE. V.30014.

DESCRIPTION. *Fruit*: Two-loculed with one seed in each locule. The septum is formed of transverse fibres; its worn edges can be seen lying between the two seeds in a much abraded specimen (Pl. 19, fig. 16). The locule-lining is formed of fine transverse cells with a few longitudinal ripples.

Seed (as preserved): Elongate, pointed ellipsoid, almost uncompressed, pointed at the hilar end. Testa largely abraded or, in the detached seed, concealed by remains of the fruit so that the form of the hilar facet and scar is unknown, smooth where seen, formed externally of longitudinally aligned elongate cells, 0.016 mm. in diameter, and within, of a mass of longitudinally elongate and aligned cells. Within again is a coat of transversely elongate and aligned cells. Tegmen cells about 0.025 mm. broad, more or less transversely aligned except around the large elongate-oval chalaza which lies on the ventral side of the seed at its distal end, occupying

about half its length (Pl. 19, figs. 16, 17, *ch.*). Around this organ they diverge. Length of seeds (as preserved), 4.5 mm.; breadth, 2 to 2.5 mm.; thickness about 2 to 2.5 mm.

REMARKS AND AFFINITIES. Two specimens. One comprises two seeds held together by the remains of the much abraded fruit. The second is a detached seed surrounded in part by the locule or its impression in pyrites. The seeds are unusually small when compared with most living genera, but an undetermined gathering of seeds from Yunnan (Forrest Coll.) in the Reid Collection agrees in size and character. The fossil probably belongs to *Corylopsis*. The seeds are also smaller than species with testa preserved from Sheppey (Reid & Chandler, 1933: 249, pl. 9, fig. 6) and seeds of Hamamelidaceae from Bovey (Chandler, 1957: 100, pl. 14, figs. 97-99). Owing to the absence of any evidence regarding the hilar facets an important diagnostic character is missing, but the remains of the testa resemble *Corylopsis* rather than genera like *Hamamelis* in which the testa cells are rather conspicuously digitate.

V.30014 Holotype, figured Pl. 19, fig. 16. Two abraded seeds protruding from the remains of the two-loculed fruit (now largely abraded).

V.30015 Figured Pl. 19, fig. 17. A detached seed showing testa and chalaza scar (*ch*). The seed appears to be partially embraced by the locule-lining or its cast in pyrites.

Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Corylopsis? latisperma n. sp.

Plate 19, figs. 18-20; Text-fig. 20

DIAGNOSIS. Seed pointed sub-ovoid, compressed. Hilar scar narrow about one-third the length of the seed. Hilar facet as broad as long, about half the length of the seed. Length of seed, 3.75 mm.; diameter, 2 to 2.6 mm.

HOLOTYPE. V.30016.

DESCRIPTION. *Seed*: Pointed sub-ovoid, somewhat compressed. Hilum associated with a large basilateral scar on one side of the seed, and a basilateral facet on the other. The scar is narrow, sunk, with rough surface and sharply defined margin, it extends about one-third the length of the seed; the shining testa ends abruptly against it and does not cover it. The facet

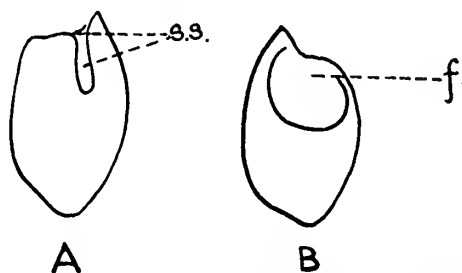


Fig. 20. *Corylopsis? latisperma* n. sp. A, side showing narrow sunk scar of hilum. B, opposite side showing large hilar facet. *ss*, sunk scar; *f*, facet.

is slightly concave, at least as broad as long, rough, ending more or less sharply against the smooth testa, extending for almost half the length of the seed. Testa smooth, black, shining, structure obscure owing to abrasion which has polished and scratched the original surface. Length of seed, 3.75 mm.; breadth, 2.6 mm.; thickness, 2 mm.

REMARKS AND AFFINITIES. One seed, shorter and relatively broader than other Hamamelidaceae from Bognor or Sheppey and distinguished also by the form and size of the facets. It may be a species of *Corylopsis*.

V.30016 Holotype, figured Pl. 19, figs. 18–20; Text-fig. 20. A single seed. Owing to decay of the testa since the photographs were taken the hilar scar is now obscure. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus?

Plate 19, figs. 21, 22

DESCRIPTION. *Seed*: Sub-ellipsoid, much compressed, concavely truncate at the base the truncation slightly oblique to the axis of the seed so that one side is a little longer than the other in outline, with two basilateral facets formed by the bilobed slightly concave hilar scar. Hilum basal at the extremity of the longer side where it passes into the scar. Testa much abraded but remains of elongate spirally thickened(?) cells can be seen on one side arranged longitudinally but having a general transverse alignment over the chalazal area. Length of seed, 6.25 mm.; breadth, 3.5 mm.; thickness, 2.5 mm. Length of facets, 2.5 mm.; breadth about the same.

REMARKS AND AFFINITIES. A seed belonging to the family Hamamelidaceae, section Hamamelidoideae (Niedenzu), genus unknown, from Sheppey (Reid & Chandler, 1933: 249, pl. 9, fig. 6) differs from the specimen described above in possessing only a single oblique facet at the hilar end. A smaller, less inflated, but somewhat similar species with two large unequal facets has been described from the Lignite of Bovey Tracey (Chandler, 1957: 100, pl. 14, figs. 97, 98). The two are probably generically related but their preservation is different, the seed from Bovey Tracey having the inner coat exposed, while in the other specimen the outer coat is preserved. Hence they are not exactly comparable.

V.30017 Figured Pl. 19, figs. 21, 22. A somewhat abraded seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family LEGUMINOSAE

Genus LEGUMINOCARPON Goeppert, 1855: 40

A form-genus to include fruits of Leguminosae with or without visible seeds, the nearer relationship of which has not been determined.

Leguminocarpion nervosum (Reid & Chandler) Chandler

1879 *Bauhinia primigenia* Ettingshausen (pars), p. 396.

1933 *Carpolithus nervosum* Reid & Chandler, p. 517, pl. 31, figs. 1–6.

The species was fully described in 1933 from well-preserved material. Although it has been impossible to make a sufficiently detailed study of the family Leguminosae to relate this fossil to any living genus, it is now clear that it is leguminous, contrary to the statement made in 1933, p. 518.

The scattered circular pits on the surface of the pod probably represent stout hair-bases. The transverse fibres lining the pod are seen in many Leguminosae. Single seeded pods are not uncommon in the family. Branched raphes may occur in leguminous seeds, e.g. *Butea* and *Ormosia*. Sometimes they occur within a thick testa so that their presence and character could only be ascertained after long study with dissection of many living seeds. No branched raphes which agree closely with those of the fossils have yet been seen. In *Ormosia* the loops formed by the branching raphe extend from pole to pole of the seed, not as in the fossil from a terminal hilum to a chalaza at about the middle of the seed. The species would repay prolonged investigation when this is possible.

V.30024 A worn fruit showing part of the locule-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

LEGUMINOSAE ?

Genus ?

Plate 19, fig. 24

A much compressed seed, hooked at one end, pointed at the other, almost semicircular along the dorsal margin. It is preserved as a pale yellow clay cast covered by considerable remains of a dark shining integument. On the hooked (ventral) margin is a flattened elongate-triangular area, its broad end abutting on the hook. The integument is preserved in places on this area and over the hook as well as on the general surface of the seed, showing that the present outline is original; it is formed of equiaxial cells, 0.012 mm. in diameter, with a tendency to be arranged in short parallel rows producing a striate effect, the direction of the striae varying in different patches. No organs were detected so that the true anatomy is obscure.

The hooked outline is reminiscent of certain Leguminosae or Rutaceae, but there is no clear evidence of relationship. Length of seed, 17.5 mm.; breadth measured across the hook, 11 mm.; breadth measured above the hook, 8 mm.; maximum thickness, 4 mm.

The appearance and preservation is not that of a typical London Clay fossil and the question may be asked whether the specimen could have come from the Oldhaven Beds below.

V.30025 Figured Pl. 19, fig. 24. A seed. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent. Believed to come from the London Clay, but perhaps from older beds.

Genus ?

Plate 19, fig. 25

A bisymmetric seed, flattened at right angles to the plane of symmetry, approximately sub-circular in outline but somewhat truncate on the ventral margin. Margin of seed sharp. Surface irregularly but finely rugose, cell-structure obscure. Length of seed, 13 mm.; breadth, 11.5 mm.; thickness, 4 mm.

V.30026 Figured Pl. 19, fig. 25. A seed. *A. G. Davis Coll.* Warden Point, Sheppey.

Family RUTACEAE

Genus CANTICARYA Reid & Chandler, 1933:257

Canticarya sheppeyensis Reid & Chandler

Plate 19, figs. 26–28

1933 *Canticarya sheppeyensis* Reid & Chandler, p. 258, pl. 10, figs. 1–5.V.30027 Figured Pl. 19, figs. 26–28. A carpel broken to show the seed within. *J. E. Cooper Coll.* Herne Bay, Kent.V.30028 A locule-cast. *G. F. Elliott Coll.* Warden Point, Sheppey.V.30029 A seed-cast. *A. G. Davis Coll.* Warden Point, Sheppey.*Canticarya ventricosa* Reid & Chandler1933 *Canticarya ventricosa* Reid & Chandler, p. 259, pl. 10, figs. 6, 7.

V.30030 A seed-cast with adherent remains of the testa and carpel along the ventral margin.

V.30031 A seed-cast with remains of testa.

Both *J. E. Cooper Coll.* Herne Bay, Kent.*Canticarya* sp.

Plate 19, fig. 29

DESCRIPTION. *Carpel*: Sub-ovoid, somewhat compressed laterally, dorsal margin gibbous, ventral margin approximately straight, bisymmetric, stylar end somewhat broken. Surface worn, formed, as preserved, of equiaxial cells 0.025 mm. in diameter; within is a coat of transversely or obliquely aligned coarse cells (secreting?) about 0.1 mm. in length by 0.025 mm. in breadth in the place where they could best be measured. Locule-lining of equiaxial cells similarly aligned, 0.016 mm. broad. Length of carpel, 4.5 mm.; breadth in plane of symmetry, 3.5 mm.; thickness, 2.75 mm.

REMARKS AND AFFINITIES. One somewhat crumpled and distorted specimen. The shape of the fruit and character of the pericarp place it in the family Rutaceae. It is referred to the form-genus *Canticarya* without specific diagnosis on account of the distortion and the difficulty of investigating the successive coats.

V.30032 Figured Pl. 19, fig. 29. A distorted and somewhat abraded carpel. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus RUTASPERMUM Chandler, 1957:102

Rutaspermum minimum n. sp.

Plate 19, figs. 30, 31

DIAGNOSIS. Sub-ovoid, dorsal margin somewhat gibbous, ventral margin straight, but apparently without any clearly defined differentiated hilar scar (perhaps abraded?). Length of seed, 3 mm.; breadth, 2.5 mm.; dorsiventral thickness, 2.25 mm.

HOLOTYPE. V.30033.

DESCRIPTION. *Seed*: Sub-ovoid, bisymmetric, gibbous in outline as seen from the side, somewhat laterally compressed with straight ventral margin and slightly gibbous dorsal margin. Hilar aperture at the somewhat broader end of the seed on the ventral margin leading into a short basiventral raphe canal which communicates with a large circular chalaza in the lower part of the rounded dorsal margin (Pl. 19, fig. 31) in the plane of symmetry. Micropyle a small aperture at the pointed opposite end of the ventral margin to the hilar aperture. Testa columnar in section, finely and unevenly rugose superficially, rugosities about 0.03 to 0.05 mm. in diameter, thickness about 0.1 mm. Innermost layers formed of transversely elongate and aligned cells which give rise to striations about 0.025 mm. apart. Tegmen of narrow elongate cells which diverge from the large circular chalaza. Length of seed, 3 mm.; breadth, 2.5 mm.; dorsiventral thickness, 2.25 mm.

REMARKS. A single detached seed partially abraded so that tegmen and chalaza are exposed. Two ventral excavations, one on each side of the ventral margin, are undoubtedly due to decay and are not original features. The bisymmetric inflated seed with ventral margin bearing at one end the micropyle and at the other the entrance to the short raphe canal, the sub-basal, large, rounded chalaza and the structure of the integuments point to Rutaceae, and probably to the section *Zanthoxyleae*. The typical clearly defined hilar scar of this group is, however, missing; it may or may not have been abraded. The seed is considerably smaller than other fossil Rutaceae seeds of this type, and the testa is distinguished by its low, rounded, fine rugosities. In the absence of fuller knowledge and of more comparable living material it is referred to the form-genus *Rutaspermum* as *R. minimum*.

V.30033 Holotype, figured Pl. 19, figs. 30, 31. A small partially abraded seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Rutaspermum (*Zanthoxylon*?) *bognorensis* n. sp.

Plate 19, fig. 32; Text-fig. 21

DIAGNOSIS. Seed truncate-oval in outline, compressed laterally. Length, 4 mm.; breadth, 3.7 mm.; thickness, 1.25 mm. Finely crenulate cells of surface, 0.025 mm. in diameter.

HOLOTYPE. V.30034.

DESCRIPTION. *Seed*: Bisymmetric, truncate oval in outline, more compressed laterally than *Canticarya ventricosa* Reid & Chandler and smaller than that species. Truncation formed by the hilar scar (Pl. 19, fig. 32, *h*) which is triangular, 2.5 mm. long and about 0.75 mm. broad. A large aperture at the broad end of the scar marks the actual hilum and gives access to the raphe canal which appears to extend for three-quarters of the length of the seed in the plane of symmetry as indicated by a slight constriction parallel with the lower rounded margin (Text-fig. 21A). Surface of testa formed of equiaxial cells with finely toothed margins, about 0.025 mm. in diameter. Longest diameter of seed, 4 mm.; breadth at right angles, 3.7 mm.; thickness, 1.25 mm.

REMARKS AND AFFINITIES. A single seed, distinguished by its form and smaller size from *Canticarya sheppeyensis* and *C. ventricosa* and by its marked difference of form from *C. gracilis*. The seed has suffered some abrasion so that the hilar scar appears rounded at the edges not sharply delimited from the adjacent testa. In form and size the specimen recalls

Zanthoxylon compressum Chandler from the Upper Eocene of Hordle but the surface cells are smaller (0.05 mm. in *Z. compressum*) and the chalaza end is somewhat more rounded. The seed

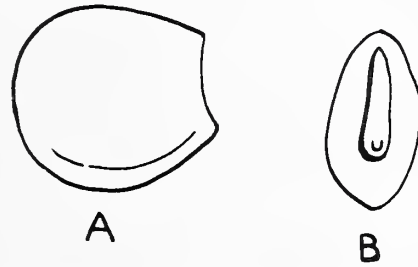


Fig. 21. *Rutaspermum* (*Zanthoxylon* ?) *bognorensis* n. sp. A, side of seed with hilar scar to the right and position of raphe canal indicated below. B, ventral margin showing triangular hilar scar and opening at its base for raphe.

is certainly referable to the *Zanthoxyleae* and as its fruit is unknown it is placed in the form-genus *Rutaspermum*. It may possibly belong to the genus *Zanthoxylon*.

V.30034 Holotype, figured Pl. 19, fig. 32; Text-fig. 21. A seed, somewhat worn over the hilar scar. *E. M. Venables* Coll. 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus CAXTONIA Reid & Chandler, 1933:265

Caxtonia glandulosa Reid & Chandler

Plate 19, figs. 33-36

1933 *Caxtonia glandulosa* Reid & Chandler, p. 265, pl. 10, figs. 17-19.

DESCRIPTION. *Carpels*: Ovoid, somewhat laterally compressed, bisymmetric, dehiscing into two valves in the plane of symmetry; dorsal margin more convex than the ventral. Fruits with two or more carpels, partly united along their ventral margins? as indicated by a long, narrow, triangular flattening. This character was not seen in the original Sheppey material. External coat several cells thick, formed of equiaxial cells, 0.05 to 0.1 mm. in diameter, with a shining black secretion, but as the coat is worn and furrowed, its true external surface is not known. This coat was not seen at all in the Sheppey fruits. Within is a thick coat of parenchyma 0.15 to 0.25 mm. thick (described already in the Sheppey specimens), with radially arranged cells. Within again, are oblique or transverse fibres which diverge from the ventral attachment. The locule-lining is formed of cells aligned in rows to form a 'finger-print' pattern. Length of fruit, 5 to 6 mm.; breadth, 4 to 4.5 mm.

Seed: Solitary, pendulous, conforming to the carpel in shape, obovoid, anatropous with lateral raphe, large oval chalaza, 1 by 0.6 mm. in diameter at the broad end. Sometimes the chalaza shows a median ridge (parallel with the greatest breadth of the seed) sometimes a central depression or pit from which small parenchymatous cells diverge, the appearance varying with the state of preservation. Micropyle at the narrow end of the seed. Surface of testa formed of interlocking digitate cells varying in size and shape in different parts, here seen as

an impression on pyrites, not previously observed. Inner layers of testa as much as 0.4 mm. thick, formed of several layers of large equiaxial cells, 0.05 to 0.15 mm. in diameter, containing a glistening black secretion (Pl. 19, figs. 33, 36). Length of seed, 4 to 5.5 mm.; breadth, 4 to 4.5 mm.; thickness, 3.5 mm.

REMARKS AND AFFINITIES. The form and character of seed and fruit relate these specimens to *Caxtonia glandulosa*, a fossil species formerly referred doubtfully to the Rutaceae. New evidence from Bognor that there was originally more than one carpel, that the carpels were partially united along their ventral margins, and that they dehisced into symmetrical valves confirm this relationship which may now be regarded as satisfactorily established.

V.30035 Figured Pl. 19, figs. 33, 34. The cast of a partially dehiscent carpel which encloses a seed.

V.30036 Figured Pl. 19, figs. 35, 36. An incomplete carpel which has been split so as to show the side of the seed. Near the apex the testa has been removed and the tegmen is visible.

Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30037 A seed surrounded by remains of the fruit. *J. G. Turner Coll.* Sheppey.

V.30038 A seed-cast partially enclosed in remains of the fruit. *A. G. Davis Coll.* Warden Point, Sheppey.

Caxtonia elongata n. sp.

Plate 19, figs. 37-39

DIAGNOSIS. Carpel conical or pointed-ovoid, about 11 mm. long by 7 to 7.5 mm. broad. Seed agreeing with the locule in shape. External surface of testa formed of deeply sinuous cells. Length of seed, 8 mm.; greatest transverse diameter, 5 mm.

HOLOTYPE. V.30039.

DESCRIPTION. *Carpel*: Conical or pointed-ovoid, one-loculed, one-seeded. Epicarp abraded exposing longitudinal fibres embedded in a mass of cells which on the worn surface appear equiaxial or elongate, variously aligned and from about 0.02 to 0.03 mm. in diameter. This coat, which is about 0.25 mm. thick, overlies a thicker coat from which it is sharply delimited. The inner coat, varying from about 0.4 to 0.6 mm. in thickness, is fused with the outer coat (as preserved) and is formed of elongate cells aligned at right angles to the surface, the cells being about 0.03 mm. broad. The innermost layers of the carpel are formed of elongate cells or fibres parallel with the surface of the locule about 0.1 mm. thick. Locule-lining (seen on fragments of the external and internal cast) formed of square cells about 0.016 mm. in diameter, aligned in rows to form striae variously grouped and oriented producing a 'finger print' effect. Length of carpel as preserved, 11 mm.; diameter, 7.5 by 7 mm.

Seed: Conforming to the locule in shape, pointed at the micropylar end, rounded at the chalazal end, oval chalaza (obscured largely by adherent testa) with a marked median ridge in the plane of symmetry. External surface of testa one cell thick, the cells in section 0.016 to 0.025 mm. in diameter, with deeply sinuous outlines in surface view. Within, are several layers of rounded cells, about 0.1 mm. in diameter, containing a black shining secretion. The testa cells become narrower, smaller, and more elongate longitudinally towards the pointed apex of the seed. Innermost coat of testa of equiaxial cells, 0.012 to 0.03 mm. in diameter, possibly more than one cell thick. Tegmen only exposed at the extreme micropylar end, cell-structure not clear. Length of seed, 8 mm.; greatest transverse diameter, 5 mm.

REMARKS AND AFFINITIES. One fruit fractured longitudinally to show the seed. In general morphological features and detailed cell-structure the specimen closely resembles *Caxtonia*

glandulosa (Reid & Chandler, 1933: 265, pl. 10, figs. 17-19 and Pl. 19, figs. 33-36, p. 193 of the present work), but it represents a larger, more elongate species (length of *C. glandulosa*, 5 to 7.5 mm.; and of seed, 4 to 5.5 mm.). It must be regarded as distinct.

V.30039 Holotype, figured Pl. 19, figs. 37-39. A fruit, fractured longitudinally to show the seed. *A. G. Davis Coll.* Warden Point, Sheppey.

Section AURANTIOIDEAE

Genus CITRISPERMUM nov.

DIAGNOSIS. Form-genus to include seeds with large terminal chalazas resembling those of *Citrus* or allied genera of the section Aurantioideae which cannot at present be placed in a living genus.

Citrispermum sheppeyense n. sp.

Plate 20, figs. 1-4

DIAGNOSIS. That of the genus.

HOLOTYPE. V.30040.

DESCRIPTION. *Seed*: Sub-obovoid (often distorted and compressed) or somewhat irregular in form, pointed at the hilar-micropylar end, rounded at the opposite chalazal end where abraded specimens show a large, domed, clearly defined chalazal scar (Pl. 20, fig. 3), about 3 to 4 mm. in diameter, usually delimited by a groove from the surrounding tissue. Surface rather smooth, obscurely longitudinally ridged, formed of equiaxial cells 0.02 to 0.033 mm. in diameter. In section these cells can be seen aligned at right angles to the surface, forming a definite outer layer about 0.05 mm. thick, beneath which are several layers of longitudinally aligned cells or fibres, the two coats together forming a carbonaceous integument, about 0.1 to 0.15 mm. thick, generally preserved only in hollows of the surface or where protected by adherent patches of pyrites. When, as is commonly the case, this integument is abraded, the surface then exposed shows marked longitudinal ridges and striations (Pl. 20, fig. 1) due to longitudinal fibres embedded in small equiaxial cells about 0.01 to 0.012 mm. in diameter. Inner integument rarely exposed, formed of transversely aligned almost equiaxial cells, 0.016 to 0.018 mm. in diameter. Surface of chalaza when well preserved black and shining formed of equiaxial cells, 0.02 mm. in diameter, testa much thickened around the chalaza by layers of glandular cells. Length of seeds about 8 to 12.25 mm.; breadth, 6 to 7.5 mm.

REMARKS. Thirteen seeds varying considerably in development and form, also in the degree of distortion. They closely resemble the anatropous seeds of certain Rutaceae, section Aurantioideae. The chalaza is quite commonly exposed by the abrasion of the testa over the rounded end in which abraded condition the fossils much resemble orange seeds as seen in marmalade which have been rendered translucent by prolonged boiling so that the chalaza forms a conspicuous feature. The testa closely resembles that of *Citrus* (orange) and *Aegle* in its fibrous texture, and in the outer layer of coarse cells aligned at right angles to the surface.

There is a superficial resemblance between these seeds and those of *Echinocarpus*. It is

possible that V.22813, a seed from Herne Bay, described by Reid & Chandler (1933: 391, 392) as probably belonging to *Echinocarpus*, should be united with the present species.

- V.30040 Holotype, figured Pl. 20, fig. 1. A typical seed with part at least of the testa preserved over the chalaza. Herne Bay, Kent.
- V.30041 Figured Pl. 20, figs. 2, 3. Two inflated seeds showing varying degrees of abrasion over the chalaza. West side of town, Herne Bay, Kent.
Both the above *J. E. Cooper Coll.*
- V.30042 Figured Pl. 20, fig. 4. A seed, abraded at the chalazal end so as to expose the domed scar. The testa is preserved in depressions of the surface where it has been protected by pyrites which fills them.
- V.30043 A seed.
- V.30044 A seed with chalaza exposed.
The above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30045 A seed with testa preserved over the chalaza, but broken away in one small patch to expose the inner chalaza beneath it.
- V.30046 A compressed seed.
The above *G. F. Elliott Coll.* Warden Point, Sheppey.
- V.30047 A crushed seed, now fractured. *F. M. Womacott Coll.* Warden Point, Sheppey.
- V.30048-49 A seed, now fractured, and a complete seed showing the thickening over the chalaza. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30050 A much abraded seed, now fractured, showing the chalaza. Part of the external coat of longitudinal fibres is chipped away, showing a coat of more or less transversely aligned cells below. Also a second seed. *J. E. Cooper Coll.* Herne Bay, Kent.

Family BURSERACEAE

Genus PROTOCOMMIPHORA Reid & Chandler, 1933:272

Protocommiphora europaea Reid & Chandler

Plate 20, fig. 5

1933 *Protocommiphora europaea* Reid & Chandler, p. 273, pl. 11, figs. 1-7.

- V.30051 Figured Pl. 20, fig. 5. An endocarp somewhat abraded so that the cast of the abortive locule is partially exposed on one side. On the other side the germination valve of the fertile locule is clearly seen (Fig. 5). The specimen is somewhat smaller and more inflated than the endocarps described from Sheppey. Length, 6.25 mm.; breadth, 4.5 mm.; thickness, 3.5 mm. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30052 A locule-cast with remains of endocarp adhering.
- V.30053 A worn fruit in which the fertile and abortive locules are both exposed; the valve of the fertile locule has opened.
Both the above *G. F. Elliott Coll.* Warden Point, Sheppey.

Genus BURSERICARPUM Reid & Chandler, 1933:275

Bursericarpum aldwickense n. sp.

Plate 20, figs. 6-11; Text-fig. 22

DIAGNOSIS. Pyrene sub-ovoid, triangular in transverse section, probably about 3 to 5 in a fruit as indicated by the ventral angle. Germination valve extending from the apex for about three-quarters of the length of the pyrene. Hilum and chalaza contiguous immediately under-

lying the placenta at the middle of the ventral angle, chalaza an arched band of fibres. Length of pyrene, 5 to 6 mm.; breadth, 3.5 to 4 mm.; thickness, 3 mm.

HOLOTYPE. V.30054.

DESCRIPTION. *Pyrene*: Sub-ovoid in outline, triangular in transverse section with more or less equal sides. Two of the faces meet in the upper half of the pyrene in a sharp longitudinal median ventral angle which becomes rounded in the lower part (Pl. 20, figs. 7, 10). A deep slit, concave towards the apex of the pyrene, situated at the junction of the rounded and sharp angles approximately half way down the median ventral angle represents the placenta (Pl. 20, fig. 10). Germination is by an oval dorsal valve extending from the apex for at least three-quarters of the length. Locule-cast sub-ovoid, sub-triangular in transverse section, rounded at the base, convex dorsally, convex ventrally but roundly angled below and sharply angled in the upper part on this side, the placenta being situated where the rounded and sharp angles meet. Pericarp woody, formed of several coats; the outer coat is one cell thick, the cells being hexagonal, about 0.05 mm. in diameter (Pl. 20, fig. 9); next comes a thick woody

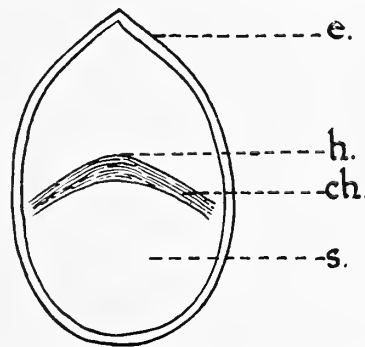


Fig. 22. *Bursericarpum aldwickense* n. sp. Pyrene with ventral wall removed to expose the seed and characteristic chalaza. *e*, endocarp; *ch*, chalaza; *h*, hilum; *s*, seed.

coat, 0.05 mm. thick, of obscure structure. The lining layer as seen impressed on the locule-cast is formed of polygonal cells 0.016 mm. in diameter. Length of pyrene, 5 to 6 mm.; breadth, 3.5 to 4 mm.; thickness, 3 mm.

Seed: Agreeing with the locule-cast in shape. Hilum at the middle of the ventral angle contiguous with the chalaza (Pl. 20, fig. 11), an arched band of fibres from which the square tegmen cells diverge to form a striate surface (Pl. 20, fig. 11; Text-fig. 22). Testa cells equiaxial, angular, 0.016 mm. in diameter.

REMARKS AND AFFINITIES. Eight pyrenes, one abraded so that the locule-cast is exposed. The markedly triangular form and ventral angle suggest that there must have been from three to five pyrenes in the fruit radially arranged around an axis. The structure and form of pyrene and locule, dorsal germination valve, and ventral curved placental aperture are highly characteristic of Burseraceae (cf. *Protium* (*Marignia*) *obtusifolium* (Lam.) March.). The long, narrow, curved chalazal band resembles that of *Canarium* and *Protium* among living, and of *Tricarpellites* and *Protocommiphora* among fossil genera. The absence of an appreciable length of raphe between hilum and chalaza distinguishes this fossil species from *Protium* and *Tricarpellites*. The form of the endocarp distinguishes it from *Canarium* and *Tricarpellites*. The

several carpelled fruit and triangular pyrenes are unlike the two-loculed fruits (with one abortive locule) and compressed ovoid pyrene of *Protocommiphora*. As the species is not in close agreement with any living or fossil form hitherto described, it has been referred to the form-genus *Bursericarpum*. *B. angulatum* Reid & Chandler (1933: 275, pl. 11, figs. 8-10) bears a general resemblance to it but is much larger (length, 10 mm.). The name *B. aldwickense* is given because the 'Upper Fish Tooth Bed' in which the specimens were found, crops out opposite the village of Aldwick.

- V.30054 Holotype, figured Pl. 20, figs. 6, 7. A complete pyrene.
 V.30055 Figured Pl. 20, figs. 8, 9. A pyrene broken at the apex and abraded so as to expose the locule-cast in the lower part.
 V.30056 Figured Pl. 20, fig. 10. A pyrene showing the form and ventral placental aperture very clearly.
 V.30057 Figured Pl. 20, fig. 11. A pyrene broken so as to expose the ventral surface of the seed with its curved chalazal band.
 V.30058 Three pyrenes, one cracked and incomplete at the apex, another fractured.
 V.30059 A small, narrow, somewhat abraded pyrene, probably referable to this species.
 All *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Bursericarpum bognorensense n. sp.

Plate 20, figs. 12-14

DIAGNOSIS. Pyrene sub-ovoid, somewhat compressed dorsiventrally, broadly triangular in transverse section the wide ventral angle probably indicating not more than three pyrenes in the fruit. Placenta at about the middle of the ventral angle or sometimes nearer to the apex. Hilum and chalaza contiguous underlying the placenta. Chalaza an arched band of fibres. Length of pyrene, 6.75 mm.; breadth, 4.5 to 4.75 mm.; thickness, 3 to 4.25 mm.

HOLOTYPE. V.30060.

DESCRIPTION. *Pyrene*: Oval in outline, somewhat compressed dorsiventrally, triangular, or rounded triangular in transverse section, having a somewhat rounded median ventral angle in the lower two-thirds or half, and a sharper, median ventral, wide angle in the upper part of the endocarp. Locule-cast sub-ovoid, somewhat compressed dorsiventrally but much inflated and rounded at the base, convex dorsally, convex ventrally but with a median rounded angle below and a sharp median angle in the upper part, the meeting place of the sharp angle and rounded angle marking the position of a pair of placentas. Germination by an oval dorsal valve extending from the apex for at least two-thirds of the length. Pericarp woody, formed of four coats: a thin outer coat, one cell thick, of uniform hexagonal cells 0.03 to 0.05 mm. in diameter; a thick median coat (0.013 to 0.02 mm. thick on the ventral side in the lower part where it could be measured in section) of fine equiaxial cells, 0.01 mm. in diameter, with a tendency to radial alignment; a thinner coat, several cells thick, of interlocking digitate cells, 0.07 mm. in diameter; also a coat, one cell thick, of hexagonal cells, 0.025 mm. in diameter where measured, between the thick median coat and the inner coat of digitate cells (seen in section in one place only, typical of the pyrenes of Burseraceae). Length of pyrene, 6.75 mm.; breadth, 4.5 to 4.75 mm.; thickness, 3 to 4.25 mm. Length of locule-cast in the same specimen, 6.25 mm.; breadth not seen. Length of locule-cast in a second specimen, 4.75 mm.; breadth, 2.75 mm.

Seed: Solitary. Pointed-oval in outline, broadly sub-triangular in transverse section, rounded at the base, slightly convex dorsally, convex ventrally, rounded in the lower half

beneath the hilum with a wide angle in the upper half above it. Hilum at the middle contiguous with the chalaza and immediately underlying the placenta. Chalaza an arched band of fibres as in *B. aldwicense*.

REMARKS AND AFFINITIES. Four detached pyrenes. The size of the ventral angle suggests not more than three pyrenes in the fruit. The form and structure, dorsal germination valve and position of the ventral placenta indicate Burseraceae. The living genera *Bursera* and *Commiphora* bear a close general resemblance to the fossil but the strap-shaped chalaza appears to distinguish this species from either of these genera. There is a marked superficial resemblance to *Protocommiphora* (Reid & Chandler, 1933, pl. 11, figs. 3, 4), but this genus has a distinctive two-loculed endocarp with one abortive locule while its seed and locule-cast are cordate at the base and grooved in the lower two-thirds on the ventral side below the placenta. Although very similar, *Bursericarpum aldwicense* is more sharply angled above, narrower and somewhat smaller. The species has been referred to the form-genus *Bursericarpum* with the distinctive name *B. bognorensis*.

- V.30060 Holotype, figured Pl. 20, figs. 12, 13. A somewhat compressed pyrene. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30061 Figured Pl. 20, fig. 14. A more inflated pyrene showing the dorsal valve and ventral aperture associated with the placenta but incomplete at the apex.
- V.30062 A broken specimen showing the enclosed seed.
- V.30063 A small, somewhat flattened pyrene, showing the ventral scar connected with the placenta, and the chalaza on the exposed ventral surface of the seed.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Bursericarpum ovale n. sp.

Plate 20, figs. 15-17; Text-fig. 23

DIAGNOSIS. Pyrene oval in outline, much inflated dorsiventrally, ventral facets meeting in a broad, rounded angle of about 90° , probably indicating four pyrenes in the fruit. Placenta apparently at about one-quarter of the length of the ventral angle from the base. Hilum probably underneath the placental aperture. Chalaza a conspicuous rounded scar on the ventral angle beneath the placenta. Length of pyrene, 2.7 mm. (as abraded); breadth and thickness, 2 mm.

HOLOTYPE. V. 30064.

DESCRIPTION. *Pyrene*: Oval in outline, much inflated dorsiventrally, dorsal surface convex, ventral facets inclined at an angle of about 90° suggesting four pyrenes in the fruit, facets somewhat unequal, the two surfaces abutting upon a narrow median facet or platform in the lower quarter of the pyrene and meeting in a rounded angle in the upper three-quarters of its length. Dorsal wall largely abraded so that the limits of the germination valve are not sharply defined, but apparently it extended from the apex for rather more than half the length on the dorsal side. Placentas obscure probably lying at one-quarter of the length from the base as indicated by a marked indentation along the ventral angle. Pericarp woody, three coats are preserved: an outer coat about 0.05 mm. thick; a thin coat, one cell thick, of regular equiaxial polygonal or hexagonal cells about 0.037 to 0.5 mm. in diameter (cf. 'beautifully reticulated' layer of Bowerbank (1840) in *Tricarpellites*); an inner thick coat, 0.1 mm. thick, formed of fine

woody parenchyma. Length of pyrene (as abraded), 2.7 mm; breadth, 2 mm.; dorsiventral thickness, 2 mm.

Seed: Solitary, conforming to the locule in shape, much inflated dorsally. Hilum not seen, probably immediately underlying the placenta in the indentation of the ventral angle. Micropyle apical. Chalaza a conspicuous rounded scar about 0.6 mm. broad and 0.4 mm. deep, broadest over

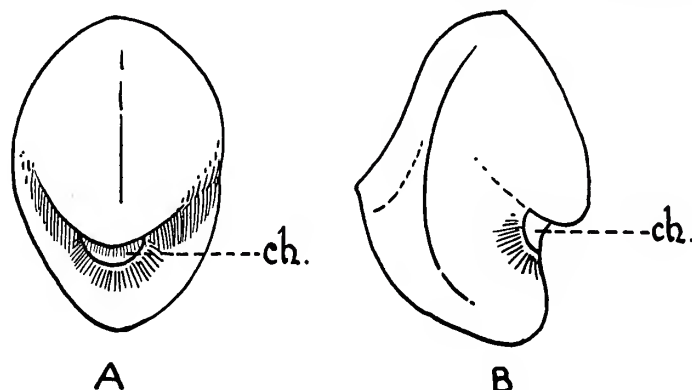


Fig. 23. *Bursericarpum ovale* n. sp. A, seed, ventral, showing chalaza (*ch.*). B, seed, lateral, with chalaza (*ch.*) turned to the right and germination valve impression to the left, its lower limit indicated by dotted line.

the middle where the ventral surface is somewhat flattened and situated near the base on the ventral angle in the bottom of the indentation (Text-fig. 23). Testa formed of equiaxial cells about 0.012 to 0.016 mm. in diameter. Lining of testa (impressed on seed-cast) formed of elongate cells, 0.006 mm. broad, which diverge from the chalaza on the ventral surface but are longitudinally aligned on the dorsal surface.

REMARKS AND AFFINITIES. One pyrene. The form and characteristic structure with its 'beautifully reticulated surface' and the general arrangement of endocarp and seed, indicate relationship with the Burseraceae. In the absence of fuller knowledge and of more material it has been placed in the form-genus *Bursericarpum* with the name *B. ovale* to indicate the broad oval form. No such small species has previously been described fossil, and no comparable living fruit has yet been seen.

V.30064 Holotype, figured Pl. 20, figs. 15-17; Text-fig. 23. A pyrene. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Bursericarpum venablesi n. sp.

Plate 20, figs. 18-21

DIAGNOSIS. Pyrenes sub-ovoid pointed above, cuneate in transverse section, 4 (or 2 two-seeded pyrenes) occurring in the fruit. Germination valve extending from the apex for at least three-quarters of the length. Placenta and hilum at about the middle of the ventral angle. Length of pyrenes about 4.5 to 5.3 mm. (sometimes 3 mm.?); breadth, 1.75 to 3.6 mm.; dorsiventral thickness, 1.5 to 1.75 mm. Length of a valve, 3.25 mm.

HOLOTYPE. V.30065.

DESCRIPTION. *Fruit:* Sub-ovoid, stipitate when the axis is preserved so that it projects beyond the pyrenes at the base (Pl. 20, fig. 21) four-lobed at the base, formed of 4 pyrenes (or 2 two-seeded pyrenes). Individual carpels pointed, sub-ovoid, cuneate in transverse section. Ventral angle 90° , dorsal surface flattened above for at least three-quarters of the length, the flattening corresponding with a germination valve, but rounded below. Placentation axile, the placentas being fed from a median fibrous axis which extends the whole length of the fruit. Ventral wall of each carpel infolded to form a projection into the locule above or about the middle, associated with the placentae. External surface worn so that the cell-structure cannot be seen. Pericarp of three coats: an outer coat, 0.45 mm. thick, formed of irregular parenchyma; a middle coat of a single layer of hexagonal cells, about 0.03 mm. in diameter (where best exposed near the placenta these cells are somewhat elongate); and an inner coat, about 0.1 mm. thick, of compact parenchyma. Locule-lining of fine interlocking cells. Length of carpel about 4.5 to 5.3 mm.; breadth, 3.6 mm. Length of detached locule-cast from a second specimen, 3.75 mm.; breadth, 2 mm.; thickness, 1.75 mm. Length of valve, 3.25 mm.

Seed: Shrunken and folded so that the complete form is not seen. Confused impressions of several coats are preserved on the seed-cast, one coat having equiaxial cells 0.016 mm. in diameter. The hilum apparently underlies the placenta. Chalaza not seen.

REMARKS AND AFFINITIES. Two fruits and a solitary pyrene. One is a complete fruit, the other is represented by two joined pyrenes. A longitudinal fracture of the complete specimen to establish its identity showed the axile canal and strand of fibres with branches arising above the middle and passing to the placentae. Both specimens, on fracture, showed the integuments and the infold associated with the placentae projecting into the locules. It has been suggested above that the specimen may be formed of two two-loculed pyrenes rather than of four one-loculed stones. The evidence for this suggestion is that the perfect specimen readily broke longitudinally into two but would not split into four, whereas the incomplete specimen had already split into two but again would not subdivide further. Possibly, however, pyrites cement observed along the junction of the united carpels in each apparently two-loculed pyrene may account for the reluctance to split. Its occurrence along one plane of splitting only in both fruits must in that case be regarded as an unusual coincidence.

The mode of placentation, form and character of the coats indicate relationship with Burseraceae. In the absence of further information about the seed and its chalaza the fruits have been referred to the form-genus *Bursericarpum*, and are named *B. venablesi* after the finder.

Note: A detached and abraded pyrene (length, 3 mm.; breadth, 1.75 mm.; dorsiventral thickness, 1.5 mm.) was subsequently lost while setting up for photography. It was collected at Bognor by E. M. Venables and apparently belonged to this species.

- V.30065 Holotype, figured Pl. 20, figs. 18–20. Half a fruit, photographed and then fractured to show the locule-cast and placentation. 'Upper Fish Tooth Bed.'
- V.30066 Figured Pl. 20, fig. 21. A slightly stipitate fruit, fractured to show the axis and structure. One of the pyrenes is detached intact, another, detached, has been fractured transversely. The stipitation is formed by the prolongation of the peduncle into the axis. 'Upper Fish Tooth Bed.'
- V.30067 A detached pyrene. 'Beetle Bed.'
- All *E. M. Venables Coll.* Bognor, Sussex.

Genus PALAEOBURSERA nov.

DIAGNOSIS. Syncarpous fruits referable to Burseraceae with angular pyrenes, germination valve $\frac{2}{3}$ to $\frac{4}{5}$ of length. Chalaza, hilum and placenta contiguous near middle. Chalaza sub-triangular to broad and shallow triangular. Genus apparently allied to *Bursera*.

TYPE SPECIES. *Palaeobursera bognoensis* n. sp.

Palaeobursera bognoensis n. sp.

Plate 20, figs. 22, 23; Text-fig. 24

DIAGNOSIS. Pyrene narrow sub-ovoid, narrowly triangular in transverse section suggesting 5 pyrenes in the fruit. Germination valve occupying more than three-quarters of the length. Placentas just below the middle of the ventral angle. Hilum and chalaza contiguous immediately underlying the placenta. Chalaza a shallow broad triangle (almost strap-shaped), not emarginate below. Length of pyrene, 4.5 mm.; breadth, 1.75 mm.; thickness, 2 mm. Testa cells on the dorsal surface of seed, 0.03 mm. broad.

HOLOTYPE. V.30068.

DESCRIPTION. *Fruit*: Syncarpous (by inference) apparently with 5 pyrenes indicated by the acute angle of the ventral margin.

Pyrenes: Narrow sub-ovoid, so as to be narrowly triangular in transverse section, the ventral faces meeting at an angle of less than 90° which extends throughout the length although somewhat rounded below the placenta. Dorsal surface convex, narrow sub-oval in outline, pointed at both ends, more narrowed at the apex than at the base. Ventral angle pierced just below the middle by a transverse curved aperture, concave upwards, associated with the two placentas and funicle. Dorsal germination valve a narrow oval occupying more than three-quarters of the length at the upper end, its exact lower limits not very clear. Carpel wall, where seen in section on the dorsal side, about 0.15 mm. thick. Locule-lining of digitate cells (seen impressed on a pyrite film) about 0.05 mm. in diameter. The characteristic reticulated layer and the outer layers of the endocarp are somewhat obscure.

Length of pyrene, 4.5 mm.; dorsal breadth, 1.75 mm.; dorsiventral thickness, 2 mm.

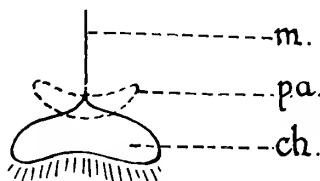


Fig. 24. *Palaeobursera bognoensis* n. sp.
Diagram of chalaza as seen from ventral surface of seed. *m*, median angle of seed; *pa*, position of external placental aperture on pyrene; *ch*, chalaza.

Seed: Solitary, resembling the pyrene in shape, hilum ventral, closely adjacent to the ventral placenta. Chalaza ventral, a shallow broad (almost strap-shaped) triangle immediately

beneath the hilum, not emarginate below, about 0.9 mm. broad and 0.2 mm. deep (Text-fig. 24). Testa formed of elongate cells which diverge from the chalaza, near which they are 0.016 to 0.02 mm. broad, longitudinally aligned on the dorsal face where they are 0.03 mm. broad.

REMARKS AND AFFINITIES. The single specimen is closely comparable in size and structure with a species of *Palaeobursera* to be described in a forthcoming volume from the Lower Bagshot Beds of Dorset, but it appears to differ in the narrower ventral angle indicative of five pyrenes in a fruit, not three as in the Lower Bagshot species, also in the shallower triangle of the chalaza 0.9 mm. broad and only 0.2 mm. deep with no trace of an obcordate form. Also the cells of the testa are much coarser and broader. The relationship appears to be with *Bursera* rather than with other living genera but it differs in the larger number of pyrenes and in the position of the placenta below the middle of the ventral angle. A new generic name *Palaeobursera* has therefore been given.

V.30068 Holotype, figured Pl. 20, figs. 22, 23; Text-fig. 24. A pyrene with carpel wall broken in places so that the seed-cast within is exposed showing the character of the chalaza. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family MELIACEAE

Genus TOONA M. Roemer

Toona sulcata (Bowerbank) Reid & Chandler

Plate 20, figs. 24, 25

1933 *Toona sulcata* (Bowerbank) Reid & Chandler, p. 276, pl. 11, figs. 11-19; text-fig. 5.

V.30069 Figured Pl. 20, figs. 24, 25. A stipitate ovoid syncarpous five-lobed fruit now incomplete and abraded so that the overlapping winged seeds are exposed. It is referable to *Toona sulcata*. Length, including short stalk, 10 mm.; breadth, 5 mm. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family EUPHORBIACEAE

Genus EUPHORBIOTHECA Reid & Chandler, 1933:284

Euphorbiotheca minima n. sp.

Plate 20, figs. 26-28; Text-fig. 25

DIAGNOSIS. Fruit sub-globose, slightly 3-lobed with septicidal and loculicidal suture-lines and 2-seeded locules. Axis extending for more than half the length of the fruit. Length, 3.5 mm.; diameter about 4 mm. Seed sub-oval in outline with flat lateral surfaces, wedge-shaped in transverse section without hilar facet, micropyle apparently towards the base of the locule, chalaza towards the apex, testa 0.1 mm. thick, columnar in section, formed at the surface of equiaxial cells 0.01 to 0.016 mm. in diameter. Tegmen of longitudinally aligned elongate digitate cells about 0.012 mm. broad. Length of seed, 2.75 mm.; dorsiventral thickness, 0.9 to 1.5 mm.; breadth at dorsal margin, 0.75 to 1.4 mm.

HOLOTYPE. V.30070.

DESCRIPTION. *Fruit*: A sub-globose capsule somewhat flattened below and pointed above, with three longitudinal lobes corresponding with 3 two-seeded locules, the shallow depressions between corresponding with the septa (Pl. 20, fig. 26). Dehiscence septicial and loculicidal indicated by suture lines down the grooves and along the middles of the lobes. Pericarp formed externally of fine parallel sets of fibres which diverge obliquely downwards from one another at angles of about $100-110^\circ$ from the loculicidal sutures, and upwards from one another at septicial sutures. In section a fine columnar structure is seen of curved or sloping fibres, the columns about 0.016 mm. broad being themselves more finely striate longitudinally. Within, immediately around the locules, is a layer of coarser cells aligned at right angles to the locule-surface. Locule-lining (seen in one small patch only) obliquely striate. Fibrous axis extending for more than half the length of the fruit, falling free on dehiscence. Septa very thin. Seeds probably hanging from the top of the axis on very short funicles.

Length of fruit, 3.5 mm. Diameter (slightly exaggerated by compression), 4 mm.

Seed: Rounded sub-oval in outline so as to be more convex along the dorsal than along the ventral margin, lateral surfaces broad and flat (Pl. 20, fig. 28), transverse section more or less wedge-shaped, the narrow end of the wedge ventral, the broad end slightly convex and varying to some extent in width in different seeds. Anotropous or half-anotropous as indicated by the presence of an organ at opposite extremities of the seed. The relation of the seeds to the central axis of the fruit as they lie in the position of growth rather points to a half anotropous structure.

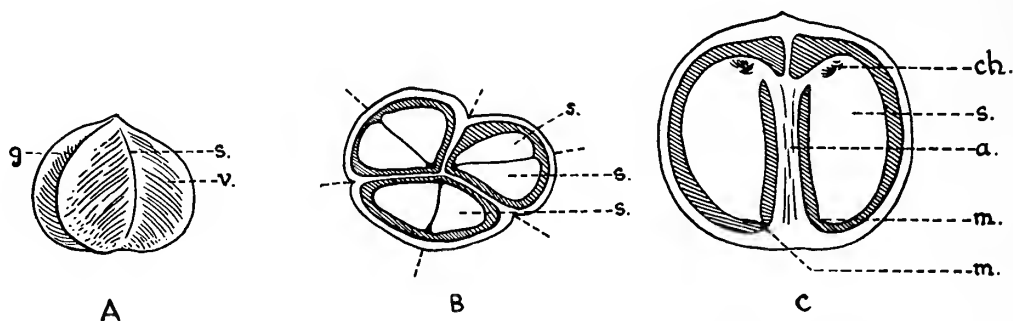


Fig. 25. *Euphorbiothecha minima* n. sp. A, fruit exterior. B, diagrammatic transverse section. Dotted lines indicate loculicidal and septicial planes of splitting. C, diagrammatic longitudinal section showing seeds in locules and fruit axis. *a*, axis; *ch*, chalaza; *m*, micropyle; *s*, seed; also suture for loculicidal dehiscence flanked by fibres directed obliquely downwards; *g*, groove in which suture for septicial dehiscence lies flanked by fibres directed obliquely upward; *v*, valve.

If this is a correct interpretation the chalaza is represented by an oval scar at the end which lies towards the apex of the fruit, and the micropyle by a small prominent circular scar at the opposite end around which the cells are concentrically aligned. The micropyle appears originally to have been marked by a small snout-like projection conspicuous on one seed (Pl. 20, fig. 28, *m*) when the fruit was first fractured. This gave the appearance of a hilum and short funicle but the structure of the fruit with its axis and fibres showed that this interpretation would not hold good. The actual hilar scar has not been seen, but a comparison with *Phyllanthus* suggests that it may have been close to the chalaza and to the top of the fruit axis. Surface of testa smooth and shining formed of rounded equiaxial cells about 0.01 to 0.016 mm. in

diameter. There is some tendency for these cells to be aligned in transverse rows across the broad lateral surfaces of the seed. In section the testa is about 0.1 mm. thick and columnar, the ends of the columns forming the equiaxial surface cells. So far as they have been exposed the columns are straight, not curved. Tegmen, where exposed, of longitudinally elongate and aligned cells of uncertain length with somewhat digitate walls, their breadth about 0.012 mm. Length of a perfect detached seed, 2.75 mm.; dorsiventral thickness, 1.5 mm.; breadth at dorsal margin, 0.75 mm. Length of a second seed, 2.75 mm.; dorsiventral thickness, 0.9 mm.; breadth at dorsal margin, 1.4 mm.

REMARKS AND AFFINITIES. One six-seeded fruit subsequently fractured in an attempt to discover the structure. The specimen is markedly smaller than any other species described from the London Clay, and more globular. Moreover, its seeds distinguish it from any species of fruit with seeds preserved and from any species based on isolated seeds. The flat-sided wedge-shaped form of seed and absence of both hilar faceting and long raphe are unusual features and these together with a slight difference of size separate it from the small seeds described under the name *Euphorbiospermum bognoense* (p. 207). The straight columnar cells of the testa, and the elongate digitate cells of the tegmen are other distinguishing characteristics. The two-seeded locules appear to relate it to the Phyllanthoideae, Manihoteae or Porantheroideae of Pax, but few fruits and seeds belonging to these groups have been seen. Until a comparison with more living forms is possible the specimen is referred to the form-genus *Euphorbiotheca*, the specific name *minima* denoting the small size. On the well-marked characters already described the species should be readily recognizable if found again, and should more material make clear the position of the hilum and exact manner of attachment of the seeds a more precise determination should be possible if comparable material exists in any herbarium.

V.30070 Holotype, figured Pl. 20, figs. 26–28; Text-fig. 25. A fruit with six seeds. It was shattered in an attempt to discover the detailed structure. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus EUPHORBIOSPERMUM Reid & Chandler, 1933:289

Euphorbiospermum eocenicum Reid & Chandler

Plate 21, figs. 1–6

1933 *Euphorbiospermum eocenicum* Reid & Chandler, p. 290, pl. 12, figs. 20–25.

V.30071 Figured Pl. 21, figs. 1–3. A seed with well-preserved testa somewhat worn so as to expose the chalaza. At the opposite end a characteristic tendency to split into three valves is apparent, two lines of splitting being traceable almost to the chalaza, giving the appearance of a ligulate valve. Length of seed, 6 mm.; diameter, 7 mm. *D. J. Jenkins Coll.* Herne Bay, Kent.

V.30072 Figured Pl. 21, figs. 4, 5. A somewhat compressed seed, now fractured longitudinally, abraded to show the chalaza. *A. G. Davis Coll.* Warden Point, Sheppey.

V.30073 Figured Pl. 21, fig. 6. A seed showing 3-partite splitting at the hilum.

V.30074 A seed split at the hilar end so as to give a 2-valved effect. Testa cells 0.016 to 0.02 mm. in diameter, inner coat formed of equiaxial cells 0.5 to 0.7 mm. in diameter.

Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Euphorbiospermum obliquum Reid & Chandler

1933 *Euphorbiospermum obliquum* Reid & Chandler, p. 293, pl. 12, figs. 30, 31.

V.30084 A seed. *D. J. Jenkins Coll.* Warden Point, Sheppey.

Euphorbiospermum subovoideum Reid & Chandler

1933 *Euphorbiospermum subovoideum* Reid & Chandler, p. 294, pl. 12, figs. 34-36.

V.30085 A seed with much testa preserved. *A. G. Davis Coll.* Warden Point, Sheppey.

Euphorbiospermum ambiguum Reid & Chandler

1933 *Euphorbiospermum ambiguum* Reid & Chandler, p. 295, pl. 13, figs. 1, 2.

V.30086 The cast of a distorted seed. *G. F. Elliott Coll.* Sheppey.

Euphorbiospermum cooperi n. sp.

Plate 21, figs. 7-9

DIAGNOSIS. Seed almost circular in outline, obscurely pointed at the hilar end, compressed dorsiventrally, hilar facet with two hollows, shallow and small, making an angle of 117° with the ventral face. Cells of columnar coat 0.033 mm. in diameter. Chalaza sub-terminal on the dorsal surface. Length of seed, 12.5 mm.; breadth (estimated) about 13 mm.; thickness, 7.5 mm.

HOLOTYPE. V.30075.

DESCRIPTION. *Seed*: Approximately circular in outline but obscurely pointed at the hilar end, compressed dorsiventrally so as to be sub-lenticular in transverse section. Hilar facet small, scarcely hollowed, sub-divided medianly by a short sharp longitudinal ridge about 3 mm. long, continued beyond the facet as a rather obscure rounded angle extending almost the length of the ventral face; facet making an angle of about 117° with the ventral face. Dorsal surface gently convex. Cells of columnar coat 0.033 mm. in diameter. Chalaza sub-terminal on the dorsal surface, indicated by a sharply defined circular scar from which the testa cells radiate at the opposite end to the hilum (Pl. 21, fig. 9). The cells of the inner coat of the testa cannot be distinguished. Length of seed, 12.5 mm.; breadth incomplete, estimated at about 13 mm.; thickness, 7.5 mm.

REMARKS AND AFFINITIES. One seed-cast, incomplete on one side near the base with a marked tendency to split and decay along the broken surface. The seed had evidently split longitudinally at the hilar end as for germination, for in addition to the median ridge of the hilar facet, there are two lateral ridges, extending for different distances, formed by infiltration and subsequent hardening of pyrites along fissures in the testa (now removed by abrasion).

Among fossil species, this seed most nearly resembles *E. subquadratum* Reid & Chandler (1933: 291, pl. 12, figs. 26, 27) and *E. crassitestum* Reid & Chandler (1933: 296, pl. 13, figs. 5-7). It differs however from *E. subquadratum* in its rounded outline, small hilar facet, and in the position of the chalaza (if this is original and not merely due to distortion) on the dorsal surface. It differs from *E. crassitestum* also in the more rounded outline, in its dorsiventral compression, its less pointed hilar end, smaller, flatter and less conspicuous hilar facet. The testa cells are coarser than in either of these previously described species. The species has been named *Euphorbiospermum cooperi* after the finder.

V.30075 Holotype, figured Pl. 21, figs. 7-9. A seed-cast, broken on one side near the base. *J. E. Cooper Coll.* Herne Bay, Kent.

Euphorbiospermum bognorensis n. sp.

Plate 21, figs. 10, 11

DIAGNOSIS. Seed narrow sub-ovoid, truncate at chalazal end, slightly compressed dorsiventrally, hilar facet subdivided into two, making an angle of about 52° with the ventral face. Cells of columnar coat about 0.016 mm. in diameter. Length of seed, 3.25 mm.; breadth, 2 mm.; thickness, 1.1 mm.

HOLOTYPE. V.30076.

DESCRIPTION. *Seed*: Anotropous with hilum and chalaza at opposite ends; narrow sub-ovoid, truncate at the chalaza end, slightly compressed dorsiventrally, hilar facet, which makes an angle of about 52° with the ventral surface, small, medianly divided by a conspicuous ridge into two depressions (Pl. 21, fig. 10) therefore the seed was probably arillate. Chalaza a circular scar, testa much abraded, columnar in section with straight or curved columns about 0.016 mm. in diameter, surface imperfect, inner coat not seen. Length of seed, 3.25 mm.; breadth, 2 mm.; thickness, 1.1 mm.

REMARKS AND AFFINITIES. The seed is clearly related by its form and columnar testa to Euphorbiaceae, but the characters are not such as to permit of closer determination (see Reid & Chandler, 1933: 283). It has therefore been referred to the form-genus *Euphorbiospermum*. The species is distinguished by its small size and narrow form from any previously described from the London Clay of Sheppey or Herne Bay, hence a new specific name *E. bognorensis* has been chosen to indicate the locality in which it was first found.

V.30076 Holotype, figured Pl. 21, figs. 10, 11. A seed with testa much abraded. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Euphorbiospermum venablesi n. sp.

Plate 21, fig. 12

DIAGNOSIS. Seed sub-ovoid, slightly compressed dorsiventrally, conspicuously pointed at the hilar end, hilar facet subdivided into two, making an angle of about 63° with the ventral face. Cells of outer coat 0.012 to 0.016 mm. in diameter. Inner coat of cells 0.025 to 0.05 mm. in diameter. Length of seed at least 3.75 mm.; breadth, 2.5 to 3 mm.; thickness, 1.75 to 2.5 mm.

HOLOTYPE. V.30077.

DESCRIPTION. *Seed*: Anotropous with hilum and chalaza at opposite ends; sub-ovoid, rounded at the chalaza end, slightly compressed dorsiventrally but convex on both surfaces, conspicuously pointed at the hilar end, hilar facet subdivided into two, making an angle of about 63° with the ventral face. Outer coat of fine equiaxial cells 0.012 to 0.016 mm. in diameter (preserved on a film of pyrites as impressions, the pyrites largely obscures the carbonaceous coat itself). Internal cast of seed showing impression of larger equiaxial cells 0.025 to 0.05 mm. in diameter. The cells of both coats show a tendency to longitudinal alignment producing a fine longitudinal striation of the surface. Length of holotype, 3.75 mm.; breadth, 3 mm.; thickness, 1.75 mm. Length of second specimen (abraded and incomplete at the base), 3.75 mm.; breadth, 2.5 mm.; thickness, 2.5 mm. Both of the latter dimensions increased by the bursting of the specimen in fossilization.

REMARKS AND AFFINITIES. Two seeds, one somewhat crushed. The species bears a close resemblance to *E. bognoyense* but it is somewhat larger and broader with more rounded contours. The seeds are also more pointed at the hilar end, and the angle formed by the ventral facet with the ventral surface is a little larger. While therefore it is tempting to regard these two specimens as larger examples of *E. bognoyense*, the evidence as a whole indicates a distinct species which has been named *Euphorbiospermum venablesi*.

V.30077 Holotype, figured Pl. 21, fig. 12. A seed slightly crushed.

V.30078 Another specimen which has begun to burst longitudinally in fossilization.
Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Euphorbiospermum subglobulare n. sp.

Plate 21, figs. 13-16

DIAGNOSIS. Seed sub-globular without dorsiventral compression, having an obscure pair of depressions at the hilar end. Columnar cells of testa 0.016 mm. in diameter. Inner coat with cells 0.05 to 0.1 mm. in diameter. Length of seed, 2 mm.; breadth, 1.8 to 1.9 mm.

HOLOTYPE. V.30079.

DESCRIPTION. *Seed*: Sub-globular, not dorsiventrally compressed, obscurely triangular at the hilar end where it tends to split into three (Pl. 21, fig. 13), having a very obscure shallow pair of arillar depressions at this end, anatropous with hilum and chalaza terminal at opposite ends, the chalaza large, circular, 0.8 to 0.9 mm. in diameter (Pl. 21, fig. 15). Testa much abraded, formed of a single layer of columnar cells which are equiaxial in surface view and in cross-section and about 0.016 mm. in diameter. Besides the impressions of these cells, the seed-cast also shows the impressions of large equiaxial areas, 0.05 to 0.1 mm. in diameter, which diminish in size towards the micropyle. These appear to be impressions of the inner surface of the columnar testa, and may probably coincide in form and size with a soft thin coat now decayed (Pl. 21, fig. 14). Length of seed, 2 mm.; breadth, 1.8 to 1.9 mm.

REMARKS AND AFFINITIES. Five seeds with remains of testa, two showing a tripartite split at the hilar end; two are abraded so as to show the chalaza. Every character indicates alliance with Euphorbiaceae, but for reasons already published (Reid & Chandler, 1933: 283) no reference to a living genus can be made. The species is therefore referred to a form-genus under the name *Euphorbiospermum subglobulare*.

V.30079 Holotype, figured Pl. 21, figs. 13, 14. A seed with testa much abraded showing the coarse cell-impressions.

V.30080 Figured Pl. 21, figs. 15, 16. A seed with testa partly preserved.

V.30081 Three seeds.

All *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Euphorbiospermum sp.

Plate 21, figs. 17, 18

A much distorted seed is clearly referable to Euphorbiaceae, but the distortion makes it difficult to determine the original form. As preserved, it is oval in outline, convex on one face with a median longitudinal angle for the lower two-thirds of its length, concave (owing to distortion) on the opposite face with a median angle for one-third of its length. On both faces

patches of carpel wall adhere on each side of the median line and show oblique striae diverging from it due to narrow elongate-pointed cells about 0.025 mm. broad. The position of the hilum is obscure possibly on account of distortion, possibly owing to adherent fragments of carpel. The testa, which is abraded, is represented by impressions of equiaxial cells, 0.025 mm. in diameter, on the internal cast, caused by the inner ends of the columnar cells which formed the main thickness of the testa. The inner coat is likewise represented by cell impressions, 0.1 mm. in diameter, on the same cast. The tegmen cells, seen as impressions on an inner cast, are equiaxial, 0.025 mm. in diameter, and are arranged both radially and concentrically around a terminal area representing the micropyle. At the opposite end is a sub-circular internal chalazal scar about 0.2 mm. in diameter. Length of seed-cast, 5.75 mm.; breadth, 4 mm.; thickness measured through the median ridges, 3 mm.

The uncertainty as to the original form of this seed makes specific diagnosis impossible, although the family relationship is quite clear.

V.30082 Figured Plate 21, figs. 17, 18. A distorted seed, now fractured. *A. G. Davis Coll.* Warden Point, Sheppey.

?*Euphorbiospermum* sp.

Plate 21, fig. 19

Seed: Sub-circular in outline, probably originally globular, but now much distorted by compression. External integument carbonaceous, largely abraded, showing superficially equiaxial cells about 0.016 mm. in diameter, varying considerably in thickness from 0.01 mm. to 0.025 mm. in different parts of the seed; columnar in section, the columns lying oblique to the surface in one patch, but usually at right angles to it. Seed-cast showing the impressions of two layers of cells, equiaxial impressions, 0.016 mm. in diameter, representing the ends of the columnar cells of the testa and beneath them, and more conspicuous, the impressions of a thin smooth coat, one cell thick, formed of polygonal cells very variable in size and form; they may be equiaxial, or twice as broad as long, their diameters varying from 0.05 to 0.1 mm. Within again is a crumpled thin tegmen, its cells are obscure, but there are traces of equiaxial cells 0.016 mm. in diameter, and in other parts a suggestion of elongate cells 0.016 mm. broad. No organs have been seen.

Diameter of seed (as crushed), 5.25 mm. Near the margin there are patches of pyrites wrinkled parallel with the circumference of the seed. No structure can be seen on these patches, but the alignment of the wrinkles suggests that this is an impression of an outer coat (aril?) now abraded.

REMARKS AND AFFINITIES. One seed. Its systematic position is not clear. The columnar coat and inner coat at once recall Euphorbiaceae, but against such an ascription is the absence of any evidence of a chalaza, usually clearly seen on seed-casts in this family. The most careful scrutiny has also failed to detect a hilum or raphe. Hence the relationship with Euphorbiaceae cannot be regarded as conclusively established. The specimen is unlike any species of *Euphorbiospermum* hitherto described.

V.30083 Figured Pl. 21, fig. 19. A seed-cast with remains of testa. *G. F. Elliott Coll.* Warden Point, Sheppey.

Family EUPHORBIACEAE?

Genus WETHERELLIA Bowerbank, 1840:84

Wetherellia variabilis Bowerbank

Plate 19, fig. 23

- 1933 *Wetherellia variabilis* Bowerbank: Reid & Chandler, p. 251, pl. 9, figs. 7-22.
 1954 *Wetherellia variabilis* Bowerbank: Chandler, p. 172.

The true relationship of this distinctive species still remains obscure. Reid & Chandler (1933) connected it with the family Linaceae, but in 1954 Chandler (p. 174) gave reasons for correcting this ascription suggesting instead a possible alliance with Euphorbiaceae. The grounds for this suggestion were the combination of loculicidal and septicidal dehiscence, the number of radially arranged locules, the point of origin of the funicles from the axis and the solitary pendulous seeds with ventral raphe.

Two species of the genus are discussed (Chandler, 1954: 173) and an allied genus *Palaeowetherellia* described (Chandler, 1954: 168).

- V.30018 Figured Pl. 19, fig. 23. A coccus much encrusted with pyrites.
 V.30019 A second specimen.
 The above *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30020 A coccus broken transversely showing the seed and seed-cast within the flat locule, and the coarse parenchyma of the carpel. The specimen is coated with pyrites.
 V.30021 Numerous cocci or parts of cocci, a locule-cast and seed-cast.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30022 A coccus. *D. J. Jenkins Coll.* About 40 feet from the top of the cliff, Beltinge, Herne Bay, Kent. *In situ.*
 V.30023 Five much decayed cocci. *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31).

Genus LAGENOIDEA Reid & Chandler emend Chandler, 1954:166

AMENDED DIAGNOSIS. The raphe may be ventral or dorsal, chalaza sub-basal ventrally or dorsally.

TYPE SPECIES. *L. trilocularis* Reid & Chandler.

Lagenoidea trilocularis Reid & Chandler

Plate 30, fig. 16

- 1933 *Lagenoidea trilocularis* Reid & Chandler, p. 493, pl. 29, figs. 1-18.
 1954 *Lagenoidea trilocularis* Reid & Chandler: Chandler, p. 167, pl. 12, figs. 16-20.

HOLOTYPE. V.23126.

REMARKS. A well-preserved fruit found in 1937 shows clearly that the branching fibres at the apex of the fruit (see Reid & Chandler, 1933: 494) pass into the locules and form apical placentas. Hence, as noted (Chandler, 1954) the seeds are pendulous, not ascending and erect as was at one time believed. The chalaza in this species was seen in a basiventral position

(Reid & Chandler, 1933, pl. 29, fig. 16), hence the seed must have been anatropous with ventral raphe, lying on the more convex surface. In other respects the original description remains unaltered. As stated in 1954 the shape of the fruit and combined loculicidal and septicidal dehiscence is typical of Euphorbiaceae. Pendulous seeds with ventral raphe also occur in this family although in it the placentation is truly axile. The reference to the family must therefore be regarded as doubtful.

- V.30491 Figured Pl. 30, fig. 16. A small fruit with pendulous seeds and apical placentation. *F. M. Wonnacott Coll.*
 V.30492 A fruit fractured longitudinally showing the attachment of the seed and its chalaza in section. *A. G. Davis Coll.*
 Both from Warden Point, Sheppey.

Lagenoidea bilocularis Reid & Chandler

Plate 30, fig. 17

- 1933 *Lagenoidea bilocularis* Reid & Chandler, p. 496, pl. 29, figs. 19-27.
 1954 *Lagenoidea bilocularis* Reid & Chandler: Chandler, p. 167, pl. 12, figs. 21-23.

AMENDED DIAGNOSIS. Fruit sub-ovoid, laterally compressed, two-loculed, with six longitudinal furrows for splitting, two broad pairs of segments forming two valves, two narrower segments between them being the protruding edges of the endocarp or its axis. Length, 8 to 15 mm.; greatest diameter, 8 to 15 mm.; least diameter, 5 to 8.5 mm.

HOLOTYPE. V.23141.

REMARKS. The published description still holds good except that the seed in this species is pendulous and unlike *L. trilocularis* appears to have a dorsilateral raphe (Pl. 30, fig. 17) seen as a ridge passing into the chalaza on the seed-cast. The dorsal surface is the more convex side in this species. The connexion with *L. trilocularis* suggests Euphorbiaceae. While in Euphorbiaceae the raphe is normally ventral, Hooker (1855) states that it may be dorsal rarely.

Again in Euphorbiaceae the seeds are pendulous from a central axis of varying length whereas in the fossil the funicles appear to originate from the fibres which turn in at the apex after traversing the thick external wall of the pericarp and so give rise to the pendulous seeds.

In spite of these difficulties the fruits are provisionally referred to Euphorbiaceae.

- V.30493 Figured Pl. 30, fig. 17. A fruit, fractured longitudinally, showing a seed with well-preserved dorsilateral raphe.
 V.30494 A much abraded fruit showing seeds and locule-casts.
 V.30495 A perfect fruit. Swale Cliff.
 The above *D. J. Jenkins Coll.* Herne Bay, Kent.
 V.30496 An endocarp fractured longitudinally. *F. M. Wonnacott Coll.*
 V.30497 A small fruit fractured longitudinally. *G. F. Elliott Coll.*
 Both the above from Warden Point, Sheppey.

?*Lagenoidea* sp.

- V.30498 A fragment of a fruit showing radially arranged fibres and an incomplete impression of a locule, may possibly belong to one of the species of *Lagenoidea* described from the London Clay, but is too imperfect for definite determination. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family ANACARDIACEAE

Genus DRACONTOMELON Blume

Dracontomelon subglobosum Reid & Chandler

Plate 21, figs. 20, 21

1933 *Dracontomelon subglobosum* Reid & Chandler, p. 299, pl. 13, figs. 10-19; text-fig. 6.

- V.30087 Figured Pl. 21, figs. 20, 21. A five-loculed endocarp showing the large apical apertures some of which are still closed by plugs, and the small paired apertures below the equator. Length along the axis, 9 mm.; diameter, 11 mm.
- V.30088 A second specimen (now fractured) of about the same dimensions, but obliquely compressed. The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30089 An endocarp much encrusted with pyrites which covers each plug and aperture making them conspicuous. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30090 Eight endocarps. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30091 An endocarp. *D. J. Jenkins Coll.* Herne Bay, Kent.

Dracontomelon minimum Reid & Chandler

Plate 21, figs. 22, 23

1933 *Dracontomelon minimum* Reid & Chandler, p. 302, pl. 13, figs. 20-24.

- V.30092 Figured Pl. 21, fig. 22. A much abraded endocarp figured to show the locule-casts protruding below. Some locule-casts have fallen out. Abrasion has almost obliterated the paired lateral apertures.
- V.30093 Figured Pl. 21, fig. 23. A much worn fruit with two locule-casts almost completely exposed, two other casts have fallen out. The paired apertures are again obliterated by abrasion.
- V.30094 Three worn endocarps.
- V.30095 Seven endocarps in various states of abrasion. The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30096 Twelve endocarps, some worn so as to expose the locule-casts. *A. G. Davis Coll.*
- V.30097 One endocarp. *G. F. Elliott Coll.*
- V.30098 Three endocarps. *F. M. Wonnacott Coll.*
All from Warden Point, Sheppey.

Genus PSEUDOSCLEROCARYA Reid & Chandler 1933: 303

Pseudosclerocarya lentiformis Reid & Chandler

Plate 21, figs. 24-26; Text-fig. 26.

1933 *Pseudosclerocarya lentiformis* Reid & Chandler, p. 303, pl. 13, figs. 25-28.

The discovery of a specimen at Herne Bay has made it possible to add certain particulars to the description previously published.

DESCRIPTION. *Fruit* (not previously known): Circular in outline, flattened above and below, not angled at the equator. Epicarp abraded exposing a rather worn surface of mesocarp partially covered by a thin film of pyrites. At the base is a pentagonal scar of attachment (Pl. 21, fig. 26) from which arise strong longitudinal strands of fibres which pass into the pulp

where they branch and anastomose so as to produce a network discernible over the whole surface exposed by abrasion. Decay and abrasion have also eaten into the apex producing a considerable excavation there (Pl. 21, fig. 25). Mesocarp in section about 1.5 mm. thick, formed of elongate pulpy (?) cells, 1.5 mm. long and 0.05 mm. broad, aligned at right angles to the surface. Length of fruit, 12 mm.; breadth, 18 mm.

Endocarp (seen in longitudinal section only in the new specimen): Comparable with those previously described although agreeing in shape with the fruit which has protected it from

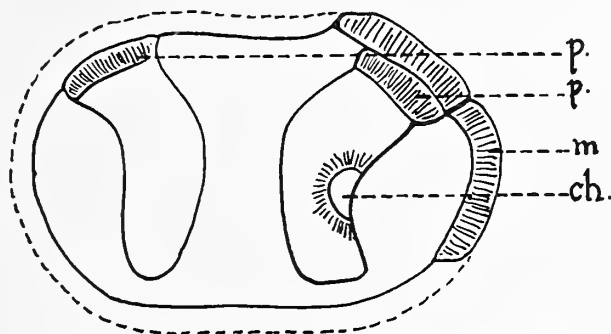


Fig. 26. *Pseudosclerocarya lentiformis* Reid & Chandler. Fruit longitudinally sectioned showing two locules and seeds. *ch*, chalaza; *p*, germination plugs of locules. Mesocarp is preserved at *m* and the dotted line indicates where it has been worn away.

abrasion so that it is less sharply lenticular in section, and rounded, not angled, at the margin. Two locules, seen in longitudinal section, are complete at base and apex unlike those previously described; the base is obliquely truncate (Pl. 21, fig. 24) and the apical plug is about 1 mm. thick, preserved intact within the covering of mesocarp. The locules and seeds are similar in size, form and curvature to those of specimen V.22551. The outer wall of the endocarp appears to be formed by a layer of fine longitudinal fibres, 0.5 mm. thick as seen in section; it is apparently abraded in specimens V.22550-52. Length of the endocarp in the new specimen about 10 mm.; diameter about 15 mm.

Seeds: As previously described, but the testa, better seen in a few patches, is formed of rather flat-topped rounded equiaxial or oval cells approximately 0.016 mm. in diameter. One seed shows a particularly well-preserved chalazal scar. (Pl. 21, fig. 24 *ch*.)

REMARKS. The species was previously referred to the fossil genus *Pseudosclerocarya* to indicate relationship not amounting to identity with the living *Sclerocarya*. The new material extends the range of this plant to Herne Bay, previous records being from Sheppey only. Four specimens are now known.

V.30099 Figured Pl. 21, figs. 24-26; Text-fig. 26. A fruit with mesocarp preserved, fractured longitudinally. *J. E. Cooper Coll.* Herne Bay, Kent.

Pseudosclerocarya subalata Reid & Chandler

1933 *Pseudosclerocarya subalata* Reid & Chandler, p. 304, pl. 13, figs. 29-31.

V.30100 A small endocarp, 13.5 mm. in diameter, 5 mm. in height. *G. F. Elliott Coll.* Sheppey, Kent.

Genus CHOEROSPONDIAS Burt & Hill

Choerospondias sheppeyensis (Reid & Chandler) Chandler

Plate 21, figs. 27-31

1933 *Spondias sheppeyensis* Reid & Chandler, p. 305, pl. 13, figs. 32-34.

A better preserved specimen than the holotype has now been found so that in certain minor respects the original description can be amplified.

DESCRIPTION. 'Stone': obovoid, slightly compressed laterally, with five radially arranged one-seeded locules, longitudinally elongate and tangentially compressed, which communicate with the exterior by small narrow-oval apertures arranged in a ring about one-quarter of the length of the 'stone' below the apex (Pl. 21, fig. 29); at the base a circular scar of attachment is surrounded immediately by a ring of small narrow apertures situated on the radii alternating with the locules as in *Choerospondias* (Pl. 21, fig. 30). On the sides of the 'stone', longitudinal rows of small apertures (each row with about three apertures) can be seen, the rows are arranged in pairs associated with the locules, one row on each side of a locule and closely adjacent to it. At the surface the apertures are often obscure, when seen in section they appear to communicate with the tissues which immediately surround the locule but not with the locule itself. The 'stone' is formed of compact masses of fibres (often tortuous) and of parenchyma. On the abraded surface the fibres are very clearly seen. A fibrous axis may be isolated during fossilization by decay of the surrounding tissues. A compact coat of equiaxial cells, about 0.05 mm. in diameter, immediately surrounds each locule. Length of endocarp, 12 to 13 mm.; diameter, 11 by 12.5 mm.

Seed (Pl. 21, fig. 31): Conforming to the locule in shape, slightly concave on the dorsal margin and convex on the ventral (inner) margin, much compressed tangentially, slightly truncate obliquely at the hilar end, narrowly triangular in transverse section, the base of the triangle forming the ventral margin. Testa (as seen in the holotype) formed of regular equiaxial cells arranged in longitudinal rows (not preserved in a recognizable condition in a second fruit). Tegmen (impressed on the internal cast of the seed) formed of equiaxial cells, 0.012 mm. in diameter, arranged in rows, the thickening of the lateral walls producing a striate effect. Around the chalaza the striae diverge; in the distal part of the seed (i.e. below the chalaza as the seed lies in the fruit) they are aligned longitudinally, in the hilar region they run parallel with the oblique truncation. The chalaza, a large circular scar, is situated on the dorsal margin just below the middle of the seed; the raphe has not been seen. Length of seed, 7.25 mm.; radial breadth, 3.25 mm.; maximum tangential thickness, 1.5 mm.

REMARKS AND AFFINITIES. Five specimens. The holotype (V.22554) was much worn. A specimen from Herne Bay was perfect but much encrusted with pyrites. The relationship to living genera was discussed by Reid & Chandler (1933: 306). These fruits most resemble *Sclerocarya* and *Choerospondias* in form, but the number of locules is greater than in the living *Sclerocarya*, and there are no woody plugs closing their apices as in that genus. *Choerospondias* has similar locules but a larger endocarp, it also has longitudinal rows of small holes on the lateral surfaces between the locules, but the holes in the fossils are few and somewhat irregular. Nevertheless the most nearly allied living species appears to be *C. axillaris* (Roxb.).

- V.30101 Figured Pl. 21, figs. 27-31. An endocarp now fractured to show the structure. A seed has been released and is shown in Fig. 31.
- V.30102 A decaying endocarp fractured longitudinally. Swale Cliff.
- V.30103 A second fractured specimen from the East Cliff shore.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30104 An endocarp fractured, possibly referable to this species although the locules are rather less tangentially compressed than in other specimens.
- V.30105 A second well-preserved unfractured specimen.
Both the above *J. E. Cooper Coll.* Herne Bay, Kent.

Genus LANNEA A. Rich

Lannea jenkinsi Reid & Chandler

Plate 21, figs. 32, 33

1933 *Odina jenkinsi* Reid & Chandler, p. 308, pl. 13, figs. 37-40.

- V.30106 Figured Pl. 21, figs. 32, 33. Two abraded endocarps, in one the spaces between the swirling strands of fibres are filled with amorphous pyrites which has resisted abrasion more than the surrounding carbonaceous endocarp. The two canals at the middle of the concave surface, one on each side of the seed, are also filled with pyrites so that they project as two small knobs. Abrasion has greatly reduced the size.
- V.30107 An endocarp showing a considerable degree of inflation (fractured transversely). The larger range of material now available suggests that the degree of compression or inflation varies within somewhat wider limits than was at first supposed.
- V.30108 An endocarp, somewhat incomplete below, fractured transversely.
- V.30109 Fourteen endocarps, some much encrusted with pyrites, one fractured transversely. Probably referable to this species.
- V.30110 Twenty-seven endocarps, some fractured to show the structure. They vary in the degree of inflation and some are relatively small; possibly they should be described as a distinct species, but when compared with a wide range of specimens it becomes difficult to discriminate. They are therefore retained provisionally in the species *L. jenkinsi*.
All the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30111 Three endocarps considerably obscured by adherent pyrites, one is small (6.5 mm. long) but as it agrees in its other characters with *L. jenkinsi*, specific distinction does not seem possible. *A. F. Walton Coll.* Warden Point, Sheppey.
- V.30112 A small endocarp (6.25 mm. long; 5 mm. broad) fractured longitudinally to show the seed. *F. M. Wonnacott Coll.* Warden Point, Sheppey.
- V.30113 A detached seed showing chalaza. *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31).

Lannea europaea Reid & Chandler

Plate 21, figs. 34, 35

1933 *Odina europaea* Reid & Chandler, p. 309, pl. 14, figs. 1-4.

Two syncarpous subovoid woody endocarps, both much abraded, appear to be referable to *Lannea europaea*. They have two one-seeded locules sub-parallel but slightly divergent from one another. Carpel wall thick and woody with typical swirling strands of fibres. Length (as abraded), 6 mm.; breadth, 4 mm.; thickness, 4 mm. The seed is arcuate in profile, somewhat laterally compressed, the chalaza is large, median on the concave margin. The specimens are abraded so that the locule-casts are exposed.

- V.30114 Two endocarps both much abraded. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

?Lannea sp.

Plate 21, fig. 36

DESCRIPTION. *Endocarp*: Probably ovate or semicircular in outline (incomplete on one side), somewhat compressed, smooth externally (surface much obscured by pyrites), one-loculed, one-seeded. Walls woody, with a marked tendency for the cells to be radially arranged. Locule wall smooth, lined apparently with equiaxial cells about 0.05 mm. in diameter, but owing to abrasion the cell-outlines are obscure; thickness of wall where measured at the side, 1.5 mm. Length of endocarp (somewhat incomplete), 11 mm., breadth (as preserved), 6 mm. at the middle.

Seed: (Partially obscured by locule-cast) agreeing with the locule in shape, arcuate in outline, much flattened. Chalaza median on the concave margin, circular, 5.5 mm. in diameter, half lying on one lateral face and half on the other; micropyle and raphe not seen. Testa not seen. Internal cast of seed showing fine cells arranged so as to produce fine striae which diverge from the chalaza.

Length of locule-cast (= seed), 9 mm.

REMARKS. One incomplete endocarp probably referable to *Lannea* by the form and structure. The specimen is imperfect, part of the endocarp having broken away so as to expose the locule-cast, and part of the locule-cast so as to expose the margin of the seed. The specimen is larger and more inflated than *L. jenkinsi*, the most comparable species in the London Clay. It also seems to have been smoother externally than *L. jenkinsi*, but this may be due to abrasion. Since satisfactory diagnosis is difficult or impossible on one imperfect specimen, it has been recorded merely as *Lannea* sp.?

V.30119 Figured Pl. 21, fig. 36. A broken endocarp and seed-cast. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus SPONDIAECARPON Langeron, 1899: 453

Spondiaecarpon operculatum n. sp.

Plate 21, figs. 37-39; Text fig. 27

DIAGNOSIS. A two-loculed syncarpous fruit with one-seeded locules germinating by small triangular apical valves which are almost contiguous on one face, separated by a triangular tongue of carpel wall on the other. Inner layers of endocarp of transverse fibres. Tegmen of angular cells more or less equiaxial. Length of fruit about 7 mm.; breadth, 3.75 to 4 mm.; thickness, 2.5 to 3.25 mm.

HOLOTYPE. V.30115.

DESCRIPTION. *Fruit*: Two-loculed, syncarpous, bisymmetric, roundly truncate at one end (base?), pointed at the other where two inclined almost contiguous equilateral triangular facets meet at an angle of about 67°; on one surface they are almost contiguous, on the other separated by a triangular prolongation of the fruit wall with slightly concave margins. The

facets are formed by a pair of short roundly triangular germination valves, 2.5 mm. in diameter, which are made more conspicuous by the rounded raised rim of the carpel wall in which they lie (Pl. 21, fig. 39). They are concealed in one perfect specimen (Pl. 21, fig. 37) by a thin black leathery coat ornamented with low irregular warts or rugosities which covers the whole surface of the fruit. This coat carries a pair of median longitudinal fibres clearly visible on the two surfaces in grooves at the pointed end of the fruit. One fibre divides at about the middle of the surface on which the valves lie close together, the two branches re-uniting at the truncate base (Pl. 21, fig. 38; Text-fig. 27B). The other fibre on the opposite surface of the fruit bifurcates below the middle, the branches re-uniting just above the truncate end (Text-fig. 27A).

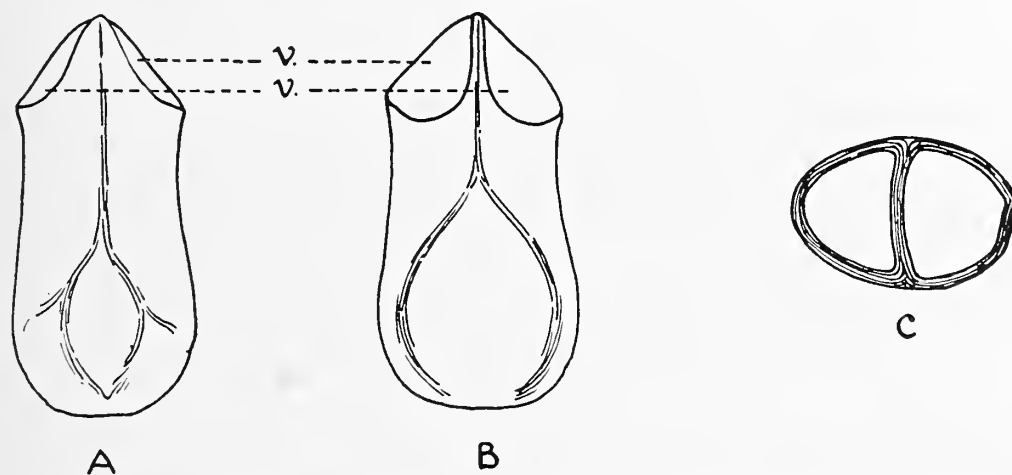


Fig. 27. *Spondiaecarpon operculatum* n. sp. A and B, opposite sides of fruit showing course of the fibres and the germination valves (v, v). C, transverse section showing locules.

Less conspicuous smaller branches give rise to a fine network widely distributed over both surfaces. The outer coat is formed in part at least of radially aligned cells, and the septum and main thickness of the endocarp of several layers of fine sometimes slightly sinuous transverse fibres. The locule-lining has corresponding fine transverse striations. Seeds solitary, placentation not seen. Length of fruit about 7 mm.; breadth, 3.75 to 4 mm.; thickness along the septum, 2.5 to 3.25 mm.

Seed: Agreeing with the locule in form, sub-cylindric (not completely exposed so that the organs are not visible). Testa? (seen in one small patch only) formed of longitudinally elongate and aligned cells about 0.016 mm. broad. Tegmen of angular cells about 0.025 mm. in diameter with a tendency to be transversely elongate. Length of seed, 6.5 mm.; breadth, 1.5 mm.; dorsiventral thickness about 2 mm.

REMARKS AND AFFINITIES. Four fruits, one perfect, another with one valve missing and the base somewhat imperfect. In the third and fourth the outer coat has gone showing the transverse fibres; one of them has been partly dissected to expose a seed.

It is tempting to ally this fruit with Anacardiaceae on account of the valves and transverse fibres. But the seed-structure and especially the cell-structure of the tegmen do not support such a relationship so far as they are known, so that the reference to the family is doubtful. The species is recorded from Bognor only.

- V.30115 Holotype, figured Pl. 21, fig. 37. A fruit with outer coat preserved, now flaking away and exposing two locules with valves preserved.
- V.30116 Figured Pl. 21, fig. 38. A fruit with outer coat abraded now dissected to show a seed.
- V.30117 Figured Pl. 21, fig. 39. A fruit incomplete at the base, with outer coat and one valve gone. Now fractured transversely to show the two locules.
- V.30118 A well-preserved cast showing indications of two locules.
All *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus?

Plate 21, figs. 40, 41

A woody fibrous endocarp much abraded so as to expose two locule-casts which are concave towards one another (i.e. on their ventral sides) both longitudinally and transversely. The arrangement of the fibres suggests a median ventral attachment.

- V.30120 A woody endocarp much abraded. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus?

Plate 21, fig. 42

Fruit: Originally sub-globular, five-loculed, syncarpous, now abraded so as to show the radially arranged locule-casts around the stout fibrous axis, with patches of endocarp persisting between them. The endocarp is formed of fibres and parenchyma, the cells near the periphery being about 0.05 mm. in diameter, those immediately surrounding the locules being about 0.025 mm. in diameter. Locules single-seeded. Locule-casts tangentially compressed, straight on the ventral margin, convex in outline on the dorsal, inflated on the dorsal side in the lower part, sharply angled in the upper part. Length of fruit as preserved, 8 mm., diameter (incomplete), 7.5 mm.

REMARKS. One fruit much abraded from which one locule-cast has fallen. A second has broken leaving the shrunken seed exposed, but no organs or structures are visible upon it. The relationship has not been discovered, but the form and structure of the endocarp wall suggest the family Anacardiaceae, the angled upper dorsal margin of the locule-casts suggesting germination apertures as in *Choerospondias* but longer.

- V.30121 Figured Pl. 21, fig. 42. An abraded endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

- V.30122 A smaller endocarp, 5 mm. long, also abraded and incomplete. *F. M. Wonnacott Coll.* Warden Point, Sheppey.

Family ANACARDIACEAE?

Genus LOBATICARPUM Reid & Chandler, 1933:314

Lobaticarpum variabile Reid & Chandler

Plate 21, figs. 43, 44

1933 *Lobaticarpum variabile* Reid & Chandler, p. 314, pl. 14, figs. 16-20; text-fig. 7.

- V.30123 Figured Pl. 21, fig. 43. A fruit with two well-developed lobes, and scars where two smaller (?immature) ones have broken away. The external surface is better preserved than in any specimen yet seen, it

shows peculiar circular scars or pits perhaps associated with bristles or hairs. Length of fruit, 10.5 mm.; breadth, 18.5 mm. *J. E. Cooper Coll.* Herne Bay, Kent.

- V.30124** Figured Pl. 21, fig. 44. A fruit with two 'floats' preserved, and two scars where two others have been. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30125** Two fruits, now fractured.
- V.30126** A perfect three-loculed fruit with three well-developed 'floats'.
- V.30127** Three fruits, now fractured, and difficult to piece together.
The above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30128** A fruit which must originally have had two well-developed 'floats' (now gone) and two small 'floats' on alternate radii. The specimen is fractured longitudinally and shows carpel wall closely adhering to a locule-cast parallel with which the break has occurred. *J. E. Turner Coll.*
- V.30129** A much abraded fruit, fractured longitudinally, and a second specimen with 'floats' removed and locules exposed.
- V.30130** Two fruits with two and three 'floats' respectively, and a third three-loculed specimen which apparently never had more than one 'float' as two of the locules without 'floats' are still covered by the carbonaceous fruit wall. *E. M. Venables Coll.*
The above from 'Upper Fish Tooth Bed': Bognor, Sussex.

Family ICACINACEAE

Section IODEAE Engler

Genus IODES Blume

Iodes corniculata Reid & Chandler

Plate 22, figs. 1, 2

1933 *Iodes corniculata* Reid & Chandler, p. 323, pl. 14, figs. 34-43.

A few specimens have now been found with the endocarp wall perfectly preserved. In the unworn condition the apex appears much more sharply pointed than in the somewhat abraded specimens originally described. The surface sculpture is also sharper and more prominent.

- V.30131** Figured Pl. 22, fig. 1. An endocarp more or less perfect. Length, 10 mm.; breadth, 6.25 mm.; thickness, 4.25 mm.
- V.30132** Figured Pl. 22, fig. 2. An endocarp, broken to show the relatively small locule-cast within.
- V.30133** Three endocarps with carpel wall preserved.
- V.30134** A locule-cast originally covered by endocarp now breaking away.
All *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

Iodes multireticulata Reid & Chandler

Plate 22, figs. 3-5

1933 *Iodes multireticulata* Reid & Chandler, p. 325, pl. 15, figs. 1-11.

As in the case of *Iodes corniculata* better preserved endocarps with the carbonaceous carpel wall in unworn condition have now been found.

- V.30135** Figured Pl. 22, fig. 3. A well-preserved specimen with carbonaceous endocarp, 4 mm. thick. *F. M. Wonnacott Coll.* Warden Point, Sheppey.
- V.30136** Figured Pl. 22, fig. 4. A good specimen with endocarp preserved. *J. E. Cooper Coll.* Herne Bay, Kent.

- V.30137 Figured Pl. 22, fig. 5. An endocarp broken on one face at the apex, much abraded but having part of the carbonaceous endocarp preserved, the inner layers being much pyritized and adhering to the locule-cast. The remains of the funicular canal can be seen at the apex. Length of endocarp, 9.5 mm.; breadth, 6.75 mm. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30138 Two locule-casts with poorly-preserved remains of endocarp at the apex. The casts are much inflated; they probably belong to this species. *J. E. Cooper Coll.* Herne Bay, Kent.

Iodes sp. (?*I. multireticulata*)

Plate 22, fig. 6

DESCRIPTION. A small endocarp, sub-circular in outline and considerably inflated, is preserved as a locule-cast. It shows the apical placenta and the impressions of the close-set papillae of the locule-lining on the surface. About thirty to forty shallow concave areas separated by rounded ridges can also be seen arranged irregularly. Length and breadth of cast, 4.5 mm., thickness, 3.75 mm.

REMARKS AND AFFINITIES. The papillate locule-lining suggests relationship with *Iodes*. Only two London Clay species are at all comparable, *I. corniculata*, and *I. multireticulata*. *I. corniculata* is distinguished by its greater size and more regular arrangement of the concave areas, *I. multireticulata* by its greater size and less inflated form. The specimen may represent a new species of *Iodes* or a small abnormal endocarp of *I. multireticulata*. This specimen is similar in form and size to a cast from the Bognor Rock described as *Icacinicarya bognovensis* Reid & Chandler (1933: 355, pl. 16, figs. 37, 38) but the two are very differently preserved and do not show the corresponding integuments. The details of structure cannot therefore be compared unless further material should be obtained.

- V.30139 Figured Pl. 22, fig. 6. A locule-cast showing the impression of the papillate locule-lining. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Iodes davisii n. sp.

Plate 22, figs. 7-9

DIAGNOSIS. Endocarp ovate in outline; surface with a network of sunk fibres (not raised as in *I. multireticulata*), Stylar canal without a transverse rimmed aperture or flanking 'horn-like' projections. Length, 12.5 mm.; breadth, 8.5 mm. Length of seed, 6.5 mm.; breadth, 5 mm.

HOLOTYPE. V.30140.

DESCRIPTION. *Endocarp*: Bisymmetric, ovate in outline, lenticular in transverse section. External surface somewhat abraded, covered by remains of a thin black coat (exocarp and mesocarp?). Endocarp light brown (carbonaceous as preserved), smooth, covered by a coarse network of fibres sunk in furrows so as to be approximately level with the surface (Pl. 22, fig. 7). In section the carpel wall appears to be formed of several coats difficult to distinguish clearly in the irregular and worn sections available. A strong, prominent rounded rib along one margin indicates the position of the funicle which entered the locule near the apex. Style terminal and apical, flanked by a pair of small depressions leading into canals occupied by fibres. [Anatomical study of living endocarps of Icacinaceae shows that the fibres arise from the funicle close to the apex. In some genera they are associated with small knob-like projections, as in *Iodes corniculata* Reid & Chandler (1933: 323, pl. 14, figs. 34-36)]. Locule-

lining bearing low, rounded, closely-spaced papillae about 0.025 mm. in diameter as in the genus *Iodes*. Seed solitary, pendulous. Length of endocarp, 12.5 mm.; breadth, 8.5 mm.; thickness (incomplete) estimated at about 5 mm.

Seed: (Pl. 22, fig. 9.) Agreeing in form with the locule, with a sharply defined circular hilar scar at the narrow end (towards the apex of the endocarp), micropyle obscure. Anotropous, with median longitudinal raphe on one of the broad surfaces. Testa poorly preserved, where seen, formed of angular equiaxial cells 0.016 to 0.025 mm. in diameter. A smooth flat median cast parallel with the broad surfaces along the face of which the seed has been split longitudinally, suggests the impression of an embryo with broad flat cotyledons, but the preservation is too poor to show any structural details (cf. Reid & Chandler, 1933, pl. 16, fig. 18). Length of seed (imperfect at chalazal end), 6.5 mm.; breadth, 5 mm.

REMARKS AND AFFINITIES. One specimen. The endocarp is carbonaceous, relatively little pyritized, part of one valve has been broken away, the rest remains firmly adherent to the other valve. A poorly preserved calcite seed-cast is partially surrounded by a film of calcite locule-cast on which the impressions of the papillae (described on the locule-lining) can be detected. The preservation is so unlike that of any of the heavily pyritized Sheppey or Herne Bay fruits, that despite the destruction of labels by enemy action in 1940, there can be little doubt that it represents one of two specimens collected by the late A. G. Davis at the new plant locality of Bawdsey, Suffolk (cf. *Dunstania multilocularis*, V.30435, a somewhat more pyritized fruit, p. 288). Confirmation of this would be afforded by the collection of further similarly preserved material at Bawdsey.

The form of the endocarp and character of the locule-lining indicate relationship with the section Iodeae and the genus *Iodes*. There is a superficial resemblance to *Iodes multireticulata* Reid & Chandler (1933: 325, pl. 15, figs. 1-11; also above, Pl. 22, figs. 3-6), but *I. davisii* is more broadly ovate in outline, and more inflated, while the reticulations of its surface are coarser and less conspicuous and are flush with the surface, not raised as in *I. multireticulata*. Further, the style has no transverse rimmed aperture, and there are no flanking horns or prominences, while the presence of parts of the outer coat suggests that abrasion has not been sufficient to remove all traces of these features had they ever been present. Usually *I. multireticulata* is a smaller form. The species has been named *Iodes davisii* after the finder.

V.30140 Holotype, figured Pl. 22, figs. 7-9. A carbonaceous endocarp with one perfect, and one imperfect valve enclosing a calcite seed-cast. A. G. Davis Coll. Bawdsey, Suffolk.

? *Iodes* sp.

Plate 22, figs. 10, 11

1933 ?*Iodes* sp., Reid & Chandler, p. 330, pl. 15, figs. 16, 17.

A small endocarp, 6.5 mm. long, 6 mm. broad, 4 mm. thick, broadly oval in outline, lentiform in transverse section. The external surface shows an irregular obscure network of rather low rounded ribs; part of the carpel wall is broken away towards the apex on one side, but a film still overlies the locule-cast, and the cell-structure is obscure.

The funicular canal is not visible, there are no conspicuous horns or prominences preserved flanking the style. The seed is not exposed. The appearance is that of Icacinaceae and the size

and form are closely comparable with *Iodes* sp. from Assington (Reid & Chandler, 1933: 330, pl. 15, figs. 16, 17). Neither show the typical papillate locule-lining of *Iodes*, although the relationship appears to be with that genus. The ornamentation is less regular than that of *Iodes multireticulata* and *I. corniculata*, and the size is smaller. *I. minima*, although equally small, is distinguished by its peculiar broad and frequently depressed form. No specific name is given pending the discovery of more and better preserved material.

- V.30141** Figured Pl. 22, figs. 10, 11. An endocarp. Part of the carpel wall is chipped away at the apex on one side. *J. E. Cooper Coll.* Herne Bay, Kent.

Section PHYTOCRENEAE Engler

Genus PALAEOPHYTOCRENE Reid & Chandler, 1933:333

Palaeophytocrene foveolata Reid & Chandler

Plate 22, figs. 12-15

1933 *Palaeophytocrene foveolata* Reid & Chandler, p. 333, pl. 15, figs. 24-32.

- V.30142** Figured Pl. 22, figs. 12, 13. An endocarp worn around the edges in places to show the typical locule-cast within. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30143** Figured Pl. 22, fig. 14. An imperfect locule-cast with fragment of adherent endocarp. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30144** Figured Pl. 22, fig. 15. A much abraded locule-cast. *J. E. Cooper Coll.* Herne Bay, Kent. The first to be recorded from this locality.
- V.30145** Five locule-casts, some with adherent fragments of endocarp. *A. G. Davis Coll.* Warden Point, Sheppey.

Palaeophytocrene ambigua Reid & Chandler

Plate 22, fig. 16

1933 *Palaeophytocrene ambigua* Reid & Chandler, p. 336, pl. 15, fig. 34.

A locule-cast broken at one end. Judging by the small number of pits on the cast and their tendency to be large and funnel-shaped, the specimen should be referred to *P. ambigua* rather than to *P. foveolata*. There was originally a second specimen (not figured) now completely decayed.

- V.30146** Figured Pl. 22, fig. 16. A locule-cast. *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31). There has been one other record of *Palaeophytocrene* (*P. foveolata*) from Division 2 beds.

Genus FABOIDEA Bowerbank emend Reid & Chandler, 1933:340

Faboidea crassicutis Bowerbank

1933 *Faboidea crassicutis* Bowerbank: Reid & Chandler, p. 341, pl. 16, figs. 3-10.

When well preserved the external surface of the endocarp is smooth and shows neither nodules nor corrugation as previously stated (Reid & Chandler, 1933: 343).

- V.30147** An endocarp with carpel wall preserved, although partially detached to show the locule-cast within. *In situ.*
- V.30148** A locule-cast. *In situ.*
The above *A. G. Davis Coll.* Warden Point, Sheppey.

Genus ICACINICARYA Reid & Chandler, 1933:344

Icacinicarya platycarpa Reid & Chandler

Plate 22, fig. 17

1933 *Icacinicarya platycarpa* Reid & Chandler, p. 345, pl. 16, figs. 11-18.

V.30149 Figured Pl. 22, fig. 17. A much abraded endocarp. The worn and broken condition of the wall has exposed two layers of cells at different levels, first equiaxial cells, 0.025 to 0.03 mm. in diameter, within, more or less equiaxial cells with finely digitate outlines about 0.075 mm. in diameter. Length of specimen, 27.5 mm.; breadth, 17.5 mm. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30150 An endocarp with external surface preserved. It may perhaps represent a different species, but is referred to *I. platycarpa* provisionally in the absence of further material. It is more pointed at the ends, and more inflated in section than the normal. The surface has a more conspicuous network of ridges. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

V.30151 A locule-cast. *J. E. Cooper Coll.* Herne Bay, Kent.

Icacinicarya ovoidea Reid & Chandler1933 *Icacinicarya ovoidea* Reid & Chandler, p. 347, pl. 16, figs. 19-21.

V.30152 A cast with adherent remains of endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

Icacinicarya sp. (?*I. ovalis* Reid & Chandler)

Plate 23, fig. 9

1933 ?*Icacinicarya ovalis* Reid & Chandler, p. 348, pl. 16, figs. 22, 23.

DESCRIPTION. *Endocarp*: Bisymmetric, oval in outline, somewhat inflated, lenticular in transverse section. Surface, as preserved, ornamented with a network of low rounded ridges separating numerous irregular pits which are arranged in straight or curvilinear rows. Two longitudinal ridges are particularly prominent, while the pits are longer at one end (upper end?), shorter and more nearly equiaxial at the other. Locule covered by a mere film of endocarp as most of the carpel wall has been abraded. The locule-cast shows a tendency to split marginally. A slight break at one end shows a fragment of seed. The carpel wall appears to be formed, in part at least, of angular equiaxial cells about 0.05 mm. in diameter, but a small fragment shows digitate cells on an inner coat which appears to be the locule-lining. Length of endocarp (as abraded), 15 mm.; breadth, 12 mm.; thickness, 6.5 mm.

Seed: Scarcely visible. Testa where exposed formed of angular equiaxial cells 0.02 mm. in diameter.

REMARKS. One specimen having the size, general character and ornamentation of *I. ovalis*. No outer layer of the testa formed of coarse polygonal cells and having associated strands of fibres has been seen, but the characters of the seed in the specimen described above are scarcely visible at all. In the absence of fuller evidence the specimen is referred doubtfully only to *Icacinicarya ovalis*. Like that species it somewhat resembles *Iodes* but lacks, so far as can be seen, the papillae on the locule-lining. It is larger than the next most comparable species *Iodes multireticulata*.

V.30588 Figured Pl. 23, fig. 9. A much abraded endocarp. *A. G. Davis Coll.* Sheppey.

Icacinicarya nodulifera Reid & Chandler

1933 *Icacinicarya nodulifera* Reid & Chandler, p. 349, pl. 16, figs. 24, 25.

- V.30158** A broken endocarp with seed exposed may be referable to this species. It shows small patches of locule-cast with interlocking cells, a testa of two integuments, the outer formed of coarse inflated cells, the inner of flat quadrangular or polygonal cells 0.025 to 0.03 mm. in diameter. The endocarp is much obscured in places by a film of pyrites, but elsewhere is worn so as to show a network of coarse fibres not exposed in the better preserved endocarps originally described. These fibres may indicate a specific difference, but probably merely point to a difference of preservation and a greater degree of abrasion. The seed corresponds closely in size with that of other specimens of *I. nodulifera*.
- V.30159** A second specimen with seed-cast and fragments of endocarp. The endocarp does not show coarse fibres. The coarse-celled integument of the seed is preserved.
- V.30160** A seed-cast 9.5 mm. long, showing the coarse inflated cells of the outer coat of the testa. The specimen is much abraded and only a film of endocarp is preserved showing coarse interlocking cells. The raphe is obscurely seen, and the chalaza is partially exposed. Probably referable to this species.
- V.30161** A much abraded seed-cast (now broken) showing the raphe and the two coats of the testa, probably referable to this species.
All *ŷ. E. Cooper Coll.* Herne Bay, Kent.

Icacinicarya sp. (?*I. nodulifera* Reid & Chandler)

Plate 22, figs. 20-22

An ill-preserved endocarp and seed-cast in soft pyrites mud (since decayed), bore a marked resemblance in size and character to *Icacinicarya nodulifera*. The external surface showed a coarse network of fibres slightly sunk in furrows but the cell-structure of wall and locule-lining is obscure. The stout funicle is clearly seen within the thickness of the wall along one margin in the upper half of the endocarp; it passes inwards to a sub-apical placenta. Adjacent to the placenta is an oblique apical canal enclosing a fibre which arises from the funicle. Hence it seems probable that this canal represents not the style, but one of the passages which flank it in *Icacinaceae* and which give rise, in certain genera, to paired knob-like projections. The endocarp having split along the marginal suture above, one valve only is perfect, but in the lower part the suture is obscured by adherent remains of the second valve. The seed-cast is ill-preserved but an integument of equiaxial square or angular cells, about 0.02 to 0.025 mm. in diameter, can be seen. Length of endocarp, 11 mm.; breadth, 9.5 mm. Length of seed-cast, 9.5 mm.; breadth, 6.5 mm.; thickness, 4.25 mm.

In spite of the resemblance to *I. nodulifera*, no coarse-celled outer integument has been seen on the seed-cast, perhaps owing to the poor preservation. The specific relationship must therefore be regarded as uncertain.

- V.30162** Figured Pl. 22, figs. 20-22. A valve and seed-cast (the latter decayed). *A. G. Davis Coll.* Warden Point, Sheppey.

Icacinicarya foveolata Reid & Chandler

Plate 22, figs. 18, 19

1933 *Icacinicarya foveolata* Reid & Chandler, p. 350, pl. 16, figs. 26-28.

- V.30153** Figured Pl. 22, figs. 18, 19. An abraded endocarp with funicle exposed. Length (as preserved), 11 mm.; breadth, 8.5 mm.; thickness, 7 mm. It may belong to this species which it resembles, but the characteristic testa has not been seen. It is rather more rounded at the base and apex and less fusiform than *I. ovoidea*, also the locule-cast is more sharply angled. *D. ŷ. Jenkins Coll.* Sheppey.

- V.30154** A locule-cast and endocarp (now detached and fractured). Parts of the locule-cast are chipped away so that the seed within is exposed; the characteristic coats of the testa can be seen. The placenta is just below the apex on the lateral margin, the chalaza has a correspondingly asymmetric position on the seed. *D. J. Jenkins Coll.*
- V.30155** An endocarp showing the digitate cells of the locule-cast. *F. M. Wonnacott Coll.*
Both the above from Warden Point, Sheppey.
- V.30156** A much abraded endocarp which has dehisced into two valves exposing the seed with its two integuments. Also a much worn cast showing the coarse coat of the testa. *J. E. Cooper Coll.*
- V.30157** A locule-cast, possibly referable to this species. The placenta is on the lateral margin, not strictly terminal. *D. J. Jenkins Coll.*
Both the above from Herne Bay, Kent.

Icacinicarya minima Reid & Chandler

Plate 22, figs. 23, 24

1933 *Icacinicarya minima* Reid & Chandler, p. 351, pl. 16, figs. 29-34.

- V.30163** Figured Pl. 20, figs. 23, 24. A smooth sub-globular bisymmetric endocarp; length, 6 mm.; breadth, 5.25 mm.; thickness, 5.25 mm.; with lateral funicle in the plane of symmetry beneath a longitudinal angle or ridge. At the apex the funicle gives off two short divergent branches (Pl. 22, fig. 23). The characters above described show beyond a doubt that the specimen is referable to the family Icacinaceae. Its size, sub-globular form, and smooth surface relate it to *Icacinicarya minima* Reid & Chandler.
- V.30164** Two specimens, one much abraded and now fractured.
- V.30165** A sub-ovoid carpel obscurely bisymmetric having a wall 0.5 mm. thick, formed of fine parenchyma, probably an endocarp of *Icacinicarya minima*.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

?*Icacinicarya minima* Reid & Chandler

An endocarp (now broken), originally sub-globular and about 5.5 mm. in diameter, may be referable to *I. minima* although it appears to have been somewhat smaller than that species (7.5 by 6 mm. in diameter). It is difficult in its broken condition, with the external surface encrusted with pyrites, to be sure of the identity. The thickness of the endocarp as seen in section is 0.5 to 0.6 mm., its structure is obscure but evidently of closely compacted digitate cells. Remains of the large lateral funicular canal are seen in section, and at one point a short length of rounded ridge projecting on one lateral margin indicates its position externally. At one pole the seed shows a circular chalaza, about 0.4 mm. in diameter, from which the testa cells diverge; these cells are quadrangular or equiaxial, slightly convex externally, about 0.008 to 0.01 mm. in diameter. The most interesting feature of the specimen, however, is the mode of preservation of the seed, the cells of the albumen being replaced by calcite for a distance inwards of about 1.5 mm. Hence the specimen looks as if the actual structure of the interior of the seed were preserved; such a condition of preservation is very rare.

- V.30166** A much decayed endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

Icacinicarya reticulata n. sp.

Plate 22, figs. 25-34

DIAGNOSIS. Endocarp and seed usually transversely oval in outline, endocarp with thick embedded fibres forming a network near the surface. Locule-lining of deeply digitate cells

0.1 to 0.2 mm. in diameter. Carpel wall 2 to 3.5 mm. thick. Length of endocarp, 13.5 to 16 mm.; transverse diameter, 15 to 17 mm.; thickness, 11 to 12.5 mm. Testa of two coats, the outer several cells thick of secreting cells 0.1 mm. in diameter, with a few branching fibres; the inner of equiaxial cells 0.025 to 0.03 mm. in diameter. Length of a seed, 8 mm.; transverse diameter, 10 mm.; thickness, 5.5 mm.

HOLOTYPE. V.30167.

DESCRIPTION. *Endocarp*: Woody, bisymmetric, splitting into two valves in the plane of symmetry, one-loculed, with one pendulous seed, usually transversely-oval in outline rarely subcircular, much inflated. Attachment marginal in the plane of symmetry, placenta apical in the same plane, funicle lateral in the plane of symmetry, curving abruptly inwards to the placenta at the apex. Wall having a coarse network of stout fibre strands which in a perfect specimen were so embedded as to be scarcely seen at the surface (Pl. 22, fig. 27). In more abraded endocarps the network was conspicuously exposed (Pl. 22, figs. 25, 26, 28, 29), and in much abraded specimens almost obliterated. The fibres arise at the attachment, one stout marginal strand gives off a pair of stout branches close to the attachment, one branch on each side (Pl. 22, fig. 26), there are also about ten other longitudinal strands which give rise to numerous branches; the branches often arise approximately at right angles and appear to terminate abruptly, perhaps because their distal ends become more deeply embedded in the wall (Pl. 22, fig. 25). Occasionally the branches anastomose. Carpel wall 2 to 3.5 mm. thick, formed of closely compacted angular cells 0.03 mm. in diameter (they may be interlocking cells seen sectioned in various directions). Locule-lining of interlocking, deeply sinuous cells 0.1 to 0.2 mm. in diameter, the interlocking arms of which approximate in length to the diameter of the undivided central part.

Dimensions. (1) Length of an endocarp, 13.5 mm.; greatest transverse diameter, 15 mm.; least transverse diameter (thickness), 11 mm. (2) Length of a broken endocarp, 16 mm.; maximum transverse diameter, 17 mm. (3) Length of an endocarp which had split marginally, 14.5 mm.; greatest transverse diameter, 17 mm.; least transverse diameter, 12.5 mm.; length of locule-cast, 10 mm.; greatest transverse diameter, 12 mm.; thickness, 6 mm.

Seed: Conforming to the locule in shape, transversely oval in outline, inflated, anatropous. Testa with two coats, an outer coat, several cells thick, of coarse equiaxial secreting cells often at least 0.1 mm. in diameter. Some of the seed-casts show associated with this coat on one face, a stout bifurcating median longitudinal raphe (Pl. 22, fig. 31), the branches of which unite again over the marginal chalazal area (Pl. 22, fig. 32) from which numerous branches diverge on to the other surface of the seed. Inside the coarse-celled outer coat is a coat, one cell thick, of equiaxial angular cells, 0.025 to 0.03 mm. in diameter, such as is typical of many Icacinaceae seeds. Length of a seed, 8 mm.; transverse diameter, 10 mm.; thickness, 5.5 mm.

REMARKS AND AFFINITIES. Eighteen specimens. Form, nervation, arrangement of the organs, cell-structure of the endocarp and locule-lining at once indicate Icacinaceae. Thick testas with an outer coat of coarse secreting cells have not so far been found among living representatives, but comparatively few of these have been investigated. A similar coat has been seen in two fossil species, *Icacinicarya nodulifera* Reid & Chandler (1933: 349, pl. 16, figs. 24, 25) and *I. foveolata* (1933: 350, pl. 16, figs. 26-28). The fruits have therefore been referred to the form-genus *Icacinicarya* under the new specific name *reticulata*. Fibres in the outer coat of secreting cells are also found in the testa of *I. nodulifera*.

The species is found most commonly in the division 2 beds of the London Clay exposed at Herne Bay. It is also known from Bognor so that it cannot be regarded as an exclusively division 2 species.

- V.30167** Holotype, figured Pl. 22, figs. 25, 26. An endocarp showing the fibres exposed by abrasion. Near Bishopstone.
- V.30168** Figured Pl. 22, fig. 27. An almost unabraded endocarp unusually subcircular in outline. Owing to its perfect condition the fibres are less exposed than in the majority of specimens but they can be seen obscurely embedded in the wall. Length, 14 mm.; transverse diameter in plane of symmetry, 13.5 mm.; thickness, 10 mm. East Cliff shore.
- V.30169** Figured Pl. 22, figs. 28, 29. An imperfect endocarp showing the thickness of the carpel wall. Near Bishopstone.
- V.30170** Figured Pl. 22, figs. 30–32. An isolated seed showing the branched raphe associated with the outer integument.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30171** Figured Pl. 22, fig. 33. A seed and part of the endocarp embedded in pyrites showing very clearly the fibres of the external surface. *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31).
- V.30172** Figured Pl. 22, fig. 34. A locule-cast showing the funicle embedded in a thin flange of endocarp which surrounds part of the margin and apex of the cast. Maximum thickness of endocarp seen about 2 mm. Length of endocarp including styler canal, 8.5 or 9 mm.; greatest (transverse) diameter, 10 mm. A small part of the locule-cast has chipped away on one side, exposing the coarse equiaxial secreting cells of the outer coat of the testa. The specimen is almost certainly referable to this species and is the first record of its occurrence above Wrigley's division 2 beds (see p. 31). *J. G. Turner Coll.* 'Upper Fish Tooth Bed' Bognor, Sussex.
- V.30173** An endocarp which has split marginally showing the funicle, locule-cast, and partially exposed seed. The testa cells are well preserved. External fibres partially obliterated by abrasion.
- V.30174** An imperfect endocarp showing the external fibres and the locule-cast.
- V.30175** Fragments of a much encrusted endocarp showing funicle and enclosed seed.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30176** Four seed-casts; two detached, two with remains of endocarp.
- V.30177** A seed-cast with remains of a much cracked pyrites locule-cast.
- V.30178** An endocarp fractured to show the seed-cast and two coats of the testa. Much of the structure is obscure, and the network of fibres, if preserved, is concealed by pyrites.
- V.30179** Two battered and abraded seed-casts showing the transversely broad form of the seed and the two characteristic integuments. Probably referable to this species.
The above *J. E. Cooper Coll.* Herne Bay, Kent.

Icacinicarya forbesi n. sp.

Plate 22, figs. 35–40

1933 ?*Icacinicarya* sp. 11, Reid & Chandler, p. 355, pl. 16, fig. 39.

DIAGNOSIS. Endocarp sub-oval in outline, lenticular in transverse section, thick and woody, ornamented originally with a network of ridges. Length, 26 to 28 mm.; breadth, 21 mm.; thickness about 12.5 mm. Wall thick and woody, compact, of equiaxial cells, 0.016 to 0.025 mm. in diameter, with a tendency to radial alignment.

HOLOTYPE. V.30180.

DESCRIPTION. *Endocarp*: Sub-oval in outline, lenticular in transverse section, bisymmetric, splitting into two symmetrical valves, the line of dehiscence indicated by a marginal groove. Style and attachment inconspicuous, at opposite ends of the long axis. Surface ornamented (originally) by a network of broad vertical-sided ridges separated by deep, sunk, oval or elongate areas; on each face there is one particularly conspicuous median longitudinal ridge, and along

one margin short ridges diverging from the suture at about 45° produce a herring-bone pattern (Pl. 22, fig. 37). Apart from this there is no marked arrangement of the surface ornamentation. The walls are thick and woody, formed of closely compacted equiaxial cells, 0.016 to 0.025 mm. in diameter, with some tendency to radial alignment, funicle lateral incurving towards the placenta at the apex (Pl. 22, fig. 40). Locule-lining and seed not preserved. Length of endocarp, 28 mm.; breadth, 21 mm.; thickness, 12.5 mm.

REMARKS AND AFFINITIES. The species is known from two, possibly three specimens, if *Icacinicarya* sp. 11 (Reid & Chandler, 1933: 355, pl. 16, fig. 39) is another worn endocarp, as seems probable from its proportions and thickness. Its length through an error was given as 18 mm. instead of 28 mm. The holotype was at first difficult to interpret owing to the mode of preservation which obscures the original appearance. Thus areas which were originally sunk have become filled with pyrites mud which has hardened so as to form projecting flat-topped masses. The intervening carbonaceous ridges, which were softer and therefore more readily abraded than the pyrites, have been so worn away that they now form furrows between the pyrites masses. It is only where the carpel wall is exposed in section that this structure becomes apparent (cf. Pl. 22, fig. 38). The section of the holotype also shows that owing presumably to incomplete pyritization of the inner layers the wall appears to merge gradually into the amorphous pyrites of the locule-cast. The second endocarp is even more abraded and has not been protected by adherent pyrites masses. It has split into its two valves, one of which is broken. The surface is so worn that the original ornamentation has become obscure (Pl. 22, fig. 39) but the wall shows a peculiar tendency to break into angular chunks. The funicular canal is seen in section (Pl. 22, fig. 40) but is broken at the extreme base and apex, for although the incurving towards the locule is visible, the actual placenta is not preserved. The inner surface of each valve is obscured by a film of pyrites although the valve itself is carbonaceous. The length of the endocarp is 26 mm.; breadth, 21 mm. The relationship to *Icacinaceae* is clear, but as it has not been possible to determine its closer affinities, the species has been referred to the form-genus *Icacinicarya* with the specific name *I. forbesi* after Duncan Forbes the finder of the holotype.

- V.30180 Holotype, figured Pl. 22, figs. 35-38. An endocarp, now fractured to show the structure. *Duncan Forbes Coll.* Sheppey.
- V.30181 Figured Pl. 22, figs. 39, 40. A second endocarp, abraded, and without adherent pyrites masses. The two valves have separated and show part of the funicle. One valve is now broken. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

Icacinicarya echinata n. sp.

Plate 22, figs. 41, 42

DIAGNOSIS. Endocarp pointed-obovate in outline, sharply angled at the margin, lenticular in transverse section. Surface smooth, originally beset with stiff hairs as in *Stizocarya communis*. Hair-bases causing projections on the locule wall. Length (as preserved), 11.5 mm.; breadth, 7.5 mm.; thickness, 5 mm. Testa of equiaxial cells, 0.025 mm. in diameter, carrying branching fibres.

HOLOTYPE. V.30182.

DESCRIPTION. *Endocarp*: Bisymmetric, much compressed and sharply angled at the margin, more or less pointed-obovate in outline, lenticular in transverse section, one-loculed,

one-seeded. Carpel wall woody, now smooth superficially but probably originally beset with stiff hairs, much worn and preserved in small patches only, tending to flake concentrically as the result of decay and fossilization, formed of fine digitate cells the outlines of which are rather confused. Funicle almost completely abraded but the remains of the two associated horn-like processes adjacent to the stylar canal at the apex indicate that it was marginal in the plane of symmetry. Only the inner layers of the endocarp are preserved over most of the surface and show low rounded tubercles (Pl. 22, fig. 42). By analogy with *Stizocarya communis* Reid & Chandler (1933: 336, pl. 15, figs. 35-42; text-fig. 8) they are probably pyrites casts of hair-bearing canals which pierced the endocarp radially but are now worn away except for their swollen bases. These hair-bases apparently cause short projections on the locule-wall as in *Pyrenacantha*, *Chlamydocarya* and *Miquelia*, for on one side of the specimen the locule-cast is itself exposed and shows corresponding shallow depressions (Pl. 22, fig. 41) shallower than the projections in the genera named above. Length of endocarp (as preserved), 11.5 mm.; breadth, 7.5 mm.; thickness, 5 mm.

Seed: Agreeing with the locule in shape, exposed only on one surface by the abrasion of endocarp and locule-cast. Testa formed of equiaxial, usually quadrangular cells 0.025 mm. in diameter. Associated with the coat are branching strands of fibres which sweep transversely across the exposed part of the testa (Pl. 22, fig. 41).

REMARKS AND AFFINITIES. The form and structure relate this specimen to Icacinaceae, the structure of the endocarp with its hair-bases indicates the section Phytocreneae. No comparable living genus has been found, and the fossil has therefore been referred to the form-genus *Icacinicarya* under the name *I. echinata*.

V.30182 Holotype, figured Pl. 22, figs. 41, 42. A much abraded endocarp with seed-cast exposed in a small patch on one side.

V.30183 An imperfect locule-cast with remains of endocarp (now fractured), probably referable to this species. Both *G. F. Elliott Coll.* Warden Point, Sheppey.

Icacinicarya emarginata n. sp.

Pl 22, figs. 43, 44

DIAGNOSIS. Locule-cast subcircular in outline with a conspicuous asymmetric emargination adjacent to the stylar prominence, laterally compressed and sharply angled at the margin, lateral faces convex with a short oblique furrow at the placenta. Locule-wall evenly and finely papillate. Maximum diameter, 7 mm.; diameter at right angles to the plane of symmetry, 4.5 mm.

HOLOTYPE. V.30184.

DESCRIPTION. *Locule-cast*: Subcircular in outline but having an asymmetric emargination at the marginal placenta and, adjacent to it, a marginal prominence marking the position of the stylar canal; somewhat compressed laterally, bisymmetric about a plane including the two major axes, style and sharply angled margin; lateral faces convex, each with a short, oblique, deep furrow at the placenta. Locule-wall evenly and finely papillate with two or three papillae in a length of 0.1 mm. Maximum diameter in the plane of symmetry through the placenta, 7 mm.; diameter at right angles to the plane of symmetry, 4.5 mm.

REMARKS AND AFFINITIES. One locule-cast. The form and papillate locule-lining indicate

relationship with Icacinaceae of the section Iodeae. In the absence of evidence about the external characters of the endocarp, the cast has been referred to the form-genus *Icacinicarya* with the distinct specific name *I. emarginata*.

V.30184 Holotype, figured Pl. 22, figs. 43, 44. A locule-cast. *J. G. Turner Coll. Sheppey.*

Icacinicarya amygdaloidea n. sp.

Pl. 23, figs. 1-4; Text-fig. 28

DIAGNOSIS. Endocarp almond-shaped, flattened lenticular in transverse section, with a marked median rib which dies out gradually towards the apex of the fruit, surface otherwise smooth. Walls close and compact in texture; cells about 0.01 to 0.012 mm. in diameter, not digitate; locule-lining not papillate. Length about 33 to 35 mm.; breadth, 17 to 22 mm. Testa not seen.

HOLOTYPE. V.30185.

DESCRIPTION. *Endocarp*: Bisymmetric, compressed, almond-shaped in outline somewhat variable in length and breadth (Pl. 23, figs. 1, 2), lenticular in transverse section. External surface smooth except for a sub-median longitudinal rib conspicuous at the base and dying out gradually towards the apex. There is no evidence of a network of ribs externally. Funicle marginal, placenta sub-apical, style adjacent to the placenta (Text-fig. 28). Endocarp thin but

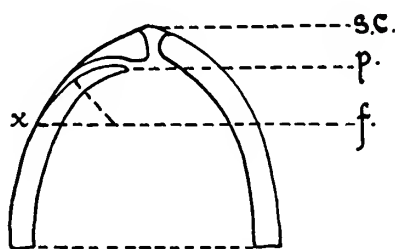


Fig. 28. *Icacinicarya amygdaloidea* n. sp. Interior of upper half of a valve showing the stylar canal (sc) and incurving of the funicle (f) to the sub-apical placenta (p). Below the point (x) where the funicle lay close to the external surface it has been abraded.

woody, close-grained, formed of small cells about 0.01 to 0.012 mm. in diameter which appear to be without digitations. Surface of locule fine-grained, cell-structure obscure. There are no traces of papillae on the locule-lining nor any evidence of an obscure network of coarse ribs as in casts of *Icacinicarya platycarpa*. Seed evidently solitary, pendulous from the apex. Length of endocarp about 33 to 35 mm.; breadth, 17 to 22 mm.

REMARKS AND AFFINITIES. Two carbonaceous specimens which have begun to crack and fracture, both from Herne Bay. The preservation as carbonaceous entities without pyrites infilling is rare among London Clay fossils.

The relationship to Icacinaceae is clearly indicated by the form, position of funicle, placenta, and stylar canal. The specimens are somewhat similar to *I. platycarpa* (p. 223) but are distinguished by their much larger size and less ornamented endocarp, the only ornamen-

tation being a median longitudinal rib on each valve, not an obscure network as in *I. platycarpa*. A new name *Icacinicarya amygdaloidea* is therefore given.

- V.30185 Holotype, figured Pl. 23, figs. 1, 2. A perfect endocarp. *In situ*, west of the pebble ridge, East Cliff shore, Herne Bay, Kent. 60 feet from the foot of the cliff. Perhaps from near the Basement Beds of the London Clay as near the spot was a large quantity of hard sandstone rock from underlying beds.
- V.30186 Figured Pl. 23, figs. 3, 4. An endocarp cracked and broken, showing the inside of the valves at the stylar end with the funicle, placenta and stylar canal. *In situ*, East Cliff shore, Herne Bay, Kent. In clay about 40 feet from the cliff foot and about 200 feet east of the promenade below the village of Beltinge. Both *D. J. Jenkins Coll.*

Icacinicarya mucronata n. sp.

Plate 23, fig. 5

DIAGNOSIS. Endocarp oval in outline, lenticular in transverse section, surface smooth, shining. Locule-cast conspicuously mucronate at the style. Length of locule-cast, 12.5 mm.; breadth, 8.5 mm.; thickness, 4.5 mm.

HOLOTYPE. V.30187.

DESCRIPTION. *Endocarp*: Oval in outline, lenticular in transverse section, bisymmetric, one-loculed, formed of compact parenchyma, surface smooth and shining. Locule-cast mucronate at the apex, the extremity of the mucro (style?) being pierced by a small canal, surface smooth. Length of internal cast including mucro, 12.5 mm.; breadth, 8.5 mm.; thickness, 4.5 mm. Thickness of endocarp wall as preserved, 0.3 mm.

REMARKS AND AFFINITIES. One specimen, a locule-cast with part of the endocarp preserved. The form clearly indicates Icacinaceae. The endocarp is more compressed than *I. foveolata* from Sheppey (Reid & Chandler, 1933: 350, pl. 16, figs. 26-28 and present work p. 224, Pl. 22, figs. 18, 19).

The smooth surface outside and in, and the mucronate locule-cast appear to be distinctive features. The name *Icacinicarya mucronata* has been given.

- V.30187 Holotype, figured Pl. 23, fig. 5. A locule-cast with remains of endocarp. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Icacinicarya glabra n. sp.

Pl. 23, fig. 6

DIAGNOSIS. Endocarp oval in outline, lenticular in transverse section, external surfaces more or less smooth. Length of endocarp, 13.5 mm.; breadth, 7.5 mm.; thickness, 4.5 mm. Length of a second specimen, 14 mm.; breadth, 9 mm.; thickness, 5.25 mm. Resembling *Icacinicarya platycarpa* in form but much smaller and with smoother surface.

HOLOTYPE. V.30188.

DESCRIPTION. *Endocarp*: Oval in outline, lenticular in transverse section, bisymmetric, external surface smooth (somewhat obscured by an incrustation of pyrites). Funicular margin not noticeably broader than the other in the present somewhat abraded condition but the funicle and its canal have apparently been worn away. Former position of the funicle along one margin indicated by a slight indentation and circular scar close to the apex in one specimen

(Pl. 23, fig. 6). Thickness of endocarp wall as preserved, 0.4 mm.; the outer layers are carbonized and flake off as an outer shell, the inner layers adherent to the locule-cast are much pyritized; cells, where clearly seen, equiaxial, about 0.012 to 0.016 mm. in diameter. Length of endocarp, 13.5 mm.; breadth, 7.5 mm.; thickness, 4.5 mm. Length of second specimen, 14 mm.; breadth, 9 mm.; thickness, 5.25 mm.

REMARKS AND AFFINITIES. One endocarp and one doubtful specimen. In the former the carbonaceous outer layers suggest that the specimen was found *in situ*. The smooth-walled flattened endocarp recalls the much larger species *Icacinicarya platycarpa* Reid & Chandler (1933: 345, pl. 16, figs. 11-18; length, 16 to 26 mm.). It is possible that the species has been found before and referred with others to *Icacinaceae*, Genus? on account of the lack of conspicuously distinctive characters.

V.30188 Holotype, figured Pl. 23, fig. 6. A smooth almond-shaped endocarp.

V.30189 A slightly rugose endocarp which agrees fairly closely with the holotype and may possibly belong to this species in spite of the less smooth surface and a somewhat more inflated form.

Both the above *A. G. Davis Coll.* Warden Point, Sheppey.

Icacinicarya sp.

Plate 23, figs. 7, 8; Text-fig. 29

DESCRIPTION. *Endocarp*: Sub-oval in outline, bisymmetric, somewhat inflated on the broad surface but sharply angled around the margin in the plane of symmetry, approximately lenticular in transverse section. Surface dimpled all over more or less evenly, formed of closely interlocking cells with sinuous walls, their outlines being rather obscure, their diameter 0.016 to 0.025 mm. Thickness of endocarp wall about 0.2 mm. at the angled margin, 0.3 mm. at the middle of the broad surfaces. In section the sinuous cells of the surface layer can be seen to be elongate at right angles to the surface, there is also an inner layer of similar elongate but somewhat coarser cells, the ends of the two layers more or less dovetailing into one another (Text-fig. 29); the cells appear to be spirally thickened; the inner layer is formed of cells



Fig. 29. *Icacinicarya* sp. Cell structure of wall in section.

about 0.15 mm. long and from 0.05 to 0.1 mm. broad. Inner lining of endocarp of rounded or angular equiaxial cells, 0.025 to 0.05 mm. in diameter, with shining black contents, much flattened at right angles to the surface of the endocarp. Seed solitary, pendulous, testa where seen near the attachment, of rounded or angular convex cells 0.025 mm. in diameter. Raphe longitudinal on the broad face, hilum a circular subterminal scar. Length of endocarp, 10 mm. (slightly incomplete at the apex); breadth, 8.5 mm.; thickness, 5 mm.

REMARKS AND AFFINITIES. One endocarp from which the wall is partly chipped away exposing the locule-lining and seed. The relationship appears to be with Icacinaceae; the outer part of the endocarp and all trace of the funicle have been abraded.

V.30190 Figured Pl. 23, figs. 7, 8; Text-fig. 29. An endocarp with wall partly chipped away showing the locule-lining and seed. *J. G. Turner Coll.* Sheppey.

Icacinicarya sp.

Pl. 23, fig. 10

A bisymmetric endocarp, subcircular in outline with remains of a much abraded carpel wall formed in part of digitate cells is clearly referable to the family Icacinaceae. The endocarp is compressed at right angles to the plane of symmetry so as to be lenticular in transverse section. A longitudinal ridge arises at the base and runs medianly for a short distance on each face. The placenta is sub-apical in the plane of symmetry. The specimen is somewhat larger than *Iodes corniculata* or *I. multireticulata*, and so far as its abraded condition affords evidence, the ornamentation of the surface is not reticulate. In the absence of fuller knowledge it is merely named *Icacinicarya* sp. Length of endocarp, 9 mm.; breadth, 7.5 mm.

V.30191 Figured Pl. 23, fig. 10. An abraded endocarp. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30192 A similar abraded endocarp with remains of funicle. *G. F. Elliott Coll.* Sheppey.

ICACINACEAE?

V.30193 A broken endocarp. One fragment shows the funicular canal at its point of entry into the locule. All show external openings of canals which pierce the wall and produce small tubercles on the locule surface. The specimen is less inflated than *Stizocarya communis* (Reid & Chandler, 1933: 336, pl. 15, figs. 35-42; text-fig. 8), but it is too imperfect for satisfactory description. *A. G. Davis Coll.* *In situ*, 20 feet above high water mark, west of Royal Oak, Minster, Sheppey.

V.30194 An oval seed or endocarp about the size of *Iodes multireticulata* (p. 219), probably too poorly preserved for determination. *A. G. Davis Coll.* 6 feet above high water mark, west of Eastchurch gap, Sheppey. *In situ*.

Family SAPINDACEAE

Genus PALAEALLOPHYLUS Reid & Chandler, 1933:359

Palaeallophylus rotundatus Reid & Chandler

1933 *Palaeallophylus rotundatus* Reid & Chandler, p. 362, pl. 17, figs. 8-12; text-fig. 9d.

V.30195 A seed with internal cast. *D. J. Jenkins Coll.* Herne Bay, Kent.

V.30196 Two seed-casts with remains of testa. *J. E. Cooper Coll.* Herne Bay, Kent.

Palaeallophylus minimus n.sp.

Plate 23, figs. 11-14; Text-fig. 30

1933 *Sapindospermum* sp. 4, Reid & Chandler, p. 373, pl. 18, figs. 12-14.

DIAGNOSIS. Seed oblong-ovoid, somewhat laterally compressed, fold of inner cotyledon rotated from the hypocotyl through an angle of about 180°; chalazal band narrow and parallel-

sided; radicle short and tapering. Length of seed about 6 to 7 mm.; breadth in plane of symmetry, 4.5 to 6.5 mm.; thickness at right angles to plane of symmetry, 4 to 5 mm.

HOLOTYPE. V.30197.

DESCRIPTION. *Seed*: oblong-ovoid, somewhat laterally compressed, slightly truncate at the hilar scar which is gibbous in outline with its straight margin abutting on the radicle. Testa largely abraded, represented in one specimen by a thin film which obscures to some extent the form of the radicle and cotyledons, and in another by irregular thick patches. Chalaza marked by a narrow transverse band on the opposite side to the radicle. Embryo curved, radicle rather short, tapering, the proximal end marked by a pair of small auricles at the point of origin of the outer cotyledon (Pl. 23, fig. 12; Text-fig. 30). Cotyledons folded together as in *Palaeallophylus* (Reid & Chandler, 1933, text-fig. 9c, d) each also folded sharply upon itself transversely.

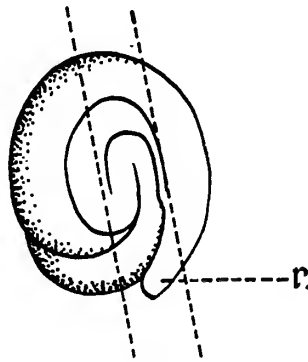


Fig. 30. *Palaeallophylus minimus* n. sp. Seed without testa showing the radicle (r) and cotyledons folded together. The dotted lines show the angle through which the cotyledons have been rotated by the folding.

The fold of the inner cotyledon is rotated through an angle of about 180° from the hypocotyl. Length of an abraded seed in plane of symmetry, 6 mm.; breadth in same plane, 4.5 mm.; thickness at right angles to this plane, 4 mm. Length of specimen with thick patches of testa preserved, 7 mm.; breadth, 7 mm.; thickness, 5 mm. Length of holotype, 6.5 mm.; breadth, 6.5 mm.; thickness, 4 mm.

REMARKS AND AFFINITIES. Four seeds in varying states of abrasion including the specimen described in 1933 as *Sapindospermum* sp. 4. (Reid & Chandler, 1933: 373, pl. 18, figs. 12-14.) They are referred to the genus *Palaeallophylus* as a distinct species *P. minimus*, distinguished by its small size, compressed oblong form and the large angle through which the inner cotyledon is rotated from the hypocotyl. The radicle is shorter than in *P. ovoideus*, less slender and less suddenly broadening than in *P. rotundatus*. The specimen previously recorded was from Minster, Sheppey; the new material comes from Herne Bay, Kent, thus extending the range in time within the London Clay of this species.

V.30197 Holotype, figured Pl. 23, figs. 11, 12. A seed-cast showing the chalaza and folding of the cotyledons also the form of the radicle. Length and breadth in plane of symmetry, 5 to 6.5 mm.; thickness at right angles to plane of symmetry, 4 mm.

- V.30198 Figured Pl. 23, figs. 13, 14. A second seed-cast with adherent patches of thick testa. The inner layers of the testa are preserved over the radicle.
Both the above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30199 A seed-cast. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus PALAEAELECTRYON Reid & Chandler, 1933:363

Palaeaelectryon spirale Reid & Chandler

1933 *Palaeaelectryon spirale* Reid & Chandler, p. 363, pl. 17, figs. 13-19; text-fig. 11.

- V.35313 A seed with part of the testa preserved, the hilar scar is broken away. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus CUPANOIDES Bowerbank emend Reid & Chandler, 1933:364

?*Cupanoides tumidus* Bowerbank

- V.30200 A fruit fractured to show the locule-casts, probably referable to this species. *J. E. Cooper Coll.* Herne Bay, Kent.

Cupanoides grandis Bowerbank

1933 *Cupanoides grandis* Bowerbank: Reid & Chandler, p. 368, pl. 17, figs. 23-33; text-fig. 12.

- V.30201 An abraded fruit (now fractured) with locule-casts exposed. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Genus SAPINDOSPERMUM Reid & Chandler, 1933:370

Sapindospermum jenkinsi Reid & Chandler

Plate 23, figs. 15-24; Text-fig. 31

1933 *Sapindospermum jenkinsi* Reid & Chandler, p. 371, pl. 18, figs. 6-8.

AMENDED DIAGNOSIS. Seed sub-ovoid to sub-globular, diameter 13 to 14 mm. Embryo sub-ovoid, radicle broad, rather more than half the length of the embryo, cotyledons fleshy, not coiled but superposed; transverse furrow at the base of the radicle straight. Greatest diameter in plane of symmetry up to 13.5 mm.; diameter in plane of symmetry at right angles to the preceding, 8.5 to 11 mm.; diameter at right angles to plane of symmetry, 8 to 10.5 mm.

HOLOTYPE. V.22769.

DESCRIPTION. *Seed*: Sub-ovoid to sub-globular, bisymmetric about a longitudinal plane through the radicle, somewhat laterally compressed, hilar scar sub-oval, truncate where the radicle abuts against it, 8 by 6 or 7 mm. in diameter, elongate in the plane of symmetry. Testa usually ill-preserved and imperfect, several coats thick, the outer coat columnar in section, about 0.05 to 0.1 mm. thick, formed superficially of equiaxial cells 0.02 mm. in diameter; within is a mass of radially compressed polygonal cells, 0.03 mm. thick; the lining of the testa shows a network of branching and anastomosing fibres. Length and breadth of seed, usually incomplete, estimated at about 13 to 14 mm.

Seed-cast (embryo): Large, exalbuminous, radicle rather more than half the length of the seed-cast and about as long as broad, cotyledons thick and fleshy lying one upon the other, not coiled, the groove which delimits them being continued along the radicle (Pl. 23, figs. 15, 16; Text-fig. 31A), transverse furrow, delimiting the radicle from the upper cotyledon, straight, conspicuous (Pl. 23, figs. 16, 18; Text-fig. 31B).

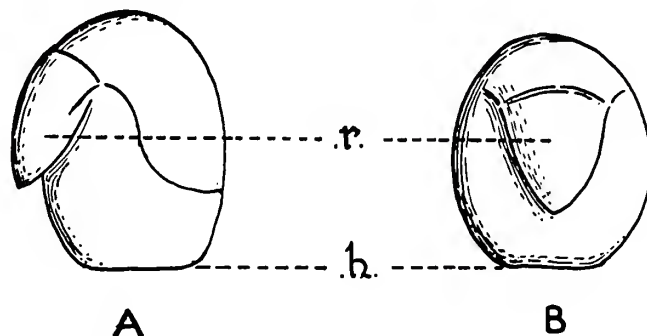


Fig. 31. *Sapindospermum jenkinsi* Reid & Chandler. A, a seed with testa removed showing radicle (*r*). B, the same looking on to radicle. The position of the hilar scar is indicated at (*h*).

Length of embryo in plane of symmetry, 9 to 13.5 mm.; diameter at right angles to this in the plane of symmetry, 8.5 to 11 mm.; diameter at right angles to plane of symmetry, 8 to 10.5 mm.

REMARKS AND AFFINITIES. Sixteen specimens in various states of abrasion. Some are seed-casts representing the embryo. In others the form of the embryo is obscured by the adherent inner layers of the testa; in some the full thickness of the testa is preserved in a few patches only.

In describing this species from a single specimen, Reid & Chandler (1933: 371) stated that it differed from *S. ovoideum* (also based on a single specimen) in its somewhat larger size, and in the straight transverse groove delimiting the radicle from the upper cotyledon. The additional material of *S. jenkinsi* now available establishes as a constant feature for this species the straight transverse groove described, but shows that considerable variation of size of seed may occur. The original description has also been amended in regard to the length of the radicle, for perfect specimens show that it is rather longer than half the length of the embryo.

V.30202 Figured Pl. 23, figs. 15, 16. A seed-cast with testa adhering around the radicle.

V.30203 Figured Pl. 23, figs. 17, 18. A seed-cast, with radicle somewhat puckered, showing the cotyledons unusually clearly. Also detached remains of testa.

V.30204 Figured Pl. 23, fig. 19. A somewhat distorted seed-cast.

V.30205 Figured Pl. 23, figs. 20, 21. A seed-cast with adherent inner layers of testa which partly conceal the cotyledons.

All the above *D. J. Jenkins Coll.* Herne Bay, Kent.

V.30206 Figured Pl. 23, fig. 22. A seed with part of the testa, especially the inner layers, preserved. Remains of the hilar scar, much encrusted with pyrites, are about 5 mm. in diameter. The form of the cotyledons is obscure partly owing to the poor preservation, and partly owing to adherent testa. The straight transverse furrow at the base of the radicle is clear. Length and breadth of radicle about 6 mm. In spite of the poor preservation there can be little doubt that the specimen should be referred to *S. jenkinsi*; otherwise recorded only from Herne Bay. *D. Ramwell Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

- V.30207 A seed-cast with remains of hilar scar and testa at the base.
- V.30208 Two seeds, one is broken, but the radicular half remains embedded in the testa. The second is a somewhat crushed seed-cast with remains (now detached) of testa.
- V.30209 A seed-cast with adherent remains of inner layers of testa.
- V.30210 A somewhat imperfect seed. East Cliff shore.
- V.30211 A seed-cast covered by the adherent inner layers of the testa. East Cliff shore.
- V.30212 A seed with inner coats of testa preserved, hilar scar missing. Swale Cliff.
- V.30213 A seed-cast with remains of testa embedded in pyrites. Swale Cliff.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30214 Two seed-casts, one much distorted. Both show remains of testa in which an outer and an inner coat can be distinguished.
- V.30215 A seed with hilar scar and testa partially preserved, the cast of the radicle and cotyledons is exposed.
The above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30216 Figured Pl. 23, figs. 23, 24. An ovoid seed-cast with only a few adherent patches of testa, is almost certainly an ill-developed specimen of *Sapindospermum jenkinsi*. The small radicle terminates at about the middle of the seed and occupies only about one-third of its length; it is delimited from the upper cotyledon by a slight furrow and is closely appressed to the lower cotyledon. The cotyledons lie simply above one another. The junction between them shows clearly in Pl. 23, fig. 24. Length of seed, 10.75 mm.; breadth in plane of symmetry, 7 mm.; breadth at right angles to plane of symmetry, 7 mm. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Sapindospermum revolutum n. sp.

Plate 23, figs. 25-30; Text-fig. 32

DIAGNOSIS. Seed sub-ovoid; radicle more than half as long as the embryo, transverse furrow delimiting it from the cotyledons, straight, cotyledons superposed, the upper short, simple, the lower bent once upon itself away from the radicle. Greatest diameter of a large seed in plane of symmetry (as preserved but abraded), 13 mm.; breadth in same plane, 12 mm.; maximum breadth at right angles to plane of symmetry, 9 mm.

HOLOTYPE. V.30217.

DESCRIPTION. *Seed*: Sub-ovoid, more or less bisymmetric about a median plane through the radicle, showing some slight degree of lateral compression. Testa thick (partly preserved only), external coat columnar in section, 0.1 mm. thick, columns about 0.03 mm. broad. Within is a thicker coat about 0.5 to 0.7 mm. thick. Hilum obscure owing to abrasion, but sub-oval in outline, the longer axis in the plane of symmetry, truncate where the radicle abuts against it, measuring about 7 by 6 mm. Maximum length of seed in plane of symmetry, 13 mm.; breadth in same plane, 12 mm.; maximum breadth at right angles to plane of symmetry, 9 mm.

Seed-cast (= embryo): Corresponding with the seed in general form. Radicle broad, about as long as it is broad, extending for more than half the length of the seed-cast, delimited from the upper cotyledon by a straight transverse line (groove or ridge according to preservation). Cotyledons thick and fleshy, the grooves delimiting them from one another being continued down the sides of the radicle. The upper cotyledon varies considerably in length but is always short, simple, truncated abruptly at the distal end where it abuts against the truncated distal end of the reflexed lower cotyledon which is bent once on itself away from the radicle (Pl. 23, figs. 26, 30; Text-fig. 32).

Greatest diameter of seed-cast in the plane of symmetry, 11 mm.; diameter in plane of symmetry at right angles to this, 10 mm.; breadth at right angles to plane of symmetry, 9 mm.

REMARKS AND AFFINITIES. Five seed-casts, one with considerable remains of testa now chipped loose. The type of folding shown by the lower cotyledon has not been matched in any

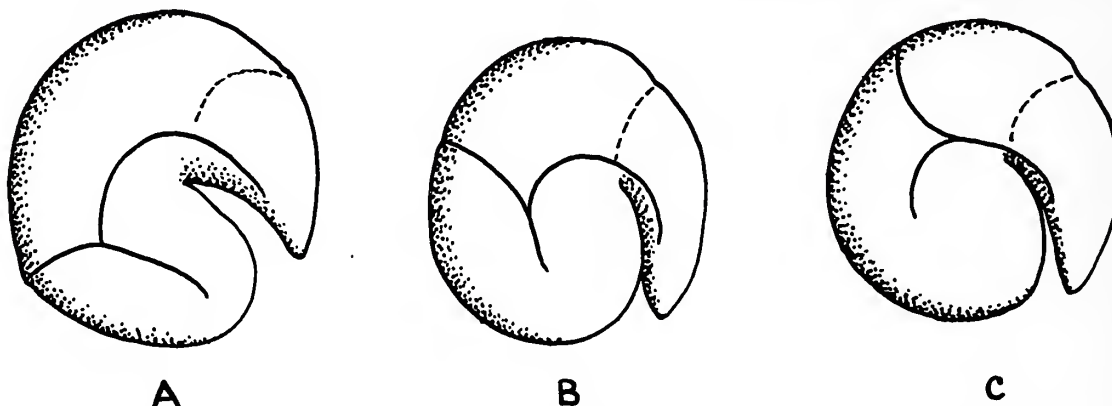


Fig. 32. *Sapindospermum revolutum* n. sp. Diagrammatic drawings of three seeds showing the radicle and cotyledons.

living seeds seen. In the majority of comparable genera the lower cotyledon if merely bent once, is bent on itself towards, not away from, the radicle. In a few genera such as *Serjania* in which the folding of the lower cotyledon is away from the radicle, a wedge-like prolongation of the upper cotyledon projects between the two folds. The folding of the cotyledon is peculiar whether among living or fossil seeds.

V.30217 Holotype, figured Pl. 23, figs. 25-27; Text-fig. 32. A seed-cast.

V.30218 Figured Pl. 23, figs. 28-30. A seed-cast with remains of hilum and testa.

V.30219 A seed-cast.

The above *D. J. Jenkins Coll.* Herne Bay, Kent.

V.30220 A seed with considerable remains of testa (now partially detached) and a battered seed-cast. *J. E. Cooper Coll.* Herne Bay, Kent.

Sapindospermum cooperi n. sp.

Plate 23, figs. 31-33; Text-fig. 33

DIAGNOSIS. Seed sub-ovoid, relatively long and narrow as compared with *S. jenkinsi*, hilar scar oblique, radicular pocket pointed-obovate as seen from the dorsal side of the seed, tapering rather abruptly, delimited by slightly convex lateral margins; ventral surface of seed faceted longitudinally. Transverse furrow on embryo delimiting radicle from cotyledons straight. Greatest diameter of seed in plane of symmetry, 14 mm.; diameter in plane of symmetry at right angles to the preceding, 8 mm.; diameter at right angles to plane of symmetry, 10 mm.

HOLOTYPE. V.30221.

DESCRIPTION. *Seed*: Sub-ovoid, obliquely truncate at the hilar end by a sub-circular hilar scar (5 mm. in diameter in the plane of symmetry of the seed, 6 mm. in diameter at right angles to this plane) so that the ventral face of the seed is considerably shorter than the dorsal (Pl. 23, fig. 31); convex on the dorsal radicular face, having a median longitudinal angle on the ventral face which produces two equal facets suggesting that the seed was derived from a three-

carpelled fruit with single-seeded locules. Surface with a few irregular rugosities or convolutions, perhaps an original feature, or possibly due to contraction and shrinkage in fossilization. Testa formed superficially of fine rectangular longitudinally aligned cells (0.05 mm. in diameter); in section showing two distinct coats, an outer columnar coat about 0.1 to 0.15 mm. thick, and an inner coat of radially compressed cells which are flattened, oval or rounded and about 0.03 mm. in diameter as seen in surface view. Radicular pocket producing on the

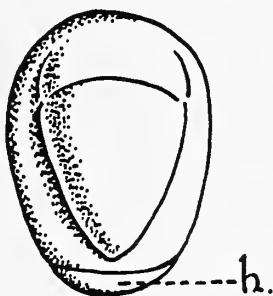


Fig. 33. *Sapindospermum cooperi* n. sp.
Seed looking on to the radicle. *h.* represents
the hilar scar.

external surface of the seed, a clearly defined, sharply-pointed, scarcely convex-sided, obovate area which extends from the margin of the hilar scar to the apex of the seed (Pl. 23, fig. 33). The pocket is delimited superficially by a deep furrow. Lining cells of the testa rectangular, longitudinally aligned over the radicle, about 0.01 mm. in breadth. Length of seed, 14 mm.; dorsiventral diameter in plane of symmetry, 8 mm.; transverse diameter parallel with the breadth of the radicle (i.e. at right angles to the plane of symmetry of the seed), 10 mm.

Seed-cast (embryo): Large, exalbuminous, radicle less than half the length of the complete seed, delimited from the cotyledons by a transverse groove, broad near the groove, tapering rather abruptly to the almost straight-sided tip; cotyledons obscured by testa. Length of radicle beyond delimiting groove about 5.5 mm.; breadth (at right angles to plane of symmetry of seed) about 5.5 mm.; maximum diameter (length) of embryo about 10.5 mm.

REMARKS AND AFFINITIES. One seed, now fractured in an attempt to expose the embryo. Unfortunately the internal cast was hollow so that it shattered and only part of the junction of radicle and cotyledons was displayed. The seed is distinguished from *Sapindospermum jenkinsi*, which perhaps most resembles it among fossil species, by its relatively longer narrower form, by the narrow, almost straight-sided radicular pocket, by the faceting of the ventral surface, and by the obliquity of the hilar scar (longest at right angles to the plane of symmetry of the seed). If the rugosities of the surface are also an original feature, they too constitute a distinctive character.

V.30221 Holotype, figured Pl. 23, figs. 31-33; Text-fig. 33. A seed, now fractured in an attempt to expose the embryo. *J. E. Cooper Coll.* West side of town, Herne Bay, Kent.

Sapindospermum davisii n.sp.

Plate 23, figs. 34-38; Text-fig. 34

DIAGNOSIS. Sub-ovoid, somewhat laterally flattened. Radicle short, broad, only about one-third the length of the seed, transverse furrow delimiting radicle from cotyledons straight.

Cotyledons superposed, not folded. Length of seed-cast, 14 mm. in plane of symmetry; diameter in same plane, 12 mm.; diameter at right angles to plane of symmetry, 10 mm. Length of radicle about 4 mm.; breadth about 6.5 mm.

HOLOTYPE. V. 30222.

DESCRIPTION. *Seed*: Sub-ovoid, bisymmetric about a plane which passes through the median line of the radicle, somewhat laterally flattened. Hilar scar sub-oval, truncate where it abuts against the radicle, measuring about 10 by 7.5 mm. in diameter (but exact limits obscure owing to pyritisation), long axis in plane of symmetry. Length of seed in plane of symmetry, 19 mm.; diameter in same plane at right angles to greatest length, 14 mm.; breadth at right angles to plane of symmetry, 12 mm.

Seed-cast (embryo): Sub-ovoid, laterally compressed. Radicle short, broad, only about one-third the length of the seed, triangular, transverse furrow delimiting radicle from cotyledons straight (Pl. 23, fig. 37; Text-fig. 34A), length about 4 mm.; breadth about 6.5 mm. Cotyledons simple, superposed not folded (Pl. 23, figs. 34, 36; Text-fig. 34B). Length of seed-cast, 14 mm.; diameter at right angles in plane of symmetry, 12 mm.; diameter at right angles to plane of symmetry, 10 mm.

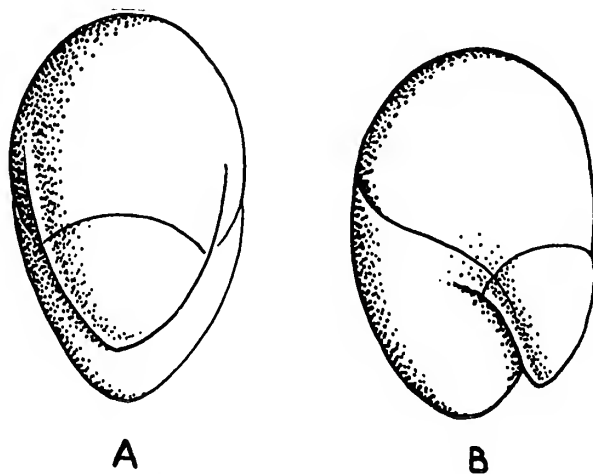


Fig. 34. *Sapindospermum davisi* n. sp. A, seed with testa removed showing radicle. B, the same with radicle turned to the right showing the cotyledons.

REMARKS AND AFFINITIES. Two seeds. In one the whole thickness of the testa seems to be preserved but is much shrivelled (Pl. 23, fig. 38). In the other the inner layers of the testa are preserved over most of the specimen, and in parts, notably over the hilum, the outer layers are preserved as well. Subsequent chipping of the second specimen exposed the radicle and cotyledons. The seeds differ from *Sapindospermum jenkinsi* (p. 235) in their larger dimensions, in the greater degree of lateral compression, and in the small, short, triangular radicle. The embryo is of a type common in the family, e.g. in species of *Guioa*, *Cupaniopsis*, *Paullinia*, *Thraulococcus*, *Smelophyllum*, *Lecaniodiscus*, *Xerospermum*, etc.; but all comparable living seeds examined have a smaller, narrower radicle. No attempt has therefore been made to relate these seeds to a living genus but they have been referred to the form-genus *Sapindospermum* as *S. davisi*, after the finder.

- V.30222 Holotype, figured Pl. 23, figs. 34-37; Text-fig. 34. A seed-cast originally covered in part by the inner layers of the testa which have now been chipped away to show the radicle and cotyledons.
- V.30223 Figured Pl. 23, fig. 38. A seed with the complete thickness of the testa preserved, but much shrivelled and puckered.
- Both *A. G. Davis Coll.* Warden Point, Sheppey.

Sapindospermum sp.

Plate 23, figs. 39-41; Text-fig. 35

DESCRIPTION. *Seed*: Truncate-obovate in outline, rounded above, truncate at the hilar end, bisymmetric about a plane through the middle of the radicle, somewhat laterally flattened and obscurely angled over the radicle in the plane of symmetry (Pl. 23, figs. 39, 40). Hilar scar oval, elongate in the plane of symmetry, 3.25 by 2 mm. in diameter. Radicle forming an angled tapering protuberance abutting on the hilum, broader on one side than on the other (contrast Text-fig. 35A, C). Testa black and shining, formed of angular equiaxial cells about 0.016 mm.

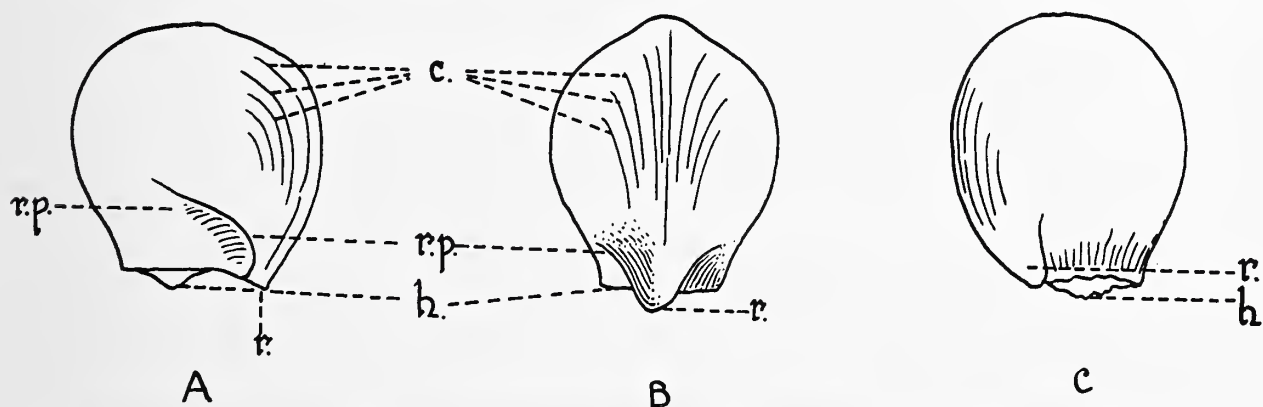


Fig. 35. *Sapindospermum* sp. Diagrammatic drawings of seed with testa. A and C, opposite sides. B, same looking on to radicle. *c.*, cells aligned in rows causing puckering or ridges; *h.*, hilum; *r.*, radicle; *rp.*, ridge delimiting radicular pocket.

in diameter, columnar in section. Where this outer coat has flaked away coarser rounded cells can be seen arranged over the radicle in longitudinal ridges, with larger cells on ridges, and smaller cells in furrows between them. Large cells about 0.03 mm. in diameter. Length of seed, 6 mm.; breadth, 5.75 mm. in the plane of symmetry; 5 mm. at right angles to the plane of symmetry.

REMARKS. This isolated seed differs in form from other detached seeds described. The evidence for determining its relationship is scanty owing to the presence of the testa which hides the radicle and cotyledons. The form and size of the seed do not exclude the possibility of reference to a species of *Cupanoides* (see Reid & Chandler, 1933: 366, 368, 369), a genus with somewhat laterally compressed seeds and large prominent radicles. Without more material a closer determination of relationship cannot be attempted.

- V.30224 Figured Pl. 23, figs. 39-41; Text-fig. 35. A seed with testa preserved. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

Sapindospermum sp.

Plate 24, figs. 1, 2

DESCRIPTION. A pyrites nodule, sub-globular in form, and about 12 to 14 mm. in diameter in which several seeds are embedded, may represent the infilling of a fruit or berry enclosing its seeds. Four seeds are clearly visible at the surface or in section and others may be preserved in the unfractured pyrites. Two of the seeds are shown in Pl. 24, fig. 1, and the uppermost of the two is more highly magnified in Pl. 24, fig. 2. The seeds are oblong ovoid, somewhat laterally compressed, the hilar scar is not seen, the testa is abraded over the radicle in three seeds but its inner layers at least remain over the cotyledons thereby concealing their form and folding. The radicle is long and tapering, its distal end curving around and partially embracing the cotyledons at the base of the seed. Estimated length of seed about 5 mm.; thickness in the plane of compression about 2 mm.; thickness at right angles to this plane about 3.5 mm.

The seeds appear to be somewhat smaller than those of *Palaeoallophylus minimus* (p. 233, Pl. 23, figs. 11-14) and there are slight but very obscure indications of a different arrangement of the cotyledons. The form of the perfect seed appears to distinguish it from the medianly inflated and somewhat marginally angled seed of *Sapindospermum* sp. (V.30224, cf. Pl. 23, figs. 39-41).

In the absence of further information it does not seem possible to give a satisfactory specific diagnosis. Hence the species can only be recorded as *Sapindospermum* sp.

V.30589 Figured Pl. 24, figs. 1, 2. A pyrites nodule (perhaps the cast of a fruit), now fractured. It shows four seeds with testa abraded over the radicle. *W. N. Croft Coll.* Herne Bay, Kent.

Family SABIACEAE

Genus MELIOSMA Blume

Meliosma jenkinsi Reid & Chandler

Plate 24, figs. 3-7

1933 *Meliosma jenkinsi* Reid & Chandler, p. 375, pl. 18, figs. 16-23; text-fig. 13.

V.30225 Figured Pl. 24, fig. 3. A specimen with endocarp preserved showing the somewhat ornate fluted surface. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

V.30226 Figured Pl. 24, figs. 4, 5. An endocarp. Dorsiventral diameter, 8 mm.; maximum diameter in plane of symmetry, 10 mm.

V.30227 Figured Pl. 24, fig. 6. A somewhat distorted and obscure locule-cast (now fractured) slightly smaller than is usual in this species. Dorsiventral diameter, 7 mm.; diameter in plane of symmetry at right angles to the above, 8 mm.; diameter at right angles to plane of symmetry, 7.75 mm. Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30228 Figured Pl. 24, fig. 7. A large locule-cast. *A. G. Davis Coll.* Frinton, Essex.

V.30229 A well-preserved endocarp. *D. J. Jenkins Coll.* Warden Point, Sheppey.

V.30230 Two seed-casts, one with adherent remains of locule-cast. *A. G. Davis Coll.* Warden Point, Sheppey.

Meliosma cantiensis Reid & Chandler

Plate 24, figs. 8, 9

1933 *Meliosma cantiensis* Reid & Chandler, p. 376, pl. 18, figs. 24-30.

- V.30231 Figured Pl. 24, fig. 8. A worn locule-cast with remains of carpel wall showing elongate interlocking cells and remains of the plug of the endocarp. The specimen is imperfect on the right.
- V.30232 Figured Pl. 24, fig. 9. A well-preserved and undistorted endocarp.
- V.30233 A much distorted and abraded locule-cast with remains of the ventral plug.
- V.30234 A specimen with endocarp and locule-cast partly chipped away to show the seed within. Dorsiventral diameter in plane of symmetry, 4.5 mm.; maximum length in same plane, 6 mm.; breadth (somewhat compressed) at right angles to plane of symmetry, 3.5 mm.
- V.30235 Three specimens of which one is a locule-cast and another a seed-cast.
- V.30236 Two large seed-casts with remains of endocarp. Probably referable to this species.
All the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30237 Two casts of endocarps which had begun to split in the plane of symmetry. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30238 Five endocarps or locule-casts. *J. E. Cooper Coll.* Herne Bay, Kent.

Meliosma sheppeyensis Reid & Chandler

Plate 24, fig. 10

1933 *Meliosma sheppeyensis* Reid & Chandler, p. 378, pl. 18, figs. 31-33.

- V.30239 Figured Pl. 24, fig. 10. An endocarp. Dorsiventral diameter, 3.75 mm.; maximum diameter in same plane, 4 mm.; breadth at right angles to plane of symmetry, 4 mm.
- V.30240 Another specimen. Both diameters in plane of symmetry, 3.25 mm.
- V.30241 Two specimens, one a more or less perfect endocarp, the other a seed-cast.
- V.30242 An endocarp.
The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30243 A somewhat distorted locule-cast. *In situ.*
- V.30244 A carbonaceous endocarp rather larger than the holotype (V.22785); longest diameter, 4.75 mm.; diameter at right angles to plane of symmetry, 4.5 mm. The locule-cast is filled with soft mud.
- V.30245 A perfect carbonaceous endocarp.
The above *A. G. Davis Coll.* Warden Point, Sheppey.

SABIACEAE?

Genus BOGNORIA nov.

DIAGNOSIS. A one-loculed endocarp resembling *Meliosma* in form with basal aperture formed by the incurved carpel walls, obcordiform ventral area forming a gap in the endocarp wall, and median dorsal ridge. A tongue-shaped projection lies between the basal aperture and ventral area. Carpel walls woody, lined with elongate cells with finely digitate outlines. Seed solitary with ventral chalaza. Length of endocarp, 6 mm.; dorsiventral diameter, 5.5 mm.; diameter at right angles to this, 4.75 mm.

TYPE SPECIES. *Bognoria venablesi* n. sp.

Bognoria venablesi n.sp.

Plate 24, figs. 11-13; Text-fig. 36

DIAGNOSIS. That of the genus.

HOLOTYPE. V.30246.

DESCRIPTION. *Fruit*: Resembling *Meliosma* in form, one-loculed, sub-ovoid but having a large obcordiform differentiated and slightly flattened area on the ventral face, bisymmetric about a plane which includes a dorsal ridge extending from a large basal aperture to the apical

margin of the differentiated ventral area. The aperture penetrates about 2.2 mm. into the endocarp and narrows inwards being about 1.1 mm. broad at the surface and 0.6 mm. broad at the inner end; it is formed by the incurving of the endocarp wall which is greatly thickened around it, more especially around the actual aperture. The ventral side of the aperture is formed by a tongue-shaped projection which extends medianly from it over the differentiated ventral area giving this area an obcordiform shape. The tongue-like projection overlies the chalaza on the seed within.

The obcordiform area is due to a large gap in the endocarp wall around which the margins are smoothly finished, slightly sinuous and fluted. The remains of a thin black smooth coat can be seen in places on the external surface of the endocarp, the largest patch overlying part of the differentiated area. Within this coat the surface of the endocarp is smooth, its cell-structure being obscure; the wall is formed of hard parenchyma which is closer in texture towards the exterior; it is 0.3 to 0.4 mm. thick, but around the margin of the aperture it is 0.6 mm. thick. The internal surface of the endocarp is formed by elongate cells with finely digitate outlines as in *Meliosma*. Similar cells, longitudinally aligned, are impressed on the locule-cast beneath the cordiform area.

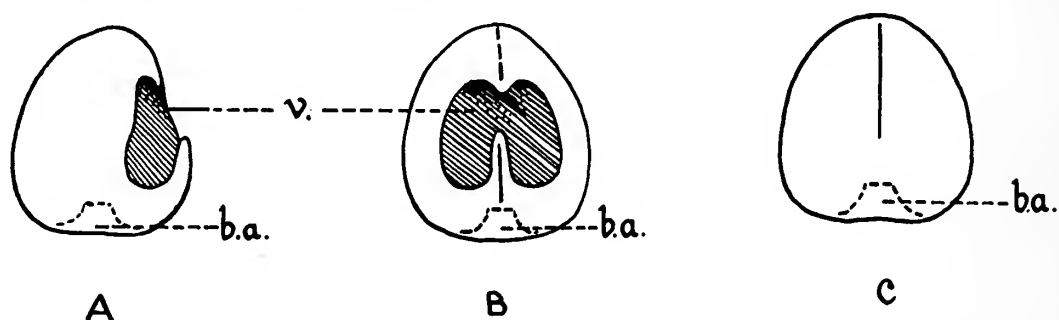


Fig. 36. *Bognoria venablesi* n. gen. & sp. A, side with cordiform area (*v*) to the right. Basal aperture with incurved edges dotted in at (*ba*). B, the same looking on to the ventral area (*v*). Basal area dotted as in A. C, the same, dorsal. The vertical line indicates the median angle; (*ba*) as above.

The locule-cast is filled with pyrites, embedded in which are remains of the seed. The chalaza lies beneath the free extremity of the ventral tongue-shaped area, it is circular, 0.9 mm. in diameter. The testa cells diverge from it so as to produce fine radial striae.

Greatest length of fruit in plane of symmetry, 6 mm.; dorsiventral diameter in plane of symmetry, 5.5 mm.; diameter at right angles to plane of symmetry, 4.75 mm.

REMARKS AND AFFINITIES. One fruit. Its form with median angle strongly recalls *Meliosma*, but there is nothing in *Meliosma* to correspond with the large differentiated area devoid of hard endocarp. The cell-structure as noted also resembles that of *Meliosma*.

If the basal aperture is completely surrounded by the endocarp, i.e. if the tongue-shaped projection forms part of the endocarp as it appears to do, there can be no real relationship to *Meliosma*. If, however, the tongue is part of the raphe and not of the endocarp so that the basal aperture and the cordate area are both part of the same gap in the endocarp wall, then it may be some extinct genus of Sabiaceae.

It is called *Bognoria venablesi* after the place of origin and the finder of the specimen.

V.30246 Holotype, figured Pl. 24, figs. 11-13; Text-fig. 36. A fruit now broken to show the structure and seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family VITACEAE

Genus VITIS (Tourn.) L.

Vitis subglobosa Reid & Chandler

Plate 24, figs. 14-17

1933 *Vitis subglobosa* Reid & Chandler, p. 379, pl. 19, figs. 34-37.

Two seeds with testa preserved, one from Warden, the other from Bognor, appear to belong to *Vitis subglobosa* although they are more inflated dorsiventrally than the specimens formerly described. Both are subcircular in outline with rounded contours, scarcely pointed at the base, very slightly furrowed at the apex (a feature not seen in the originals). The furrow is most marked in the Warden specimen. The longitudinal infolds on the ventral surface are typical, short, broad, rather far apart, concave towards the raphe ridge; they occupy about one-third to one-half the length of the seed at about the middle of the face. In the Bognor specimen the ventral face is obscurely angled and faceted especially in the lower part (Pl. 24, fig. 17). In both the chalaza is small round or suboval, sunk, median on the dorsal face; in the Warden specimen it is connected with the apex of the seed by a definite broad shallow canal not seen in the originals (Pl. 24, fig. 14), while in the unabraded Bognor specimen the canal, although indicated, is obscure (Pl. 24, fig. 16). There is also a marked groove between the chalaza and base in the Warden specimen, which is not apparent in the Bognor seed. Length of Warden seed, 4.5 mm.; breadth, 4.25 mm.; thickness, 3 mm. Length of Bognor seed, 4 mm.; breadth, 4.5 mm.; dorsiventral thickness, 3 mm.

The slight differences mentioned above between these seeds and the specimens described in 1933 seem insufficient to separate them as a distinct species. They appear rather to be individual variations, or variations due to a different degree of abrasion. Both are therefore referred to *Vitis subglobosa*.

V.30247 Figured Pl. 24, figs. 14, 15. A seed with testa preserved. *A. G. Davis Coll.* Warden Point, Sheppey.

V.30248 Figured Pl. 24, figs. 16, 17. A much inflated seed with testa unabraded. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Vitis semenlabruscoides Reid & Chandler

Plate 24, figs. 18-21

1933 *Vitis semenlabruscoides* Reid & Chandler, p. 380, pl. 19, figs. 1, 2.

AMENDED DIAGNOSIS. Seed obovate with smooth contours, roundly triangular in section, slightly stipitate; chalaza almost median, small, round, shallow, with a slight groove above; ventral infolds straight or slightly curved, divergent above. Length, 3.5 to 4.3 mm.; breadth perpendicular to the plane of symmetry, 1.75 to 3.5 mm.; thickness in plane of symmetry, 1.75 to 2.5 mm.

HOLOTYPE. V.22790.

17—(160)

REMARKS. Nine seeds from Bognor with testa preserved and two additional seeds from Sheppey. These better specimens show certain characters which were obscure in the type, and the diagnosis has therefore been slightly amended as regards the ventral infolds which are straight or slightly curved and somewhat divergent at the apex where they may be appreciably further apart than at the hilar end (Pl. 24, figs. 19, 21). The seed-cast may show slight flutings around the chalaza and infolds; between the apex and the chalaza there is a shallow raphe-furrow scarcely apparent externally where the testa is preserved. Length of a typical seed, 3.8 mm.; breadth, 3 mm.; thickness, 2 mm. Length of a damaged seed, 4.3 mm.

Figured Pl. 24, figs. 18, 19. A seed with abraded testa (now completely disintegrated).

V.30249 Figured Pl. 24, figs. 20, 21. A seed with testa preserved.

V.30250 A seed with testa preserved.

V.30251 Six seeds, three imperfect, probably referable to this species.

The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30252 A seed-cast. *A. G. Davis Coll.*

V.30253 A seed. *G. F. Elliott Coll.*

Both the above from Warden Point, Sheppey.

Vitis bilobata n. sp.

Plate 24, figs. 22-24

DIAGNOSIS. Seed obovate in outline, apex almost unchannelled. Surface smooth, dorsal side bilobed longitudinally owing to a median groove which extends from top to bottom, chalaza narrow, median within the groove, raphe ridge sharply angled throughout the length of the seed, parallel-sided, ventral infolds about one-third the length of the seed, slightly concave towards the raphe ridge. Length of seed about 6.5 mm.; breadth, 5 mm.; thickness, 3.5 mm.

HOLOTYPE. V.30254.

DESCRIPTION. *Seed*: Obovate in outline, pointed below, narrowing to an obscure rounded point above, apex almost unchannelled. Ventral surface faceted, the two uncurved lateral facets meeting at an angle of 90°; ventral infolds short, about 2.25 mm. long i.e. only about one-third the length of the seed, very slightly concave towards the raphe ridge which is almost parallel-sided (Pl. 24, fig. 23). Facets smooth except for a few inconspicuous grooves which diverge around one infold. Dorsal surface convex both longitudinally and transversely, with smooth rounded contours, chalaza median narrow (precise form obscured by pyrites), sunk in a narrow depression which is prolonged above and below? (surface worn) as a shallow furrow giving a bilobed appearance to the dorsal face (Pl. 24, fig. 22). Testa columnar, cells 0.03 mm. in diameter. Length of seed, 6.5 mm.; breadth, 5 mm.; dorsiventral thickness, 3.5 mm.

REMARKS AND AFFINITIES. A single seed. The bilobed dorsal surface is peculiar. No other *Vitis* from the London Clay resembles this species. *Vitis subglobosa* Reid & Chandler (1933: 379, pl. 18, figs. 34-37) is perhaps the most comparable form but is smaller, subglobose, unfurrowed or scarcely furrowed on the dorsal surface above the chalaza, has a small circular chalazal scar and ventral infolds more distinctly concave to the raphe ridge.

V.30254 Holotype, figured Pl. 24, figs. 22-24. A seed with testa preserved, now broken. *A. G. Davis Coll.* Warden Point, Sheppey.

Vitis obovoidea n. sp.

Plate 24, figs. 25–28

DIAGNOSIS. Seed obovoid with smooth contours, dorsal face convex, ventral faceted, facets meeting at a wide angle, raphe ridge parallel-sided, longitudinal infolds close together almost parallel, occupying the lower three-quarters of the length. Chalaza oval, median, with an obscure groove above and below. Margin obscurely angled. Length of seed, 5.2 to 6.75 mm.; breadth, 3.5 to 4.25 mm.; thickness, 2 to 2.75 mm.

HOLOTYPE. V.30255.

DESCRIPTION. *Seed*: Obovoid with smooth contours, convex on the dorsal face, faceted on the ventral face, facets meeting at a broad angle. Raphe ridge parallel-sided, rounded, longitudinal infolds close, almost parallel extending from the base to about one-quarter of the length of the seed from the apex where they diverge slightly (Pl. 24, fig. 26). Chalaza oval, approximately median, dorsal surface obscurely grooved between the chalaza and the base and apex (Pl. 24, figs. 25, 27). Surface of seed and of seed-cast slightly fluted around the infolds and chalaza having an inconspicuous marginal angle. Length of seed, 5.2 to 6.75 mm.; breadth, 3.5 to 4.25 mm.; thickness, 2 to 2.75 mm. Testa cells about 0.025 mm. in diameter.

REMARKS AND AFFINITIES. Two seeds, one with testa complete, the other (from which the testa has been partially abraded) distorted so as to be artificially shortened in length and faceted on the upper part of the ventral face. This species differs from other London Clay species in the regular ovoid form, narrow close-set parallel infolds ending short of the apex, and large median chalaza.

V.30255 Holotype, figured Pl. 24, figs. 25, 26. A perfect seed.

V.30256 Figured Pl. 24, figs. 27, 28. A distorted seed-cast. The testa has been largely abraded.

Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Vitis magnisperma n. sp.

Plate 24, figs. 29, 30

DIAGNOSIS. Seed-cast obovoid, broadly channelled at the apex, pointed at the base, flattened, dorsal face with obscure radial flutings; ventral infolds broad, deep, almost straight, occupying the lower three-quarters of the length of the seed; chalazal scar median, circular, about 2.5 mm. in diameter. Length of cast, 8.25 mm.; breadth, 6 mm.; thickness, 3 mm.

HOLOTYPE. V.30257.

DESCRIPTION. *Seed-cast*: Obovoid, broadly channelled at the apex, pointed at the base, dorsal and ventral surfaces meeting in an obscure rounded marginal angle. Ventral face flat, not fluted, not faceted either on the cast itself or on the remains of testa preserved near the apex. Ventral infolds broad, deep, steep-sided, almost straight, slightly divergent above, occupying the lower three-quarters of the length of the seed; raphe ridge sharp, narrow, broadening slightly above; apical channel extending for a short distance on the ventral face (Pl. 24, fig. 30). Dorsal face scarcely convex, broad apical channel continued to the margin of the chalazal scar which is median, circular, 2.5 mm. in diameter; between the base and the chalaza is a shallow obscure median furrow. Surface of cast with obscure flutings diverging from the chalaza (Pl. 24, fig. 29). Remains of testa so highly polished that the structure is

obscured, in its worn condition 0.15 mm. thick. Internal cast of testa showing equiaxial cells 0.02 mm. in diameter. Within is a coat, one cell thick, formed of larger equiaxial cells, 0.05 mm. in diameter. Within again, is a finely striate tegmen, the striae, 0.014 mm. apart, diverging from the chalaza and longitudinal infolds. Length of seed-cast, 8.25 mm.; breadth, 6 mm.; thickness, 3 mm.

REMARKS AND AFFINITIES. Form and size, together with the form of the internal cast distinguish this species from any other described. It is larger than any except *Palaeovitis paradoxa* (p. 259) and lacks the marked internal crenulations of that species, and its great degree of inflation.

V.30257 Holotype, figured Pl. 24, figs. 29, 30. A seed-cast with remains of testa. *G. F. Elliott Coll.* Sheppey.

Vitis venablesi n. sp.

Plate 24, figs. 31, 32

DIAGNOSIS. Seed sub-obovate in outline, apex somewhat flattened with shallow depression, somewhat compressed dorsiventrally, contours smooth, ventral face slightly convex, longitudinal infolds short and broad, almost straight, broadening upwards, occupying the lower half of the seed. Dorsal face rounded, chalaza spatulate in the upper half of the seed. Surface not grooved between hilum and chalaza. Length of seed, 5 mm.; breadth, 4.3 mm.; thickness, 2.7 mm.

HOLOTYPE. V.30258.

DESCRIPTION. *Seed*: Sub-obovate in outline, roundly truncate above with apex somewhat flattened but having a shallow depression, triangular below, somewhat compressed dorsiventrally, contours smooth and rounded. Ventral face not angled, slightly convex, longitudinal infolds short and broad, almost straight, broader above than below, 2.5 mm. long, 0.75 mm. wide in their widest part (probably about 1.3 mm. on the internal cast); raphe ridge narrow, parallel-sided and rounded, not continued into the upper part of the seed, about half as long as the seed (Pl. 24, fig. 32). Dorsal face rounded with spatulate chalaza, the lower margin of the chalaza being 2.25 mm. from the apex, not grooved between the chalaza and the hilum (Pl. 24, fig. 31). Testa 0.1 to 0.2 mm. thick, cells of testa 0.025 mm. in diameter. Length of seed, 5 mm.; breadth, 4.3 mm.; thickness, 2.7 mm.

REMARKS AND AFFINITIES. A seed with testa preserved except in a few small patches. In size and external characters it most closely approaches *Palaeovitis paradoxa* but is smaller in all its dimensions, its base is more pointed, its infolds are narrow, straight and parallel, and the raphe ridge is also parallel-sided and narrow. The testa is thinner and the internal cast shows no sign of the conspicuous fluting seen in *P. paradoxa*.

V.30258 Holotype, figured Pl. 24, figs. 31, 32. A seed with testa preserved.

V.30259 A second specimen represented by a seed-cast with remains of testa in the ventral hollows and over the chalaza may belong to this species although it is somewhat smaller. Length of seed, 4.5 mm.; breadth, 3.5 mm.

Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Vitis platyformis n. sp.

Plate 24, figs. 33, 34

DIAGNOSIS. Seed obovate in outline, markedly mucronate at the base, deeply channelled at the apex, more or less compressed dorsiventrally, surface smooth; raphe ridge gradually broadening above, rounded, ventral infolds about half as long as the seed, situated in the lower part of the seed, broad, almost straight but slightly divergent upwards; chalaza small, circular, just above the middle of the seed. Length of seed about 5 mm.; breadth about 3.75 mm.; thickness, 2 mm.

HOLOTYPE. V.30260.

DESCRIPTION. *Seed*: Obovate, mucronate at the base, deeply channelled at the apex, dorsiventrally compressed. Ventral surface flattened, raphe ridge rounded, gradually broadening above, ventral infolds broad almost straight, occupying about half the length of the seed, terminating about twice as far from the apex as from the base, diverging slightly upwards (Pl. 24, fig. 34). Dorsal face gently convex. Chalaza small, circular, situated just above the middle of the seed, surrounded by a narrow channel which is continued to the apex as a broad flat furrow (Pl. 24, fig. 33). Testa smooth without any trace of fluting around the chalaza, formed of columnar cells which produce a pitted surface of thick-walled cells 0.02 to 0.025 mm. in diameter. Length of seed about 5 mm.; breadth about 3.75 mm.; dorsiventral thickness, 2 mm.

Seed-cast: Obovate in outline with a small basal mucro, much flattened dorsiventrally, ventral face flat, infolds broad and deep as described for the seed itself, dorsal face gently convex, deeply channelled above, the channel continued as a depressed oval area around the small chalazal scar and as a shallow inconspicuous furrow extending from the chalaza to the base. Dorsal surface inconspicuously fluted around the median depression especially above. Length of cast, 4.5 mm.; breadth, 3.5 mm.

REMARKS AND AFFINITIES. A single seed, with testa originally complete (Pl. 24, figs. 33, 34) but now almost entirely cracked and detached. The seed resembles *Vitis rectisulcata* in form but is somewhat larger and has shorter more divergent ventral infolds situated nearer the base than the apex whereas in *V. rectisulcata* they are usually equidistant from both. Also the chalaza is situated a short distance above the middle of the seed, not strictly median as in *V. rectisulcata*. The new specific name of *Vitis platyformis* has therefore been given.

V.30260 Holotype, figured Pl. 24, figs. 33, 34. A seed originally with testa complete, now largely broken and detached. *G. F. Elliott Coll.* Warden Point, Sheppey.

Vitis elegans n. sp.

Plate 24, figs. 35, 36

DIAGNOSIS. Seed pointed-obovate in outline with smooth rounded contours, slightly channelled at the apex, attenuated to the base, ventral face angled and faceted throughout its length. Ventral infolds almost straight, diverging upwards, extending from the base for at least three-quarters of the length of the seed. Chalaza ovate, large, situated above the middle of the seed, surrounded by a groove; a shallow groove also connects the chalaza and base and apex of the seed. Length of seed, 4.4 mm.; breadth, 3.15 mm.

HOLOTYPE. V.30261.

DESCRIPTION. *Seed*: Pointed obovate in outline, slightly channelled at the apex, attenuated to the pointed base, with rounded contours. Ventral face faceted, facets meeting at a more or less rounded angle which extends throughout the length of the seed. Ventral infolds almost straight, diverging upwards, extending from the base for three-quarters or more of the whole length (Pl. 24, fig. 36). Dorsal face rounded with large ovate chalaza having its lower end at about the middle of the seed. The chalaza is surrounded by a groove, a shallow groove also occurring between the chalaza and the base and apex (Pl. 24, fig. 35). Length of seed, 4.4 mm.; breadth, 3.15 mm.; length of chalaza about 1.7 mm.; breadth about 1.3 mm.

REMARKS AND AFFINITIES. Two seeds from Bognor and a third from Sheppey. The Sheppey specimen is more unequally compressed and sharply faceted than the other two. The species is distinguished by its slender pointed-obovate form combined with its smooth contours, large chalaza in the upper half of the dorsal face, and long divergent ventral infolds.

V.30261 Holotype, figured Pl. 24, figs. 35, 36. A single seed.

V.30262 A second specimen.

Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30263 A seed, more sharply and asymmetrically faceted ventrally. *A. G. Davis Coll.* Warden Point, Sheppey.

Vitis bracknellensis n. sp.

Plate 25, figs. 1-5

DIAGNOSIS. Seed sub-globular or obovoid, contours smooth, apex emarginate, base pointed or rounded; chalaza median subcircular surrounded by a groove, surface furrowed between chalaza and apex, and more obscurely between chalaza and base. Ventral infolds long, extending almost the length of the seed, slightly convex to the raphe ridge, markedly divergent upwards. Length of seed, 4.5 mm.; breadth, 4 to 4.25 mm.; thickness about 2.25 to 3.25 mm.

HOLOTYPE. V.30264.

DESCRIPTION. *Seed*: Sub-globular to obovoid, emarginate at the apex, owing to a conspicuous apical channel, pointed or obscurely pointed at the base, contours smooth and rounded. Ventral face rounded or faceted, facets equal or unequal meeting along a sharp symmetrically or asymmetrically placed angle. Ventral infolds long, divergent upwards, very slightly convex to the raphe ridge, extending from end to end of the seed. Dorsal face rounded, the apical furrow continued on to it to and around the chalaza, below which there is a less conspicuous, narrower, groove extending to the base. Chalaza large, subcircular, about 2 mm. in diameter, situated at about the middle of the face. Testa columnar in section. Length of seed from Bracknell, 4.5 mm.; breadth, 4 mm.; thickness, 2.25 mm. Length of seed from Warden, 4.5 mm.; breadth, 4.25 mm.; thickness, 3.25 mm.

REMARKS AND AFFINITIES. Three seeds. One from Bracknell has such marked flattened unequal facets as to suggest the presence of more than one seed in the berry. Remains of decayed testa adhere to the cast in calcite. The specimen is not pyritized. The second seed from Warden is more inflated and appears not to have suffered compression during growth. It is a typical pyrites cast covered by the highly polished testa except over the chalaza where it is broken away. The ventral face is not faceted. The third seed from Bognor (no longer extant) was also more inflated and only slightly asymmetric.

The species is larger than *Parthenocissus monasteriensis* and *Vitis longisulcata*. It is distinguished also from the former by its broader form, and larger more median chalaza, also by its more divergent infolds and in consequence it has a more broadly triangular raphe ridge than the latter.

- V.30264** Holotype, figured Pl. 25, figs. 1, 2. A calcite seed-cast from a septarian nodule with remains of carbonaceous testa. *A. G. Davis Coll.* Modiola Beds: Down Mill Brickyard, Bracknell, Berkshire.
- V.30265** Figured Pl. 25, figs. 4, 5. A seed with testa preserved except over the chalaza. *A. G. Davis Coll.* Warden Point, Sheppey.
Figured Pl. 25, fig. 3. A seed 4.25 mm. in length and breadth, 2.5 mm. thick, showing typical divergent ventral infolds was accidentally lost in setting up for photography. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Vitis sp.

Plate 25, figs. 6, 7

Three fragments of a Vine seed, each showing the impression of one ventral infold with remains of the testa. The infolds were straight, relatively broad, and short, occupying rather more than half the length of the seed. No other evidence of specific character is available. The specimens were preserved in blocks of Bognor Soft Rock.

An impression of the dorsal surface of a seed, with its chalaza preserved in carbonaceous substance was previously recorded from the Bognor Soft Rock by Reid & Chandler (1933: 382, pl. 19, fig. 5) under the name *Vitis bognorensis*; as the ventral surface was not preserved no comparison with the more recently discovered fragments is possible. Plant-remains at this horizon are very rare.

- V.30266** Figured Pl. 25, fig. 6. Ventral side of half a seed showing one infold. The testa was originally preserved.
- V.30267** Figured Pl. 25, fig. 7. Ventral side of an imperfect seed represented by the internal cast showing one infold.
- V.30268** Fragment of a third seed.
All *E. M. Venables Coll.* Soft Rock: Bognor, Sussex.

Vitis longisulcata (Reid & Chandler) Chandler

Plate 25, figs. 8-15

1933 *Tetrastigma? longisulcata* Reid & Chandler, p. 384, pl. 19, figs. 9, 10.

AMENDED DIAGNOSIS. Seed sub-globose or sub-obovoid, sometimes roundly quadrilateral in outline, usually much inflated but sometimes flattened on the ventral side; apical groove shallow continued on the dorsal surface to the chalaza; chalaza circular, median; ventral infolds usually convex to the raphe ridge, diverging above, frequently extending to the margin at their upper ends; raphe ridge rounded, broadening above; surface of cast with fine flutings diverging from the chalaza. Length of seeds, 3.5 to 4.1 mm.; breadth, 3 to 3.9 mm.; thickness, 1.75 to 3 mm.

DESCRIPTION. *Seed:* Sub-globose or sub-obovoid, sometimes roundly quadrilateral in outline, usually much inflated on the dorsal surface, often much inflated on the ventral surface also, but sometimes distorted and flattened as the result of the mutual pressure of a second seed during growth; more rarely faceted. Apical groove narrow inconspicuous as seen from the

ventral side, continued as a marked furrow between the apex and chalaza on the dorsal side, base obtusely pointed or with a small mucro. Raphe ridge rounded usually extending the whole length of the seed, broadening above, ventral infolds usually extending the whole length, straight or slightly convex to the ridge, diverging markedly upwards (Pl. 25, figs. 9, 11, 13, 15). Chalaza median, circular, about 1.25 to 1.5 mm. in diameter. Inner surface of testa sometimes with fine radial flutings especially around the chalaza (clearly seen on the seed-cast, Pl. 25, figs. 10, 12). Testa cells 0.025 mm. in diameter. Length of seeds, 3.5 to 4.1 mm.; breadth, 3 to 3.9 mm.; thickness, 1.75 to 3 mm.

REMARKS AND AFFINITIES. Over forty seeds, the majority from Bognor, a few from Sheppey. They show varying degrees of inflation. The characters are those of *Vitis longisulcata*. The greater range of material now available shows that dorsiventral compression is an individual and sometimes an accidental character and is not of specific value; the diagnosis and description have been amended accordingly. In some specimens the testa is preserved, in others only the seed-cast. Many of the specimens are less abraded than the holotype from Sheppey. A discussion of the features which distinguish this species from *Parthenocissus monasteriensis* will be found on p. 257.

- V.30270 Figured Pl. 25, figs. 8, 9. A seed-cast with remains of testa. The ventral surface is flattened as in a two-seeded berry.
- V.30271 Figured Pl. 25, figs. 10, 11. A much inflated seed-cast, markedly convex on the ventral surface as in a one-seeded berry.
- V.30272 Figured Pl. 25, figs. 12, 13. A typical seed-cast with testa worn away so that the flutings of the surface show clearly. The ventral surface is considerably flattened, but the raphe ridge has a distinct median longitudinal angle.
- V.30273 Figured Pl. 25, figs. 14, 15. A sub-globular seed with testa preserved. The ventral infolds are relatively straight although they diverge upwards. A few radial flutings can be seen on both surfaces of the seed.
- V.30274 A seed-cast asymmetrically compressed.
- V.30275 A seed with testa preserved somewhat defaced on the dorsal surface. The whole seed has been somewhat flattened in fossilization.
- V.30276 Thirty seeds showing different degrees of abrasion. Some are much inflated, others flattened. A few are ventrally faceted and somewhat resemble small specimens of *Parthenocissus monasteriensis*.
All the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30277 A small seed-cast. *F. M. Wonnacott Coll.*
- V.30278 Six seeds, one a seed-cast, the others with testa preserved. Several are much inflated, one is unusually large. *In situ.* *A. G. Davis Coll.*
Both the above Warden Point, Sheppey.

Vitis rectisulcata n. sp.

Plate 25, figs. 16-21

DIAGNOSIS. Seed oval or slightly oboval in outline, mucronate at the base, slightly truncate or channelled above, dorsiventrally compressed. Surface more or less smooth; raphe ridge long, more or less parallel-sided, ventral infolds straight occupying about three-to four-fifths of the length of the seed; chalaza small, median, oval, with shallow groove between it and the base. Length of seed about 3 to 4 mm.; breadth, 2.75 mm.; thickness, 1.75 mm.

HOLOTYPE. V.30279.

DESCRIPTION. *Seed*: Oval or slightly oboval in outline, mucronate at the base, slightly truncate or channelled at the apex, dorsiventrally compressed, ventral face (Pl. 25, figs. 17, 19)

with two conspicuous, broad, straight, longitudinal infolds occupying about three- to four-fifths of the length of the seed. Raphe ridge long, conspicuous, scarcely broader above than below, passing above into a broad shallow groove which extends on to the dorsal face and is continued around and below the small median oval chalaza to the base (Pl. 25, figs. 16, 18, 20). Dorsal face with obscure sulci and ridges diverging from the chalaza. Internal surface of testa formed of equiaxial cells, 0.025 mm. in diameter. Length of seed about 3 to 4 mm.; breadth, 2.75 mm.; thickness in plane of symmetry, 1.75 mm.

REMARKS AND AFFINITIES. Two seed-casts and one seed referable to this species. The seeds somewhat resemble *Vitis longisulcata* but differ in their wider, straight, ventral infolds and median furrow between the chalaza and base, also in the smaller median oval chalaza. A distinct specific name has therefore been given.

V.30279 Holotype, figured Pl. 25, figs. 16, 17. A seed represented by an internal cast.

V.30280 Figured Pl. 25, figs. 18, 19. A smaller seed probably of the same species, also represented by an internal cast.

Both *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

V.30281 Figured Pl. 25, figs. 20, 21. A seed with testa preserved, partly encrusted with pyrites on the dorsal surface. Doubtfully this species. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus TETRASTIGMA Planchon

Tetrastigma davisii n. sp.

Plate 25, figs. 22, 23

DIAGNOSIS. Seed obovate in outline, deeply channelled at the apex, sharply pointed or stipitate at the base. Both surfaces ornamented with prominent radial lobes separated by deep grooves. Raphe ridge extending the whole length of the ventral face, ventral infolds about half the length of the seed, somewhat concave to the raphe ridge, diverging upwards. Chalaza oval median deeply sunk. Length of seed about 7 mm.; breadth, 4.6 mm.; thickness, 3.1 mm.

HOLOTYPE. V.30282.

DESCRIPTION. *Seed*: Obovate in outline, deeply channelled at the apex, sharply pointed or stipitate at the base. Ventral face faceted with sharp conspicuous raphe ridge extending the whole length of the seed terminating against the apical notch. Ventral infolds occupying about half the length, somewhat concave to the raphe ridge diverging upwards (Pl. 25, fig. 23). Dorsal surface with an oval chalaza situated at about the middle in a deep hollow which is continued as a deep furrow to the apex of the seed and as a wide deep channel to the base (Pl. 25, fig. 22). Dorsal surface ornamented with about ten prominent rounded lobes separated by deep grooves which diverge from the chalaza. The lobes are not continued over the margin on to the ventral surface which has an independent series of lobes around the ventral infolds somewhat less conspicuous than those on the dorsal face. Testa much decayed but remaining in a cracked condition especially in the hollows; it is formed of columnar cells about 0.03 mm. in transverse diameter. Length of seed about 7 mm.; breadth, 4.6 mm.; thickness, 3.1 mm. (somewhat reduced by compression).

REMARKS AND AFFINITIES. One seed. It somewhat resembles *Tetrastigma corrugata* from Bognor (Pl. 25, figs. 24, 25) but is larger, broader, more definitely stipitate at the base

and thicker dorsiventrally than that species which is comparable in its oval chalaza and deep apical notch. Both have furrowed surfaces but the furrows of *T. davisii* are deeper and more conspicuous than those of *T. corrugata* especially on the ventral surface. It also bears some resemblance to *T. elliotti* (Pl. 25, figs. 26, 27) but is distinguished again by its much greater size, and the deeper lobing of the dorsal surface. Further, *T. elliotti* has no apical notch, and its ventral face is smooth, not lobed.

V.30282 Holotype, figured Pl. 25, figs. 22, 23. A seed. *A. G. Davis Coll.* Warden Point, Sheppey.

Tetrastigma corrugata n. sp.

Plate 25, figs. 24, 25

DIAGNOSIS. Seed-cast elongate-obovate in outline narrowing to a point below but not stipitate, deeply channelled at the apex; both surfaces with radial lobes; ventral face with sharp raphe ridge extending the whole length of the seed; ventral infolds long, straight, divergent, chalaza oval, just above middle, deeply sunk. Length of seed-cast, 5.5 mm.; breadth, 2.9 mm.; thickness, 2.1 mm.

HOLOTYPE. V.30283.

DESCRIPTION. *Seed-cast*: Elongate-obovate in outline, narrowing to a point below but not stipitate, deeply channelled at the apex. Ventral face faceted with sharp conspicuous raphe ridge extending the whole length of the seed terminating against the apical notch. Ventral infolds long approximately straight, broadening and diverging towards the apex but not extending to the apex of the seed (Pl. 25, fig. 25). Dorsal surface with an oval chalaza situated above the middle in a deep hollow which is continued to the apex of the seed and passes below into a wide flattened quadrangular area. Both surfaces are ornamented with a few conspicuous rounded lobes which diverge from the chalaza on the dorsal face, there being five on one side of the chalaza and four on the other, two lobes flank the deep apical channel and two diverge from the base of the chalaza and flank the flattened area below (Pl. 25, fig. 24); these lobes are not continuous with those of the ventral face but tend to alternate with them, so that the margin of the seed where the two surfaces meet is angled, the course of the angle being zig-zag. The lobes of the ventral face are less conspicuous than those of the dorsal, their projecting ends obscure the outlines of the infolds. Testa preserved in part, especially in some of the hollows, but mostly abraded. Testa cells 0.025 mm. in diameter as impressed on the seed-cast. Parts of the internal cast show impressions of fine striae (tegmen?) diverging from the chalaza and ventral infolds. Length of seed-cast, 5.5 mm.; breadth, 2.9 mm.; thickness, 2.1 mm.

REMARKS AND AFFINITIES. One seed-cast with remains of testa. It is distinguished from almost all London Clay vine seeds by its radiating lobes and deep apical notch and by its narrow attenuated form. In some of these respects it resembles a much larger and more deeply lobed species, *T. davisii* (p. 253). It also somewhat resembles *T. elliotti* from Warden (see p. 255), but this species has less prominent rounded lobes on the dorsal surface, and is without lobes on the ventral; it is also without an apical notch.

V.30283 Holotype, figured Pl. 25, figs. 24, 25. A seed with some remains of testa. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Tetrastigma sheppeyensis n. sp.

Plate 25, figs. 26, 27

DIAGNOSIS. Seed obovate-pointed in outline, somewhat channelled at the apex, ventral surface with sharp raphe ridge and obscure radial flutings, ventral infolds straight diverging above, occupying about three-fifths or rather more of the length of the seed. Dorsal surface with a few conspicuous rounded radial lobes. Chalaza small, median, circular, sunk. Length of seed, 4.1 mm.; breadth, 2.85 mm.; thickness, 1.5 mm.

HOLOTYPE. V.30285.

DESCRIPTION. *Seed*: Obovate-pointed in outline (extreme base broken), somewhat channelled above; ventral surface with obscure radial flutings unequally faceted (owing to distortion) with a sharp raphe ridge broadening above; longitudinal infolds straight, narrow, diverging above, occupying three-fifths or more of the length of the seed (Pl. 25, fig. 27). Dorsal face convex with a small median circular chalaza in a depression which is continued as a broad shallow channel to the base, and as a rather narrower deeper channel to the apex; surface with about seven conspicuous rounded radial lobes diverging from the chalaza separated from one another by broad furrows (Pl. 25, fig. 26). Dorsal and ventral surfaces meeting at a rounded angle. Length of seed, 4.1 mm. (broken at the extreme base); breadth, 2.85 mm.; thickness (decreased by distortion to some small extent?), 1.5 mm.

REMARKS AND AFFINITIES. The specimen does not agree with any other species of *Tetrastigma* described from the London Clay. Although it compares in size with *T. corrugata* it is broader, flatter, and less attenuated at the base than that species. It also has a smaller chalaza, shorter ventral infolds, and less conspicuous apical groove.

V.30285 Holotype, figured Pl. 25, figs. 26, 27. A seed-cast broken at the hilum. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*.

Tetrastigma? ellioti n. sp.

Plate 25, figs. 28, 29

DIAGNOSIS. Seed elongate-obovate in outline, narrowing to a point below but not stipitate, not channelled at the apex; ventral face with sharply angled raphe ridge, the angle extending the length of the seed, smooth, ventral infolds slightly concave, divergent upwards. Dorsal surface with a few shallow radial lobes, chalaza oval, median, deeply sunk. Dorsal and ventral faces meeting at a sharp angle throughout the length of the seed. Length about 5 mm.; breadth about 2.75 mm.; thickness, 2 mm.

HOLOTYPE. V.30284.

DESCRIPTION. *Seed*: Elongate-obovate in outline, narrowing to a point below but not stipitate, not channelled at the apex. Ventral face faceted, the facets meeting along the median line at an angle of 90°, which extends throughout the length of the seed, facets smooth not lobed or fluted, ventral infolds extending for about half the length or rather more, markedly broader at the apex than at the base, slightly concave towards the raphe ridge but with a general upward divergence (Pl. 25, fig. 29). Dorsal surface with an oval chalaza situated in a deep depression about the middle of the face the depression being continued as a deep narrow channel towards the apex and as a broad channel towards the base. Dorsal surface ornamented

with a few conspicuous shallow rounded lobes which diverge from the chalaza and median grooves, there are about six lobes on each side (Pl. 25, fig. 28). Dorsal and ventral surfaces meeting at a sharp angle throughout their length. Testa much decayed and cracking. Length of seed about 5 mm.; breadth about 2.75 mm.; thickness, 2 mm.

REMARKS AND AFFINITIES. One seed, having a general resemblance to *Tetrastigma corrugata* (p. 254) but distinguished by the absence of a deep apical channel, the less deeply lobed dorsal surface and the absence of radial lobing on the ventral surface. The ventral infolds extend further towards the apex of the seed than in *T. corrugata* but are shorter on the whole in *T. ellioti*, occupying only about half the length of the seed and dying out at some distance above the base.

A second lobed species, *T. davisii* (p. 253) is clearly distinguished by its greater size and thickness and unusually prominent rounded lobes on both surfaces separated by deep conspicuous furrows.

V.30284 Holotype, figured Pl. 25, figs. 28, 29. A seed with remains of testa. *G. F. Elliott Coll.* Warden Point, Sheppey.

Genus AMPELOPSIS Richard

Ampelopsis monasteriensis Kirchheimer

Plate 25, figs. 30, 31

- 1933 *Ampelopsis rotundata* Reid & Chandler, p. 386, pl. 19, figs. 13-17 (*nomen nudum*).
 1939 *Ampelopsis monasteriensis* Kirchheimer, p. 88.
 1939a *Ampelopsis monasteriensis* Kirchheimer, p. 11.

A well-preserved seed with testa (polished by abrasion so that the cell-structure is obscure). The specimen is asymmetrically developed, one ventral facet being broader than the other. Length of seed, 4.5 mm.; breadth, 4.4 mm.; thickness, 3 mm.

In naming this species *Ampelopsis rotundata* in 1933, the previous use of the name for a Hordle species (Chandler, 1926: 33) was unfortunately overlooked. The species was re-named *A. monasteriensis* by Kirchheimer (1939a:11), but it must not be confused with another Sheppey vine *Parthenocissus monasteriensis* (see p. 257).

V.30286 Figured Pl. 25, figs. 30, 31. A seed with testa preserved. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30287 A seed-cast with peeling testa. *G. F. Elliott Coll.* Sheppey.

Ampelopsis turneri n. sp.

Plate 25, figs. 32, 33

DIAGNOSIS. Seed obovoid, somewhat channelled at the apex, sharply angled at the margin. Surface slightly crenulate radially, especially on the dorsal side; raphe ridge sharp below, broadening above, extending the whole length of the seed, ventral infolds short, straight, about half the length of the seed, diverging markedly upwards; dorsal face convex, not channelled below the chalaza, chalaza narrow, oval, situated just above the middle of the seed. Length of seed about 4.75 mm.; breadth, 3.75 mm.

HOLOTYPE. V.30288.

DESCRIPTION. *Seed*: Obovoid, somewhat channelled at the apex; dorsal and ventral faces meeting at an angle. Ventral face faceted, the facets meeting in a sharp angle along the middle of the raphe ridge, raphe ridge narrow at the base, broadening markedly upwards; ventral infolds short, straight, about half the length of the seed, diverging markedly upwards (Pl. 25, fig. 33). Dorsal face convex; apical channel broad, continued on to the dorsal face and forming a narrow groove round the chalaza, not continued between the chalaza and base of the seed, having a raphe ridge at the apex which passes into the boss of the narrow oval chalaza situated just above the middle of the seed. From the chalazal groove to the margin, the cast is more or less crenulate with about five ridges on each side (Pl. 25, fig. 32). The ventral face also shows fluting around one of the longitudinal infolds. Testa highly polished, structure obscure. Length of seed about 4.75 mm.; breadth, 3.75 mm.; thickness somewhat distorted.

REMARKS AND AFFINITIES. One seed with testa preserved. In its form it recalls the living *Ampelopsis orientalis* Lam. in which the seeds are somewhat similarly fluted. It also somewhat resembles *A. crenulata* Reid & Chandler from Sheppey. The seeds of *A. crenulata* must have belonged to a single-seeded berry as there is no hint of ventral faceting due to the mutual pressure of several seeds in a berry during growth, but the seed of *A. turneri* is markedly faceted, its angled form showing clearly that it was one of several seeds. Any further contrasting of the two species can be regarded as provisional only, because *A. crenulata* is represented merely by seed-casts and *A. turneri* by a perfect seed with testa completely preserved. Bearing this in mind it may be noted that in *A. crenulata* the groove on the dorsal surface is continued to the base, the ventral infolds are somewhat longer and less divergent, and the chalaza appears to be relatively larger.

V.30288 Holotype, figured Pl. 25, figs. 32, 33. A seed with testa preserved. *J. G. Turner Coll.* Sheppey.

Genus PARTHENOCISSUS Planchon

Parthenocissus monasteriensis (Reid & Chandler) Scott

Plate 25, figs. 34-37

1933 *Cayratia? monasteriensis* Reid & Chandler, p. 387, pl. 19, figs. 18, 19.

1954 *Parthenocissus monasteriensis* (Reid & Chandler) Scott, p. 82.

An additional twenty seeds from Bognor and two from Sheppey are referred to this species. They vary considerably in size (from 3.75 to 4.8 mm. in length; 2.6 to 3.5 mm. in breadth; 1.75 to 2.5 mm. in thickness). The ventral infolds extend almost the whole length of the seed but end short of the upper margin, they are convex to the raphe ridge diverging gradually upwards and curving outwards at the upper extremity (Pl. 25, figs. 35, 37). The ventral surface is almost invariably conspicuously faceted, the facets meeting in a sharp angle along the raphe ridge, but occasionally the ridge is more rounded. The apex is slightly emarginate in almost all seeds. The surface is finely and obscurely fluted around the shallow median oval chalaza. Testa cells (impressed on the seed-cast) about 0.016 to 0.02 mm. in diameter.

A few seeds of this species are difficult to distinguish from *Vitis longisulcata* (cf. Pl. 25, figs. 8-15 with Pl. 25, figs. 34-37) although the two species are really clear and distinct when a large range of material is compared. As a rule seeds of *V. longisulcata* are relatively broader

and more rounded than those of *P. monasteriensis*. They are normally convex or much inflated on the ventral side (as if solitary in the berry) or flattened (as if the berry had been 2-seeded) whereas those of *P. monasteriensis* are sharply angled and faceted probably indicating a four-seeded berry. The ventral infolds in *V. longisulcata* are usually longer and more divergent at their upper ends than those of *P. monasteriensis* and one or both may extend to the margin at the apex of the seed.

- V.30289 Figured Pl. 25, figs. 34, 35. A cast somewhat imperfect around the chalaza. This seed is of the type that resembles *Vitis longisulcata*.
 V.30290 Figured Pl. 25, figs. 36, 37. A more typical but small seed with abraded remains of testa.
 V.30291 An internal cast well-preserved at the base.
 V.30292 Sixteen seeds mostly casts, some with remains of testa.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30293 A small seed. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30294 A small seed, probably referable to this species. *G. F. Elliott Coll.* Warden Point, Sheppey.

Parthenocissus jenkinsi n. sp.

Plate 25, figs. 38, 39

DIAGNOSIS. Seed obovoid, ventral face faceted, dorsal face convex longitudinally, scarcely convex transversely, surfaces smooth. Ventral infolds close together below, slightly curved and markedly divergent above, extending the whole length of the seed. Chalaza oval, median, connected with a slight apical channel by a broad furrow. Length of seed, 6.5 mm.; breadth, 4.25 mm.; thickness, 2.25 mm.

HOLOTYPE. V.30295.

DESCRIPTION. *Seed*: Obovoid, somewhat pointed at the base, slightly flattened or channelled at the apex; ventral face angled and faceted, with two longitudinal infolds almost straight and closely approximated below, slightly curved and markedly divergent above, extending throughout the length of the seed (Pl. 25, fig. 39). Raphe ridge conspicuous, long, much broader above than below. Dorsal face convex longitudinally, scarcely convex transversely, with a conspicuous broad furrow between the apex and the median oval chalaza (Pl. 25, fig. 38). Surface smooth. Length of seed, 6.5 mm.; breadth, 4.25 mm.; dorsiventral thickness, 2.25 mm.

REMARKS AND AFFINITIES. In the form and arrangement of the chalaza and infolds there is some resemblance to *Vitis semenlabruscoides* Reid & Chandler (1933: 380, pl. 19, figs. 1, 2) and p. 245, Pl. 24, figs. 18–21, of the present work, but it is twice as large as the largest seed of that species, its ventral infolds are longer, more closely approximated in the lower part of the seed, more convex towards the raphe ridge, more divergent in the upper part. It even more resembles *Parthenocissus monasteriensis* in form, curvature of the dorsal surface, and character of the infolds, and is also nearer in size to that species. But even so, it is so much larger than that species (*P. monasteriensis*, maximum length, 4.8 mm.; breadth, 3.5 mm.) that they can scarcely be united. The seed is also less narrowed to the base than those of *P. monasteriensis*, and the infolds extend closer to the margin at their upper end. The name *Parthenocissus jenkinsi* has therefore been given to this species.

- V.30295 Holotype, figured Pl. 25, figs. 38, 39. A seed. *D. J. Jenkins Coll.* Warden Point, Sheppey.
 V.30296 A second seed, upper half only, probably referable to this species. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus PALAEOVITIS Reid & Chandler, 1933:388

Palaeovitis paradoxa Reid & Chandler

Plate 25, figs. 40-44

1933 *Palaeovitis paradoxa* Reid & Chandler, p. 388, pl. 19, figs. 20-27.

- V.30297** Figured Pl. 25, figs. 40-42. A seed probably referable to this species but unusually inflated (length, 8 mm.; breadth, 8.5 mm.; thickness, 7 mm.), and having relatively short longitudinal ventral infolds more concave towards the raphe ridge than in the specimens previously examined. *G. F. Elliott Coll.* Sheppey.
- V.30298** Figured Pl. 25, figs. 43, 44. A much inflated seed with surface much worn. *G. F. Elliott Coll.*
- V.30299** Five seeds, in two of which the seed-cast is clearly exposed, one cast is exceptionally small. *A. G. Davis Coll.*
- V.30300** A seed-cast with scanty remains of testa. *F. M. Wonnacott Coll.*
All the above Warden Point, Sheppey.
- V.30301** A well-preserved seed, broken in places to show the internal cast and thickness of the testa. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30302** An internal cast of a seed. The remains of the testa are embedded in a nodule which partially surrounds it. *J. E. Cooper Coll.* Herne Bay, Kent.

Family TILIACEAE

Section TILIEAE (Schumann)

Genus CANTITILIA Reid & Chandler, 1933:393

The discovery of a second species has made it necessary to amend the diagnoses for the genus and the species *Cantitilia polysperma*.

AMENDED DIAGNOSIS OF GENUS. Fruit four- or five-loculed; many seeded but with few mature seeds; placentation axile; dehiscence loculicidal; pericarp of three coats, the middle coat thick, formed of delicate thin-walled parenchyma, the innermost layer shining, striate. A network of fine fibres occurs all over the surface between the outer and middle coats. Seed obovoid, anatropous, with large round chalaza. Testa several layers thick.

TYPE SPECIES. *Cantitilia polysperma* Reid & Chandler.

Cantitilia polysperma Reid & Chandler1933 *Cantitilia polysperma* Reid & Chandler, p. 393, pl. 20, figs. 4-11.

AMENDED DIAGNOSIS. Fruit ovoid. Length, 6.5 to 13 mm.; breadth, 5 to 11.5 mm. Seed having a testa of four layers: (1) a superficial layer of elongate cells; (2) parenchyma with secreting cells; (3) a compact coat columnar in section; (4) parenchyma. Tegmen of quadrilateral or polygonal cells 0.05 to 0.1 mm. in diameter. Length of seed, 4 to 5 mm.; breadth, 3 to 5.5 mm.

HOLOTYPE. V.22815.

V.30303 Two fruits.

- V.30304 A small four-loculed cast, originally with remains of carbonaceous wall now chipped away exposing the characteristic network of fibres.
The above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30305 A small unusually globular fruit. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Cantitilia lobata n. sp.

Plate 26, figs. 1-7

DIAGNOSIS. Fruit deeply five-lobed, normally five-loculed. Length, 6 mm.; diameter, 11 mm. Tegmen semi-translucent, cells angular, equiaxial with raised double walls, many about 0.025 mm. in diameter. Length of developed seed about 4.5 mm.; breadth, 3.75 mm.

HOLOTYPE. V.30306.

DESCRIPTION. *Fruit*: Deeply five-lobed with rounded longitudinal lobes, somewhat depressed from apex to base, the base appears to have been pointed and the apex incurved, if base and apex have been correctly interpreted. Five-loculed, one small locule corresponding to each lobe, syncarpous, many-seeded. Placentation axile, the seeds attached to a median fibrous axis with the chalaza turned towards the periphery of the fruit. In one locule about three abortive seeds can be seen (Pl. 26, fig. 4), in another one abortive and one fully developed seed which seems to have ruptured a septum as it grew so that it occupies more than one of the original locules (Pl. 26, figs. 4, 5). Apparently most of the seeds never come to maturity as in *Tilia* and *Cantitilia polysperma* Reid & Chandler (1933: 393). Surface of fruit irregularly and finely rugose covered by a thin smooth coat, about 0.012 to 0.016 mm. thick, formed superficially of fine obscure cells usually much decayed. On the inner surface of this coat a network of fine fibres can be seen as in *Cantitilia polysperma*. Within is a thick mass of thin-walled fragile parenchyma, now obscured by an infilling of pyrites. Locule-lining shining, formed of small square cells arranged end to end and grouped to produce a 'finger-print' structure. Length of fruit, 6 mm.; diameter, 11 mm.

Seed: Ovoid when developed, pointed at the hilar end, anatropous with a large circular chalaza 1.25 mm. in diameter at the broad end (Pl. 26, fig. 6). The testa which is not very well preserved is about 0.2 mm. thick, but no clean-cut section of it showing the transverse structure is available; the external surface has not been seen clearly. In its semi-decayed condition it appears to be formed of several layers of longitudinally aligned cells and it is thickened over the chalaza where it is pierced by a short wide canal for the raphe. The tegmen is semi-translucent, thin, one cell thick, the cells (superficially) being angular, equiaxial, with raised double walls, many approximately 0.025 mm. in diameter. It is on the tegmen that the large internal chalaza forms a conspicuous scar. Length of developed seed about 4.5 mm. (slightly crumpled); breadth, 3.75 mm.

REMARKS AND AFFINITIES. Two fruits now fractured. The five-loculed character, succession of coats, axile placentation, numerous seeds (mostly immature), few mature anatropous seeds with large chalaza, relate the specimen to the Malvales. There is such marked resemblance to *Cantitilia polysperma* Reid & Chandler that a close relationship must certainly be indicated (cf. Reid & Chandler, 1933: 393-396). The chief differences are the lobed and depressed form of the fruit, the character of the tegmen cells, and possibly the number of coats in the testa. In view, however, of the fact that *C. lobata* here described is represented by one specimen only which shows a mature seed and that the testa of that seed is much decayed, the

latter difference cannot at present be regarded as established. The reasons for relating *Cantitilia* to Tiliaceae and to the genus *Tilia* itself have already been fully discussed elsewhere (Reid & Chandler, 1933: 395, 396).

- V.30306 Holotype, figured Pl. 26, figs. 1-6. A five-lobed fruit now fractured to show the internal structure and seeds. It yielded one mature seed (Figs. 4, 6).
 V.30307 Figured Pl. 26, fig. 7. A five-lobed fruit; one lobe has been broken, but no seeds are preserved in the exposed locule.
 Both the above *A. G. Davis Coll.* Warden Point, Sheppey.

Family STERCULIACEAE

Genus SPHINXIA Reid & Chandler 1933: 397

Sphinxia ovalis Reid & Chandler

1933 *Sphinxia ovalis* Reid & Chandler, p. 397, pl. 20, figs. 12-23, text-fig. 14.

- V.30308 A detached carpel showing a locule-cast with remains of pericarp. Length, 12 mm.; breadth, 6 mm. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.30309 A battered fruit, broken to show the seeds. *J. E. Cooper Coll.* Herne Bay, Kent.

Family DILLENIACEAE

Genus TETRACERA Linnaeus

Tetracera eocenica Reid & Chandler

Plate 26, figs. 8, 9

1933 *Tetracera eocenica* Reid & Chandler, p. 400, pl. 20, figs. 24-29.

- V.30310 Figured Pl. 26, fig. 8. A well-preserved seed with testa showing the hilum (*h*) and radicular prominence (*r*). *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30311 Figured Pl. 26, fig. 9. A seed somewhat smaller and more abraded.
 V.30312 A seed-cast with remains of testa.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30313 A seed, and a seed-cast probably this species. *G. F. Elliott Coll.* Sheppey.
 V.30314 A seed much compressed dorsiventrally, testa much abraded, chalaza (large, oval) exposed. Outer coat of testa 0.05 mm. thick, finely columnar in section with finely pitted surface, pits 0.01 to 0.012 mm. in diameter. Inside it is a thin-walled coarse-celled coat (visible in a few patches), cells about 0.05 to 0.1 mm. in diameter. Within again are several layers of small equiaxial cells 0.001 to 0.012 mm. in diameter (carbonaceous as preserved), finally a small fragment of smooth tegmen is seen showing elongate thin-walled cells. Diameter of crushed seed, 5.5 mm.; dorsiventral diameter (compressed), 2.75 mm.; diameter of chalaza, 2.5 mm. *G. F. Elliott Coll.* Warden Point, Sheppey.
 V.30315 One seed and a second incomplete specimen. *D. J. Jenkins Coll.* Herne Bay, Kent.
 V.30316 A seed with testa partly chipped away so as to expose the large chalaza.
 V.30317 A seed somewhat broken at the radicle. The testa is separated from the seed-cast and is embedded externally in pyrites. The chalaza is seen on the cast.
 Both the above *J. E. Cooper Coll.* Herne Bay, Kent.

Tetracera crofti n. sp.

Plate 26, figs. 10, 11

DIAGNOSIS. Seed sub-ovoid, somewhat compressed dorsiventrally, hilar depression deep, transversely oval. Radicular beak on seed-cast conspicuous. Dorsiventral diameter in plane of symmetry about 5 mm.; greatest diameter in same plane, 7.5 mm.; greatest diameter perpendicular to same plane, 6.25 mm.

HOLOTYPE. V.30590.

DESCRIPTION. *Seed*: Sub-ovoid, bisymmetric about a plane passing through hilum, micropyle, and the inferred position of the chalaza. Without lateral compression but somewhat dorsiventrally compressed. Campylotropous, the hilum sunk in a deep, transverse, oval depression adjacent to the micropyle. Testa abraded over much of the hilar surface. Much of the opposite surface has been destroyed by boring animals. On the internal cast of the seed exposed by abrasion the radicle forms a conspicuous snout or beak overhanging and adjacent to the hilar depression. The chalaza (which by comparison with living seeds may be presumed to lie on the ventral surface close to the hilum on the opposite side of it to the radicle and micropyle) is completely hidden by remains of the testa.

Testa formed of several coats. The outer and thickest is always much abraded so that its true surface is not seen, it tends to break into concentric shells and shows in section hexagonal or rounded cells apparently at right angles to the surface, about 0.057 to 0.076 mm. in diameter.

Then comes a thin coat of thin-walled, irregular, loose-textured, polygonal or elongate cells aligned so as to follow the curvature of the seed. The cells may be as much as 0.171 to 0.228 mm. by 0.057 mm. in diameter. These cells have a slightly digitate appearance which may be due to superposed impressions of small equiaxial rounded cells in an adjacent coat not clearly seen.

On the radicle itself there are fine longitudinal striations overlain by a compact layer (perhaps only one cell thick) of fine rounded equiaxial cells about 0.01 mm. in diameter.

Dorsiventral diameter of seed in plane of symmetry about 5 mm.; greatest diameter in the same plane, 7.5 mm.; lateral diameter at right angles to this plane, 6.25 mm.

V.30590 Holotype, figured Pl. 26, figs. 10, 11. A seed with exposed radicle, the testa being much abraded. *W. N. Croft Coll.* Herne Bay, Kent.

Genus HIBBERTIA Andrews

Hibbertia bognoensis n. sp.

Plate 26, figs. 12-14

DIAGNOSIS. Seed sub-globular, slightly laterally compressed, hilar scar sunk within a horse-shoe shaped ridge, angled over the radicular limb at the hilar end of the seed. Testa finely pitted superficially. Inside is a layer, one cell thick, of thin-walled cells about 0.05 mm. in diameter. Dorsiventral diameter of seed in plane of symmetry, 2 mm.; diameter at right angles to this in same plane, 2 mm.; breadth at right angles to plane of symmetry, 1.8 mm.

HOLOTYPE. V.30318.

DESCRIPTION. *Seed*: Sub-globular, bisymmetric about a plane passing through the hilum,

micropyle and chalaza, slightly laterally compressed; campylotropous, beaked at the micropyle, hilar scar sunk delimited by a horse-shoe shaped ridge at the apex of which is the micropylar aperture, hilar aperture between the ends of the arms of the horse-shoe. A ridge passes from the micropyle in the plane of symmetry over the radicular limb dying out towards the dorsal surface (Pl. 26, fig. 13). Chalaza-scar large, oval, conspicuous, seen on the internal cast adjacent to the hilar depression. Testa black shining, 0.05 mm. thick, formed of several layers of cells, finely pitted superficially, the pits (possibly the collapsed walls of cells which were formerly inflated) being about 0.012 mm. in diameter. Within is a thin layer, one cell thick, of thin-walled equiaxial cells (secreting?) at least 0.05 mm. in diameter. The further succession of layers is obscure, but the tegmen appears to be formed of thin-walled, translucent, elongate cells, 0.01 mm. broad, which diverge from the large chalaza-scar. Dorsiventral diameter of seed in plane of symmetry, 2 mm.; diameter at right angles to this in same plane, 2 mm.; breadth at right angles to plane of symmetry, 1.8 mm.

REMARKS AND AFFINITIES. One seed. The campylotropous character, beaked oval form, contiguous micropyle, hilum and chalaza, large oval chalaza-scar, also the character and succession of the integuments, indicate relationship with Dilleniaceae. The lateral compression distinguishes it from *Tetracera*, a genus fairly common in the London Clay, while the form and size of the seed and the fine-celled surface of the testa suggest possible relationship with *Hibbertia*. The seed is less than half the size of the smallest *Tetracera* seeds. The testa and organs are particularly well preserved although the black coat shows signs of cracking so that it is certain to disintegrate.

The genus *Hibbertia* occurs in Australia and New Caledonia.

V.30318 Holotype, figured Pl. 26, figs. 12-14. A seed with testa preserved when the specimen was first examined. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus?

Plate 26, figs. 15, 16

DESCRIPTION. *Seed*: Ovoid, bisymmetric about a plane passing through the hilum, micropyle, and chalaza, slightly compressed laterally, obscurely ridged in the plane of symmetry at the micropylar end and angled throughout its length on one side, campylotropous, with a short transverse curved hilar depression delimiting an inconspicuous triangular beak-like prominence associated with the micropyle and radicle. Outer coat of testa preserved only in patches, obscure. Cast showing obscure impressions of coarse cells about 0.05 to 0.1 mm. in diameter as well as impressions of smaller cells 0.025 mm. in diameter. Dorsiventral diameter, 5 mm.; diameter at right angles to this in plane of symmetry, 4.5 mm.; diameter at right angles to plane of symmetry, 4 mm.

REMARKS AND AFFINITIES. A seed-cast. The form, position of the organs, and character of the coats relates this specimen to Dilleniaceae. It differs from *Tetracera* in that the direction of compression, which is clearly original, is lateral not dorsiventral. Its further determination must await the discovery of more material. Possibly one or two of the supposed distorted specimens referred to *Tetracera*(?) *cantiensis* (Reid & Chandler, 1933: 402, 403, pl. 20, figs. 30-33) should be related to this species.

V.30319 Figured Pl. 26, figs. 15, 16. A seed-cast, *G. F. Elliott Coll.* Sheppey.

DILLENiaceae?

Genus?

Plate 26, fig. 17

A transversely ovoid bisymmetric cast slightly dorsiventrally compressed, with a prominence (marking a radicle?), may be a poorly preserved seed belonging to the family Dilleniaceae. Patches of thick carbonaceous testa adhere to its surface which shows the impressions of equiaxial cells, 0.016 mm. in diameter, and a few adherent remains of flat subcircular secreting cells, about 0.05 mm. in diameter, occur outside them. Within is the internal cast of the tegmen showing elongate cells with pointed or bevelled ends. Maximum diameter of seed in plane of symmetry, 5.5 mm.; dorsiventral diameter, 5 mm.; diameter at right angles to plane of symmetry, 4.5 mm.

V.30320 Figured Pl. 26, fig. 17. A seed-cast. *A. G. Davis Coll.* Barrow Brook (10 feet above high water mark), Sheppey. *In situ*.

Family FLACOURTIACEAE

Genus ONCOBA Forsk.

Oncoba variabilis (Bowerbank) Reid & Chandler

Plate 26, figs. 18-20

1933 *Oncoba variabilis* (Bowerbank): Reid & Chandler, p. 406, pl. 21, figs. 9-18.

One exceptionally well preserved six-lobed fruit has recently been found showing a leathery exterior beset by nodules which often terminate in short sharply-recurved hooks directed towards the base of the fruit. They are shown in profile in Pl. 26, fig. 20. Length of hooks about 1 to 1.5 mm. Transverse diameter of hook bases about 1.5 mm. Longitudinal diameter about 1 mm.

After abrasion the hooks usually disappear and their transversely aligned and elongate bases may remain (Pl. 26, fig. 19). They are frequently emphasized by a small oval patch of pyrites. Bowerbank (1840) shows these bases in his pl. 13, fig. 35. He described warty excrescences sharply carinated but does not mention hooks. Clearly their preservation is rare. The surface of the fruit around the hook bases is transversely striate.

- V.30321** Figured Pl. 26, fig. 18. A highly characteristic seven-lobed placental mass. No seeds are exposed. Maximum transverse diameter (somewhat increased by compression), 19 mm.; dorsiventral diameter, 16 mm. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30586** Figured Pl. 26, figs. 19, 20. A fruit 23 mm. long, 20 by 15 mm. broad, beautifully preserved so that the external recurved hooks can be seen in places. *H. P. Wilkinson Coll.* Swale Cliff, Herne Bay, Kent.
- V.30322** A placenta with fragments of adherent fruit wall. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30323** A segment of a placenta with impressions of seeds. *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus *SAXIFRAGISPERMUM* Reid & Chandler, 1933:245

AMENDED DIAGNOSIS. Fruit ovoid, four- or five-carpelled, four- or five-valved, syncarpous, one-loculed, 11.5 to 15.75 mm. long; placentation parietal, with several rows of seeds along each longitudinal placenta embedded in a mass of fibres. Seeds 0.9 to 1.3 mm. long, ovoid acuminate, anatropous, testa of three coats, the outer apparently spinescent, the middle thick and formed of longitudinal fibres, the inner transversely striate or of transversely elongate cells; tegmen formed of polygonal cells.

TYPE SPECIES. *Saxifragispermum spinosissimum* Reid & Chandler.

Saxifragispermum spinosissimum Reid & Chandler

Plate 26, figs. 21, 22; Text-fig. 37

1933 *Saxifragispermum spinosissimum* Reid & Chandler, p. 245, pl. 8, figs. 30-35.

DIAGNOSIS. That of the genus.

HOLOTYPE. V.22417.

DESCRIPTION. *Fruit*: Ovoid, syncarpous, four- or five-valved, one-loculed, each valve bears a broad, fibrous, median longitudinal, parietal placenta with numerous seeds arranged in from about three to six longitudinal rows (see Text-fig. 37). Some of the larger fruits show nine or ten seeds in each row; the carpel wall is fibrous, the fibres appear to arise from the placentas and to run transversely over the inner surfaces of the valves; the whole locule is filled with a mass of hairs or fibres which sweep around and among the seeds. Length of fruit, 11.5 to 15.75 mm.; breadth (distorted), 8 to 13 mm.

Seed: Ovoid-acuminate, pointed at the micropyle, anatropous, with the hilum adjacent to the micropyle, raphe lateral, chalaza circular, 0.2 mm. in diameter at the broad end. Testa apparently spinescent (unless this is an effect of decay), the outer coat formed superficially of

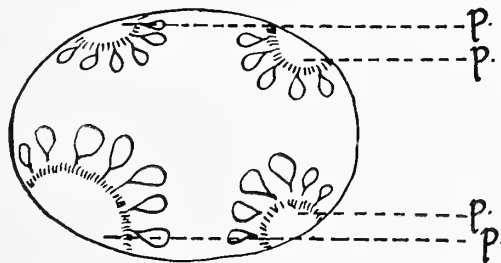


Fig. 37. *Saxifragispermum spinosissimum* n. sp. Diagrammatic transverse section of fruit showing placentas (*p*) with numerous seeds.

equiaxial hexagonal cells from which the spines appear to arise, the cells being 0.017 to 0.025 mm. in diameter, the middle coat thick, longitudinally striate, disintegrating into a mass of longitudinal fibres, the inner coat transversely striate formed, in part at least, of oblong cells 0.02 mm. by 0.05 mm. The tegmen is smooth and shining formed of polygonal cells slightly transversely elongate, 0.016 to 0.025 mm. in diameter, which diverge from the micropyle and chalaza, and are aligned in longitudinal rows in some seeds. Length of seed, 0.9 to 1.3 mm.; breadth, 0.7 to 0.9 mm.

REMARKS AND AFFINITIES. A number of fruits have been found at Herne Bay since 1933 when one only, from Sheppey, was known. A comparison was then made with the families Saxifragaceae and Nymphaeaceae, the fossil being finally referred to the Saxifragaceae largely on the character of the seeds, although no comparable living genus had been seen. Examination of more material and reconsideration of the whole evidence necessitates a correction of the supposed relationship to Saxifragaceae. The single locule with its broad parietal placentae bearing several rows of seeds is unlike any known Saxifragaceae, a family which normally shows two or more locules. It is highly suggestive of Flacourtiaceae. Moreover the succession of coats in the seed and the character of the chalaza are so closely comparable with the same features in *Oncoba* that the probability of relationship with Flacourtiaceae is confirmed. The original diagnosis and description are amended in certain small points which have become apparent from the study of new material.

- V.30324 Figured Pl. 26, fig. 21. A four-valved fruit figured to show the placentation, the seeds (or seed-casts) have been exposed by the abrasion of the surface. The specimen was fractured to establish its identity. *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30325 Figured Pl. 26, fig. 22. Another four-loculed fruit. East Cliff shore.
- V.30326 A four-carpelled fruit fractured transversely to show the parietal placentation. Swale Cliff.
- V.30327 Two fruits, one broken.
- V.30328 An exceptionally large but incomplete fruit, fractured to show the seeds, partially encrusted with pyrites. The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30329 A fractured fruit showing the seeds.
- V.30330 A fruit with exocarp abraded so that the five parietal placentas are exposed as longitudinal fibrous ribs. Some of the seeds are also seen.
- V.30331 A fruit, much encrusted with pyrites, fractured transversely to show the placentation.
- V.30332 A poorly preserved fruit, broken, shows numerous seeds and sweeping fibres. The above *J. E. Cooper Coll.* Herne Bay, Kent.

Family LYTHRACEAE?

Genus *TAMESICARPUM* Reid & Chandler, 1933:421

Tamesicarpum polyspermum Reid & Chandler

Plate 26, fig. 23

1933 *Tamesicarpum polyspermum* Reid & Chandler, pl. 22, figs. 8-21.

- V.30333 Figured Pl. 26, fig. 23. A cast of a small two- or possibly three-loculed, much compressed fruit about 8.5 mm. long, 6 mm. broad. Remains of the carbonaceous fruit wall adhere in the grooves between the locule-casts. The peduncle and inferior calyx persist below. The locule-casts show clear impressions of the numerous seeds with coarse cells.
- V.30334 A cast of a three-loculed fruit only 4 mm. long, 3.25 mm. in diameter, showing obscure impressions of the numerous seeds. Probably referable to this species but unusually small.
- V.30335 A crushed locule-cast with impression of the seeds and their coarse cells. The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30336 A cast of a three-loculed fruit showing impressions of seeds.
- V.30337 Two fruits abraded to show locule-casts. One is three- the other four-loculed. The latter retains the peduncle.
- V.30338 An internal cast of a fruit showing impressions of the closely packed seeds.
- V.30339 A three- and a five-loculed fruit cast both showing impressions of seeds.

- V.30340 Part of a fruit with a few seeds.
 V.30341 A fruit with a few actual seeds preserved.
 The above *J. E. Cooper Coll.* Herne Bay, Kent.
 V.30342 A small three-loculed fruit showing locule-casts. Swale Cliff.
 V.30343 A three-loculed fruit with epicarp abraded. The peduncle is still attached. East Cliff.
 V.30344 A small three-loculed fruit with persistent remains of perianth.
 V.30345 A three-loculed fruit abraded so as to show the locule-casts only.
 The above *D. J. Jenkins Coll.* Herne Bay, Kent.
 V.30346 A small three-loculed fruit cast showing impressions of the seeds with remains of the fruit at base and apex.
W. N. Croft Coll. Herne Bay, Kent.

Genus CRANMERIA Reid & Chandler, 1933:424

Cranmeria trilocularis Reid & Chandler

Plate 26, figs. 24–26; Text-fig. 38

1933 *Cranmeria trilocularis* Reid & Chandler, p. 424, pl. 22, figs. 22–28.

A well-preserved specimen found since 1933 has yielded fuller information in regard to this species than was originally available from the two specimens then known. The outer layers of the exocarp, however, have been largely removed by abrasion, the inner remaining so that the specimen appears pointed elongate-ovoid (not ovoid); its surface is longitudinally rugose with numerous small discontinuous ridges. The lateral limits of the three carpels are indicated on this surface by three longitudinal lines, and the median line of each carpel by a longitudinal furrow or fibre (Pl. 26, fig. 24). Within the striate surface the locule-lining is well seen in certain places, the transverse or obliquely directed striae being about 0.012 mm. apart. On fracture, the specimen showed definite evidence of splitting along the ventral suture of each carpel, i.e. along the differentiated median plane of its projecting bifurcated placenta (see Text-fig. 38).

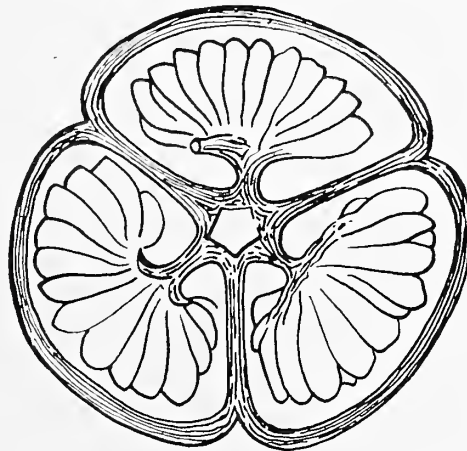


Fig. 38. *Cranmeria trilocularis* Reid & Chandler.
 Diagrammatic transverse section of fruit
 showing three locules and placentas and seeds.

There is a stout median fibrous axis. The numerous seeds are arranged in about twelve to fifteen longitudinal rows in each locule. The coarse cells of the outer coat may be as much as

0.06 mm. in diameter, they vary in outline from quadrangular to hexagonal, they are much inflated externally producing a tubercled surface, the tubercles being sometimes mamillate. They appear to have been elongate over the raphe. Within is a coat, 0.025 mm. thick, of small equiaxial cells about 0.016 mm. in diameter. Within again is a thin coat of coarse cells with finely digitate walls, these cells may be 0.05 mm. long and 0.025 mm. broad. The cell-structure of the tegmen is obscure, but the seed-cast shows transverse striations. Length of fruit as preserved, 25 mm.; diameter about 9 mm.

V.30347 Figured Pl. 26, figs. 24-26; Text-fig. 38. A fruit with the outer layers abraded, now fractured to show the placentation and the seeds. *G. F. Elliott Coll. Sheppey.*

Family RHIZOPHORACEAE

Two obviously related organisms having at first sight the appearance of elongate inferior pods with a terminal mucronate perianth disc when well preserved, and of fragments of wood when poorly preserved, have after detailed examination been referred to the family Rhizophoraceae. They evidently represent two distinct species, and possibly two distinct genera. At a much later stage of this investigation and after completion of this manuscript a third species and genus was recognized (see p. 271).

Microscopic study of the first two types showed distinctive peculiarities of structure, for in transverse and longitudinal section there is no locule cavity or seed and, except for the epidermis, no sharply differentiated and separate integuments. Instead they appear solid throughout, formed in part of loose-textured tissue which may have been cavernous and fleshy in life and therefore very liable to compression in fossilization. They have, however, become heavily impregnated with iron pyrites which fills all cell cavities and interstices and it is undoubtedly to this fact that they owe their preservation; but for this such perishable organisms without hard integuments would almost certainly have decayed.

In section they show within a smooth rather leathery-looking epidermis, one cell thick, a thick cylinder of tissue, 0.5 to about 1 mm. thick, probably in life formed in part of long air canals but having also numerous peculiar longitudinal lines of regular rounded cells which give the appearance of rows of beads when preserved as casts (Pl. 26, fig. 31). Within this cylinder of cavernous tissue is a core of rounded secreting cells more sparsely scattered in the broad form (species *lata*) than in the long narrow form (species *elongata*). In both regions the cell walls appear to have granular or finely netted surfaces giving a superficial appearance of fine equiaxial parenchymatous tissue.

The peculiar form, combined with the cellular tissue throughout, suggested that they might be viviparous embryos of Rhizophoraceae which had separated from their calices. Through the kindness of the Keeper of Botany, British Museum (Natural History), it has been possible to examine microscopically an embryo of *Bruguiera* Lam. The slightly curved spindle-shaped embryo had separated from its calyx and showed a circular disc at the proximal end with a central mucro formed by the plumule. The successive coats seen in longitudinal and transverse sections of the spindle-shaped radicle closely correspond with those of the fossil. Thus the leathery epidermis, one cell thick, is formed of longitudinally aligned more or less equiaxial rectangular cells 0.008 to 0.012 mm. long. Within is a narrow dark cylinder, a few

cells thick, of resinous cells, rectangular or square in surface view, about 0.025 mm. in diameter. Inside again, a cylinder of tissue full of air cavities shows the peculiar rectilinear rows of rounded cells like beads, each bead about 0.03 to 0.05 mm. long. The central core within this cylinder occupies about half the total transverse diameter and is formed of dense dark secreting tissue with more or less equiaxial cells, 0.03 mm. in diameter, and arranged in longitudinal rows. Rudimentary vascular tissue may be represented by longitudinal fibres or striae near the periphery of this inner core. In the core itself and in the 'beaded' area which surrounds it the cell surfaces have a finely netted or coarsely granular appearance, as described for the fossils, suggesting parenchyma but actually a pattern on the wall surface.

There seems no reasonable doubt therefore that mangroves were present in the London Clay flora. Whether *Rhizophora* shows a similar succession of coats remains to be investigated but the enormous attenuated radicle of *Rhizophora* is much less comparable with the fossils than the shorter broader radicle of *Bruguiera*.

In *Bruguiera* the radicle may be longer and narrower, or more definitely fusiform than the fossil. In some species it is more distinctly ribbed longitudinally and the surface finely puckered, in others, e.g. *B. sexangula*, the surface may be smooth. According to Watson (1928) *B. caryophylloides* Bl. is up to 15.5 cm. long and about 7 mm. broad; it is more parallel-sided than the fossil. But specimens of *B. sexangula* (measured at Kew) are only about 50 mm. long (without the calyx) and 12 mm. broad so that they correspond closely in size with the fossil. The fossils are provisionally referred to a new genus *Palaeobruquiera* to indicate the probable relationship.

Rhizophora occurs in the tropics of the Old World with one species in tropical America, *Bruguiera* only in the Old World (China, India and the Phillipines). Both are important constituents of the mangrove forests which occur in association with *Nipa* and *Acrostichum aureum*. They are evergreen trees, able to flourish in saline mud and to withstand occasional inundation by high tides: they grow gregariously over large areas along coasts where the inland flora is a tropical Rain forest associated with heavy rainfall and where large rivers bring down an abundance of fresh water and rich silt in which the mangroves flourish. An interesting account of these trees and their habits is given by Watson (1928).

The third type referred to above evidently belongs to a distinct genus with much longer, more angled and curved radicle (Pl. 32, figs. 25-29). It is represented by fragments only which show in longitudinal section the peculiar rows of rounded cells like beads.

A preliminary note on the occurrence of mangroves in the London Clay was published by the author (Chandler, 1951).

Genus PALAEOBRUGUIERA nov.

DIAGNOSIS. Fossil fruits, or seeds, or parts thereof, belonging to Rhizophoraceae, with viviparous embryos which appear most closely to resemble *Bruguiera*.

TYPE SPECIES. *Palaeobruquiera elongata* n. sp.

Palaeobruquiera elongata n. sp.

Plate 26, figs. 27-31

DIAGNOSIS. Embryo lanceolate, somewhat compressed, broadest at or above the middle. Length about 50 mm. or more; breadth about 9 to 11 mm. Surface smooth.

HOLOTYPE. V.30348.

DESCRIPTION. *Seed*: Represented only by the viviparous embryo from which the calyx and fruit have become separated, somewhat compressed originally but compression aggravated by fossilization, lanceolate in outline, the radicular end rounded or pointed, the opposite end truncated with a circular scar having a thick median prominence which represents the plumule and may show the young leaves folded together. The embryos are usually broadest at or above the middle. A low interrupted longitudinal ridge or series of overlapping ridges occurs along the middle (approximately) of each broad face. The ridges are formed of pyrites or of pyritized coarse cells projecting through the epidermis and may be due to cracking of the surface with subsequent infiltration and consolidation of pyrites. Epidermis smooth, leathery, formed of a single layer, 0.1 mm. thick, of fine rectangular cells aligned in longitudinal rows about 0.01 mm. apart. This coat flakes away on drying and is usually preserved in patches only. When it has decayed a layer of very regular rectangular cells is exposed, the cells, 0.025 mm. in diameter, being preserved as casts in shining pyrites. In section this coat appears to be only a few cells thick and has a resinous appearance. Within it there is a striate coat; the striae are about 0.03 mm. apart and are formed by regular longitudinal rows each of some twenty much inflated cells about 0.05 mm. in longitudinal diameter. They have the appearance of rows of rounded beads. Between these cells are fine rectangular meshes having the appearance of fine parenchyma but actually due to ornamentation of the cell walls. The 'beaded' coat is about 0.5 to 1 mm. thick and may be as much as twenty or more cells deep. No sharply delimited surface separates it from the central core of tissue which it surrounds. The core is formed of rounded but somewhat smaller cells which may be arranged in longitudinal rows of from ten to fifteen contiguous cells often 0.03 mm. in diameter but sometimes larger or smaller. In longitudinal sections there are indications near the edges of this core of longitudinal strands perhaps representing rudimentary fibro-vascular bundles.

Length of a perfect specimen, 49.5 mm.; breadth, 8.5 mm.; thickness, 4 mm. Corresponding measurements of a second specimen, 49.5 × 9.5 × 5 mm. Other imperfect specimens of greater size are of incomplete length; greatest breadth, 11 mm.

- V.30348 Holotype, figured Pl. 26, fig. 27. Perfect specimen with epidermis preserved in places, radicular end somewhat abraded. Hampton, Swale Cliff.
 V.30349 Figured Pl. 26, fig. 28. An abraded specimen showing both ends, about 49.5 mm. long. Near Bishopstone.
 V.30350 Figured Pl. 26, fig. 29. The truncated end of a large specimen showing enlarged plumule clearly. Radicular end imperfect. Hampton, Swale Cliff.
 V.30351 Figured Pl. 26, figs. 30, 31. The truncated end of another large specimen sectioned longitudinally and transversely to show the structure. The radicular end is imperfect. Hampton, Swale Cliff.
 All the above *D. J. Jenkins Coll.* Herne Bay, Kent.

Palaeobrugiera lata n. sp.

Plate 27, figs. 1-3

DIAGNOSIS. Embryo elongate-oval in outline. Length about 45 mm. (estimated from an almost perfect specimen); maximum breadth (above the middle) about 18 mm.; surface smooth.

HOLOTYPE. V.30352.

DESCRIPTION. *Seed*: Represented by the viviparous embryo from which the calyx and

fruit have become separated, now much compressed, probably originally only slightly compressed and subcircular in transverse section. Elongate-oval in outline (as preserved) attenuated gradually to the tip of the radicle, terminated at the plumule end by a circular scar bearing a low conical prominence which represents the leaves of the plumule folded together. Surface smooth, shining, epidermis a single layer of equiaxial cells longitudinally aligned and about 0.012 to 0.016 mm. in diameter as seen superficially, columnar in section and about 0.05 mm. thick (sometimes thinner). Within is a thin coat, about a dozen cells thick or fewer, of regular much inflated, possibly secreting cells, normally about 0.025 to 0.03 mm. in diameter. Within again is a region 0.5 to 0.6 mm. thick, some ten to fifteen cells deep of much inflated sub-globular cells from 0.05 to 0.1 mm. long, now represented by pyrites casts, possibly originally air cavities. The surrounding walls have a granular appearance as if they were formed of fine equiaxial parenchyma, each 'cell' about 0.012 mm. in diameter, probably due, as in the preceding species, to a reticulate pattern all over the cell walls. Longitudinal sections show the regular arrangement of the large inflated cells in very straight longitudinal rows giving a beaded appearance (Pl. 27, fig. 3, *s*), as in *P. elongata*. This cylinder of tissue surrounds a central core formed of coarse sub-globular cells, 0.03 to 0.1 mm. in diameter, the walls again having a granular appearance as described above. A transverse section of the embryo shows the different regions clearly but also shows that there is no sharply delimited line of separation between them such as occurs between two distinct integuments. In this central core a few interrupted longitudinal lines of cells can also be distinguished in longitudinal section. Length (not quite complete at the radicle), 39 mm; depth of scar at the plumule, 5 mm. Maximum breadth (above the middle) of the crushed embryo, 18 mm.; breadth at the circumference of the terminal scar, 11 mm.

- V.30352 Holotype, figured Pl. 27, fig. 1. A viviparous embryo slightly imperfect at the tip of the radicle (narrower end).
 V.30353 Figured Pl. 27, figs. 2, 3. Part of another with terminal scar, fractured to show the structure in transverse and longitudinal section.
 V.30354 Part of a third embryo with terminal scar, now fractured.
 All *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Genus?

Plate 32, figs. 25-29

A number of incomplete, elongate, tapering specimens with four to six sharp angles at first suggested fleshy leaves. They are pointed at one end (but always more or less abraded at the extreme point), always broken at the other end, straight or curved, occasionally much flattened. The surface between the angles is slightly concave. It is leathery and smooth with obscure and intermittent transverse wrinkles, and sometimes longitudinally furrowed. Epidermis of equiaxial cells 0.016 to 0.025 mm. in diameter, often more or less rectangular and arranged in longitudinal rows. In transverse section these cells are aligned at right angles to the surface. One specimen shows a central axis, 0.9 mm. in diameter, having a compact cylinder of cells 0.025 to 0.03 mm. in diameter, surrounding an obscure area of coarser cells within the centre. The main thickness of the section is occupied by parenchymatous cells, about 0.05 mm. in diameter, among which large air-spaces now filled with pyrites (or areas where cell walls have broken down) can be seen. A chance longitudinal fracture of a fragment showed the typical longitudinal

rows of regular rounded cells like short rows of beads as seen in *Bruguiera*. These indicate that the specimens are fragments of the roots of viviparous embryos of some genus of Rhizophoraceae. The markedly ridged or angled curved form indicates that they are quite distinct from either of the species of *Palaeobuguiera* described in the foregoing pages. Pending more complete evidence these broken specimens are referred to the family, but no attempt has been made to relate them to a living genus. It is clear, however, that the nearest relationship is not with *Bruguiera*. The largest fragment (broken at both ends) is 35 mm. long, 7 by 4.5 mm. in transverse diameter. The maximum breadth of another specimen is 5 mm.

V.30355 Figured Pl. 32, figs. 25-29. Five fragments of attenuated angular roots.

V.30356 Six fragments, one much flattened. *In situ*.
All A. G. Davis Coll. Warden Point, Sheppey.

Family ALANGIACEAE

Genus ALANGIUM Lam.

Alangium jenkinsi n. sp.

Plate 27, figs. 4, 5

DIAGNOSIS. Endocarp about 11 mm. long and 8.5 mm. broad probably about 5 mm. thick. Seed about 7.5 to 8 mm. long, 6 to 6.3 mm. broad.

HOLOTYPE. V.30357.

DESCRIPTION. *Endocarp*: Syncarpous, two-loculed, one locule apparently somewhat smaller than the other, sub-ovoid but somewhat compressed, with a slight constriction about 1.25 mm. below the apex producing a beak-like prominence. There is some evidence of an external marginal groove marking the septum between the two parallel locules. External surface smooth with a few coarse irregularly scattered depressions towards the edges of the locule. Surface cells obscure. Carpel wall woody, dorsal wall about 0.5 mm. thick, septum 1.3 mm. thick about the middle, formed of equiaxial cells with digitate walls about 0.025 to 0.03 mm. in diameter. Locule-lining smooth, formed of equiaxial cells with deeply sinuous outlines, the digitations having rounded swollen extremities. The complex interlocking of the cell walls makes the cells difficult to measure but they appear to be about 0.025 to 0.03 mm. in diameter like those within the thickness of the wall.

Locules somewhat compressed dorsiventrally, ovate in outline, narrowing rather abruptly to a point towards the top. Seeds solitary, probably pendulous as suggested by the narrowing above and the rounded opposite end. Germination possibly by dorsal valves suggested by the fact that the larger locule has lost its dorsal wall. Length of endocarp about 11 mm.; estimated breadth about 8.5 mm.; thickness probably about 5 mm.

Seed: Albuminous, probably anatropous with a marginal furrow for the raphe. Agreeing with the locule in shape, hence compressed dorsiventrally, ovate in outline, narrowed at the end adjacent to the apex of the fruit. The dorsal surface is slightly convex, the ventral almost flat. Embryo with broad flat cotyledons, each about 0.2 mm. thick at the centre of the seed, lying between two thick layers of albumen each about 0.8 mm. thick as seen in transverse section. Testa of a layer of angular equiaxial straight-sided but somewhat irregular cells about

0.025 to 0.03 mm. in diameter. Surface of endosperm and tegmen transversely striate owing to the transverse alignment of small square cells with thickened transverse walls 0.012 to 0.025 mm. apart. In places there appear to be transversely elongate cells with oblique, bevelled, pointed or rectangular ends. These cells are concentrically aligned around the rounded end of the seed-cast where there may be an obscurely delimited chalaza scar. Locule-cast (virtually a seed) about 8 mm. long, 6.3 mm. broad. Length of the seed in the smaller locule about 7.5 mm.; breadth about 6 mm.

REMARKS AND AFFINITIES. A single fruit with one locule exposed by the removal of the dorsal wall in fossilization showing the pyrites locule-cast with impressions of the sinuous cells of the locule-lining. Part of the dorsal wall of the second smaller locule was chipped away and in doing this the specimen shattered exposing a calcite replacement of the seed in which the endosperm and two cotyledons could be clearly distinguished in section. The tegmen cells were visible all over the cast and in patches on the detached valve the testa cells could be seen lying behind a transversely striate calcite film representing the tegmen.

The form of the two-loculed endocarp with its beak-like apex, the structure of the seed with marginal furrow for the raphe, and the cell-structure of carpel, testa and tegmen all agree in every respect with *Alangium*, a palaeotropical genus of about twenty species. In the living material the transverse striae of the tegmen are more conspicuous in the abortive than in the fertile locule. The cotyledons show superficial transverse striae 0.025 mm. apart made up of stout square cells. The genus is distinctive, but owing to the poor condition of the single specimen it is difficult to define specifically. Nevertheless a specific name, *A. jenkinsi*, has been given after D. J. Jenkins the finder, as there can be little doubt that the species would be readily recognizable if more specimens were obtained from the London Clay at any time.

Until comparatively recently the Alangiaceae had not been recognized as a possible constituent of Tertiary floras. Potbury (1935: 79), however, described some leaves from the Upper Eocene or Lower Oligocene La Porte flora of California under the name *Alangiophyllum petiocalum*. The main interest of these specimens which in their gross foliar characters were closely comparable with the leaves of the living *Alangium chinense* is that in some of them the internal anatomy of the petiole was well preserved. Their structure was studied by Dr. I. W. Bailey, who concluded that they did not fall within the structural range of *Alangium* and probably represented a new genus. This genus, *Alangiophyllum*, was therefore left *incertae sedis*, and not even definitely referred to the Alangiaceae (or Cornaceae). Kryshtofovich & Borsuk (1939) transferred to *Alangium* certain abundant leaves from the Miocene of the Irtysh River, Western Siberia, previously described as either *Ficus* or *Buettneria*; they suggested that leaves from other localities formerly named *Ficus tiliaefolia* and *Buettneria aequalifolia* may also have to be referred to *Alangium*. An endocarp of *Alangium* (*A. kirchheimeri*) has been figured and described by Szafer (1947) from the Pliocene of Poland. Whatever may be the conclusion as to the fossil leaves, the fruit just described shows that *Alangium* was represented in the London Clay flora.

V.30357 Holotype, figured Pl. 27, figs. 4, 5. A single carpel broken so as to show the two locules. One contains the remains of a pyrites locule-cast, the other contains the calcite cast of a seed. *D. J. Jenkins Coll.* Herne Bay, Kent.

Family NYSSACEAE

In 1933 Reid & Chandler instituted two new genera belonging to Nyssaceae distinguished chiefly by the number of locules. *Protonyssa* in addition to two locules had eight or ten longitudinal bands of fibres externally, two of which follow the margins of the germination valves. These fibres were not seen in the three- to four-loculed *Palaeonyssa*. The absence of the fibres may be due to abrasion which may also have caused the difference in appearance of the external ribbing as between one supposed species of *Palaeonyssa* and another. Kirchheimer (1939: 269, 270, text-fig. 2; 1948: 97, 98) has pointed out that Recent *Nyssa* is known with two locules viz. *N. sinensis* Oliver. Also the fossil endocarps described by him as *N. disseminata* (Ludwig) from the Brown Coal of Saxony may show usually one, but exceptionally two or even three locules. He therefore concluded that *Protonyssa* Reid & Chandler cannot be regarded as a distinct genus. His grounds for this opinion appear reasonable and it may ultimately be necessary to refer *Palaeonyssa* also to the genus *Nyssa*. It is true that its germination valves are narrowed to the base, not broad as in *Nyssa*. This, however, may be an inevitable consequence of the larger number of locules, for clearly the breadth of the valves cannot be as great where four occupy the circumference of an endocarp as in cases where there are one or two only in a corresponding space. Pending further investigation the genus *Protonyssa* is deleted. The narrow valved *Palaeonyssa* (whether three- or four-loculed) is provisionally retained until there is evidence that more than three locules with narrow valves can occur in the genus *Nyssa*.

Genus NYSSA Gronov. ex Linn.

Nyssa bilocularis (Reid & Chandler) Chandler

1933 *Protonyssa bilocularis* Reid & Chandler, p. 429, pl. 23, figs. 5-10.

- V.22896-98 The reference to a separate species is retained for the present, but as two locules cannot in themselves constitute a valid generic or specific distinction in *Nyssa* it is difficult to see how the species can be satisfactorily defined on the available material. The ovoid form may be noted. There is nothing peculiarly distinctive about the size and it may ultimately be necessary to record the specimens as *Nyssa* sp.
- V.30369 A small much abraded endocarp with locule-casts exposed showing the impressions of the dorsal germination valves at the apex. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30370 An abraded endocarp showing evidence of two locules and seeds may be referable to this species which it resembles in size. *J. E. Cooper Coll.* Herne Bay, Kent.

Nyssa cooperi n. sp.

Plate 27, figs. 6, 7

DIAGNOSIS. Endocarp about 9.5 mm. long, 6.25 mm. broad, three-loculed with broad triangular germination valves as in *Nyssa*.

HOLOTYPE. V.30371.

DESCRIPTION. *Endocarp*: Somewhat obovoid, syncarpous, three-loculed (two locules may be abortive), obscurely three-angled at the apex, locules single-seeded. Germination by broad triangular valves at the apex of the endocarp, broadest below, pointed above where they begin to gape, one to each locule, occupying about one-third of the length of the endocarp. Carpel

wall thick, woody, fibrous, its inner layers formed of masses of fine transverse fibres; having a few external longitudinal bands of fibres sunk in furrows (two such can be seen overlying the fertile locule, others elsewhere on the surface of the endocarp are concealed by an incrustation of pyrites). Locule-lining with fine mainly transverse striations, due to transversely oriented cells or fibres. Length of endocarp, 9.5 mm. (*N. sylvatica* and *N. sylvatica* var. *rugosa* 6.5 to 8 mm. and 9 mm. respectively), maximum breadth about 6.25 mm.

Seed: Anatropous, agreeing with the locule in shape, much puckered so as to be longitudinally ridged, probably as the result of shrinkage and not a specific character, dorsiventrally compressed, elongate, rounded at the base, triangular in outline at the apex, broadest at about one-fifth of the length from the apex. Raphe broad, flat, median on the ventral face which is more or less gently convex, dorsal surface not seen. Testa formed of square inflated cells about 0.03 mm. in diameter and elongate cells which diverge from the raphe at the middle of the ventral surface. Tegmen of rectangular cells about 0.025 mm. in diameter arranged in transverse rows. Length of seed, 7.75 mm.; maximum breadth, 6.3 mm.

REMARKS AND AFFINITIES. One fruit fractured to show the calcite seed and seed-cast and fertile locule, and one of the abortive locules. It agrees with the living genus *Nyssa* in having a broad triangular germination valve, unlike the forms referred to *Palaeonyssa*. *Nyssa cooperi*, named after the finder, differs from *Nyssa bilocularis* in its small size (*N. bilocularis*, length 18.5 mm.)

V.30371 Holotype, figured Pl. 27, figs. 6, 7. An endocarp fractured longitudinally showing the calcite seed and seed-cast. *J. E. Cooper Coll.* Herne Bay, Kent.

Nyssa sp.

Plate 27, fig. 8

DESCRIPTION. *Endocarp*: Elongate oboval in outline, much compressed dorsiventrally, showing the characteristic form of the apical germination valve of *Nyssa* on the dorsal surface. Woody, fibrous, much abraded especially around the margin and consequently showing the transverse alignment of the inner layers of fibres, and the longitudinal alignment of the outer layers. Locule-lining formed of oblong cells longitudinally aligned, 0.025 mm. broad, forming longitudinal striations. Length and breadth of specimen incomplete owing to abrasion.

Seed: Apparently conforming to the locule in shape. Testa obscure, tegmen represented by the impression of transversely aligned cells on the seed-cast. Length approximately 14 mm.; breadth, 6.5 mm.

REMARKS AND AFFINITIES. One endocarp abraded so as to expose the locule-cast and seed around the circumference. The evidence for the *Nyssa*-like germination valve is seen in the apical curved area on the dorsal surface of the locule-casts extending for nearly one-third of the length.

The relationship with the Nyssaceae, and probably with the normally one-loculed genus *Nyssa*, is indicated by the structure of endocarp and seed, and by the character and position of the germination valve. In view of the abraded state of the specimen no specific name has been given.

V.30358 Figured Pl. 27, fig. 8. An abraded one-loculed one-seeded endocarp with locule-cast and seed exposed around the worn margin of the specimen. Compressed dorsiventrally. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Nyssa sp.

Plate 27, figs. 9, 10

- V.30359** Figured Pl. 27, fig. 9. A locule-cast with remains of carbonaceous coat and endocarp fibres. It shows clear evidence of the germination valve occupying about one-third of the length. The form suggests that it was a one-loculed species. Length (estimated, apex not quite complete) about 10 mm.; breadth about 4.5 mm. A smaller form than V.30358, perhaps distinct.
- V.30360** Figured Pl. 27, fig. 10. A locule-cast (now fractured and incomplete) with remains of endocarp, and adherent pyrites.
Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Nyssa spp.

Plate 27, figs. 11, 12

An elongate-obovate much compressed locule-cast suggests relationship with Nyssaceae. The ventral surface has a longitudinal median furrow which carries a strand of fibres (funicle?) (Pl. 27, fig. 12), the dorsal surface has two shallow, longitudinal, median, rounded ridges delimited by three shallow furrows (Pl. 27, fig. 11). A differentiated triangular area at the apex of the cast on the dorsal surface, occupying about one-third of the length, suggests a germination valve of *Nyssa*, but there is also a shorter differentiated area at the apex on the ventral surface. Impressions of criss-cross or tortuous fibres are seen in patches on the surface especially at the apex; elsewhere the surface is longitudinally striate owing to the impressions of longitudinally elongate cells. The dorsiventral compression appears to be original. Length of cast, 11.25 mm.; breadth, 5 mm.; thickness, 1.5 mm.

- V.30361** Figured Pl. 27, figs. 11, 12. A locule-cast.
- V.30362** A somewhat similar locule-cast to V.30361 with one median rounded ridge on the dorsal surface. It is incomplete at the apex. Possibly referable to a different species.
- V.30363** A smaller locule-cast with a single rib on the dorsal surface and a valve which occupies almost half the length.
- V.30364** Two locule-casts with remains of endocarp (much encrusted with pyrites); one is fractured to show the germination valve and the seed-cast. The valve occupies about one-third of the length in each specimen. The larger specimen is about 14 mm. long, the smaller about 10 mm.
All the above *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30365** A locule-cast with adherent remains of fibrous endocarp on both surfaces. The germination valve occupies about one-third of the length of the cast. The small area of the dorsal surface exposed at the lower end of the fruit suggests that there were two median ridges on the dorsal surface. Length of specimen about 14 mm. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus PALAEOONYSSA Reid & Chandler, 1933:431

Palaeonyssa multilocularis Reid & Chandler

Plate 27, fig. 13

1933 *Palaeonyssa multilocularis* Reid & Chandler, p. 431, pl. 23, figs. 11-15.

A much abraded three-loculed endocarp with one locule-cast very perfectly preserved and well exposed by the abrasion of the woody wall of the endocarp. Remains of the other two

locule-casts can be clearly seen. The transverse fibres of the inner layers of the endocarp are exposed, and there are remains of stout longitudinal fibres in the wall between the locules.

The outline of the narrow oval germination valves is visible on the locule-casts (Pl. 27, fig. 13). They occupy about one-third of the length of the locule-casts (or seeds). The surface cells of the seed-cast are obscured by the remains of the endocarp and locule-cast. There is a rounded longitudinal median ridge on the dorsal surface of the locule-cast extending throughout the whole length. Length of endocarp (abraded and incomplete) about 13 mm.; breadth, 6.5 mm. (also incomplete). Length of locule-cast, 12.5 mm. Breadth across the broadest part of the valve, 3 mm.

- V.30366** Figured Pl. 27, fig. 13. A much abraded three-loculed endocarp showing the outlines of the narrow oval germination valves. *E. M. Venables Coll.* 'Beetle Bed': Bognor, Sussex.
- V.30367** A three-loculed endocarp with much worn exterior. Broken to establish its identity, only one locule is fully developed. *J. E. Cooper Coll.* Herne Bay, Kent.

Palaeonyssa sp.

Plate 27, fig. 14

Two carpels of a woody fibrous fruit (two others have probably broken away). The locules are long and sub-triangular in outline, and in transverse section somewhat U-, V-, or C-shaped with the concavity on the dorsal side. At the apex of each locule there is evidence of a short oval dorsal valve. Length (incomplete as preserved), 9.5 mm.; breadth, 7.5 mm.

Evidence about this specimen is slender, it appears to be referable to Nyssaceae, and is probably allied to *Palaeonyssa*. It may be specifically identical with *Palaeonyssa* sp. from Sheppey (Reid & Chandler, 1933: 433), a several-loculed form with locules of similar shape. The evidence in both is so scanty that no specific determination has been attempted.

- V.30368** Figured Pl. 27, fig. 14. An abraded incomplete endocarp, showing two locule-casts. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family MYRTACEAE?

Genus HIGHTEA Bowerbank emend. Reid & Chandler, 1933:439

Hightea elliptica Bowerbank

Plate 28, figs. 1-4

1933 *Hightea elliptica* Bowerbank: Reid & Chandler, p. 440, pl. 24, figs. 1-17.

- V.30372** Figured Pl. 28, figs. 1, 2. A fruit with part of the exterior preserved and part of the columella exposed, the apex of one seed in the upper tier is exposed at the tip of the fruit. *J. G. Turner Coll.*
- V.30373** Figured Pl. 28, fig. 3. A columella. *J. G. Turner Coll.*
- V.30374** Figured Pl. 28, fig. 4. A typical seed probably of this species (cf. Reid & Chandler, 1933: 440, pl. 24, figs. 1-17). Length, 8.5 mm.; dorsiventral thickness, 2 mm.; maximum breadth of dorsal flattening, 2.75 mm. *E. M. Venables Coll.*
- V.30375** A fruit with carbonaceous exocarp partly abraded so as to expose one of the seeds of the upper tier lying on top of the placenta. *E. M. Venables Coll.*
All the above from 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30376** An abraded fruit with some of the seeds exposed. *J. E. Cooper Coll.* Herne Bay, Kent.

Hightea turgida Bowerbank

1933 *Hightea turgida* Bowerbank: Reid & Chandler, p. 446, pl. 24, figs. 18-26.

V.30377 A fruit. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Genus ALDWICKIA nov.

DIAGNOSIS. Fruit obovoid, inferior, syncarpous, four-carpelled, originally four-loculed, four-seeded, subsequently becoming one-loculed by the separation of the pericarp which leaves a swollen fibrous columella four-rayed below owing to the pockets formed by the remains of the locules. Seeds pendulous, sub-terete, slightly flattened at the hilar end, anatropous with terminal hilum and chalaza. Length of seeds about 8 mm.; breadth about 1.5 mm.

TYPE SPECIES. *Aldwickia venablesi* n. sp.

Aldwickia venablesi n. sp.

Plate 28, figs. 5-12; Text-fig. 39

DIAGNOSIS. That of the genus.

HOLOTYPE. V.30378.

DESCRIPTION. *Fruit*: Obovoid, syncarpous, four-carpelled, inferior, calyx accrescent for most of its length but contracted at the apex and free above the contraction. Mode of dehiscence not clear, perhaps partially by longitudinal splitting as suggested by a tendency to fracture in this way, perhaps by shedding the seeds through a gaping aperture at the apex as in many Myrtaceae (cf. Pl. 28, fig. 11). External surface abraded, epicarp obscure. Exocarp formed of two thick coats, the outer coat from 1.3 mm. thick at the broadest part of the fruit to 0.55 mm. in the free apical part of the perianth, formed of pulpy cells (0.1 mm. long by 0.05 mm. broad) arranged radially (Text-fig. 39E); the inner coat, at the least 1 mm. thick, dying out at the junction of the free and accrescent parts of the perianth, formed of finer radially aligned cells than the outer coat. Between the two coats are a few longitudinal fibres which run throughout the length and branch in the upper part (Text-fig. 39A). The fruit appears originally to have had four single-seeded locules (Text-fig. 39B), but it may later have become unilocular (on ripening?) by the separation of the fruit-wall from a stout axis or columella formed by the septa and ventral walls of the locules. This columella is pointed above, four-rayed below where the septa alternate with the locules which are situated in the lower two-thirds of the fruit forming pockets on the side of the columella when isolated (Pl. 28, fig. 8; Text-fig. 39D). It has a stout fibrous axis from the top of which the seeds are suspended by long funicles which traverse the upper part of the columella and enter the locules at their apices (Text-fig. 39C). The septa are formed of stout fibres and show a marked tendency to septicial splitting (Pl. 28, fig. 6). The locule-lining is smooth, formed of fine fibres usually transversely or obliquely aligned, sometimes tortuous. Length of fruit as preserved, 14 mm.; length of accrescent calyx about 11 mm.; diameter of fruit, 8 mm.

Seed (Pl. 28, figs. 9, 10): Sub-terete, flattened at the hilar end on the dorsal surface, flanged on one side at the sub-terminal hilum, anatropous, raphe dorsilateral along the flanged margin extending for the whole or almost the whole length of the seed. Chalaza terminal at the

opposite end to the hilum, micropyle terminal adjacent to the hilum marked by divergence around it of the tegmen cells. Testa formed of a layer of digitate cells about 0.05 to 0.075 mm. long by 0.025 to 0.05 mm. broad, varying considerably in size and shape. Tegmen smooth,

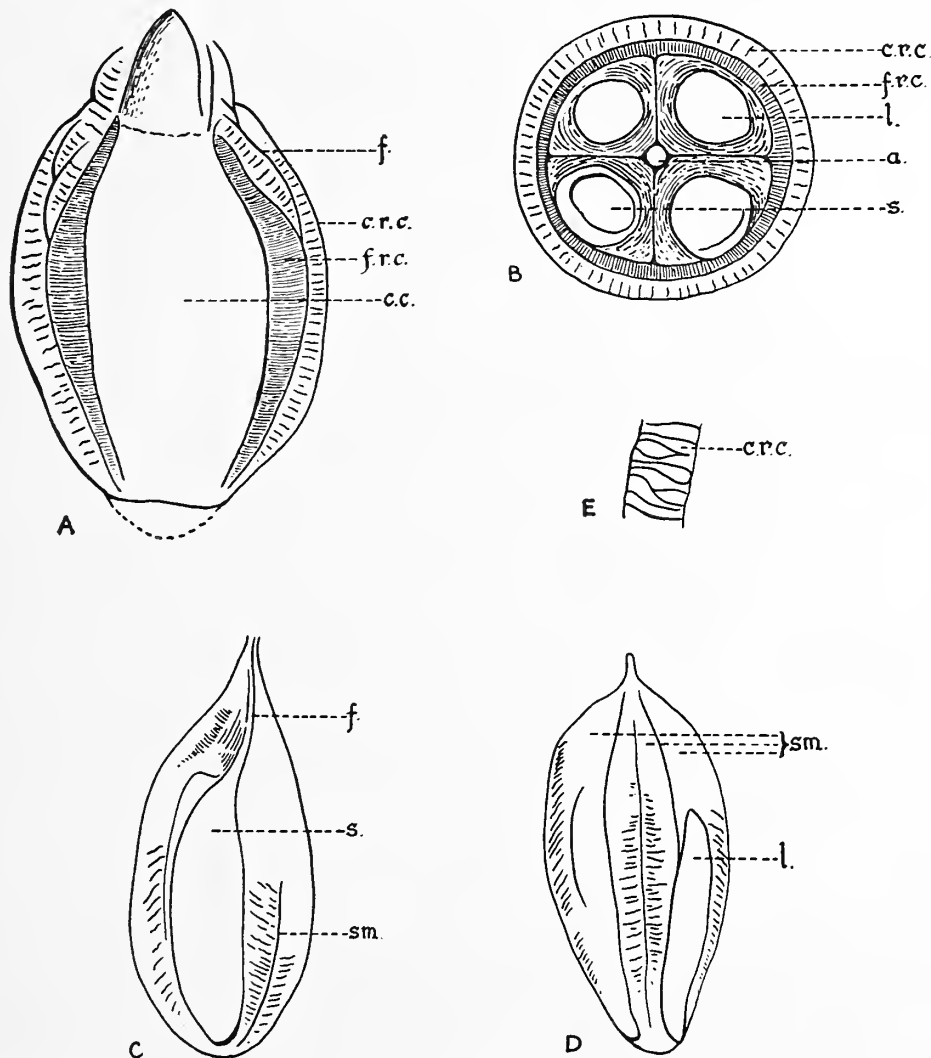


Fig. 39. *Aldwickia venablesi* n. sp. A, longitudinal section (*f*, fibres). B, transverse section. C and D, detached columella. E, section showing coarse radial cells of outer coat of exocarp. *a*, axis; *cc*, cavity for columella; *crc*, coarse radial cells of outer coat; *f*, funicle; *frc*, fine radial cells of inner coat; *l*, locule; *s*, seed lying in locule; *sm*, septum.

formed of polygonal and quadrangular cells, about 0.025 mm. in diameter, with a slight tendency to transverse alignment. Length of seed, 7.25 to 8 mm.; breadth, 1.5 mm.

REMARKS AND AFFINITIES. Three specimens. The best preserved which gave the fullest information was a fruit now rapidly splitting into longitudinal segments (Pl. 28, figs. 5-10). Inferior fruits with central axis and solitary pendulous anatropous seeds having a dorsilateral raphe are to be found in few living families, and no closely comparable living genus has been

discovered. Symplocaceae differ in the structure of endocarp and testa, Cornaceae lack the central canal and fibrous axis. The form of the fruit strongly recalls Myrtaceae, the seeds are closely akin to those of *Hightea* (tentatively referred to the Myrtaceae, Reid & Chandler, 1933: 439, 440) both in form and anatomy. There appears to be a comparable separation of the outer fruit wall from an enlarged central columella. The relationship between the two must be very close indeed. *Hightea* is distinguished by the arrangement of its seeds in two tiers, an upper tier of ascending seeds, and a lower tier of pendulous seeds; moreover there are differences in details of structure between the two fruits, and the inferior character, although it may be inferred in *Hightea* from the structure of the pericarp, has not been conclusively established in that genus. The Bognor fruit has therefore been described as a new genus *Aldwickia* (from the place of origin of the holotype near the village of Aldwick) closely allied to *Hightea*, the species is named in honour of the finder, Mr. E. M. Venables.

Another specimen (Pl. 28, fig. 11), whose true character was not at first recognized, was found at Herne Bay in 1933. The better preserved Bognor fruit made it possible to interpret this less complete example.

- V.30378 Holotype, figured Pl. 28, figs. 5-10; Text-fig. 39. A fruit, now broken, showing seeds (Figs. 9, 10) and the decaying columella (Fig. 8). *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30379 Figured Pl. 28, fig. 11. A sub-obovoid cup-shaped fruit truncate at the apex by a large smooth-rimmed aperture. The free part of the perianth seen in the Bognor specimen seems to have broken away where the fruit contracts near the apex. The specimen is obscurely five-angled with a tendency to split into longitudinal segments along stout fibres midway between the angles. The columella is not preserved. One ripe seed only remains in the gaping fruit. The seed is terete, slightly flattened at one end with organs probably at opposite ends but very obscure. The testa is formed of digitate cells, about 0.05 to 0.075 mm. in diameter; the tegmen is smooth, formed of polygonal or quadrangular cells about 0.025 mm. in diameter with a slight tendency to transverse alignment. Length of fruit, 11 mm.; breadth, 9.5 mm. *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30380 Figured Pl. 28, fig. 12. A detached columella with adherent remains of two and a half seeds. Locule-lining of fine transverse or criss-cross fibres. Testa with two layers of digitate cells, in the outermost layer the cells are equiaxial, in the inner they are longitudinally elongate, the longest diameter being about 0.05 mm. Tegmen cells about 0.05 mm. long by 0.05 to 0.1 mm. broad, with irregular transverse alignment. Length of specimen (as preserved incomplete), 10 mm.; breadth, 5.5 mm. Length of a seed, 7 mm.; breadth, 1.25 to 1.5 mm. *J. G. Turner Coll.* Sheppey.

Family ONAGRACEAE

Genus PALAEEUCHARIDIUM Reid & Chandler, 1933:426

AMENDED DIAGNOSIS. Fruit sub-globular to ellipsoid, three- to five-loculed with one seed in each locule. Length of fruit about 4 to 4.5 mm.; diameter, 2.8 to 4 mm. Seed ovate in outline, triangular in section, formed of a seed-body (lying near the dorsal side) and a thickening or wing to the ventral side; seed-body obovate in dorsal outline, sub-oval in transverse section; wing or thickening formed of large prismatic cells, 0.6 to 0.9 mm. by 0.05 mm., with their long axis perpendicular to the surface of the seed-body. Length of seed, 4 mm.; breadth of dorsal face, 2.3 to 2.75 mm.; dorsiventral thickness, 1.25 to 1.7 mm.; corresponding dimensions of seed-body, 2 by 0.6 by 0.3 mm.

Palaeocharidium cellulare Reid & Chandler

Plate 28, figs. 13-20

1933 *Palaeocharidium cellulare* Reid & Chandler, p. 426, pl. 23, figs. 1-4; text-fig. 16

DIAGNOSIS. That of the genus.

HOLOTYPE. V.22895.

DESCRIPTION. *Fruit*: Sub-globular or sub-ovoid with a large basal subcircular scar. Epicarp wrinkled (owing to shrinkage?) formed of quadrangular or polygonal cells, 0.03 mm. in diameter, aligned approximately longitudinally. Within is a coat of oblong secreting cells varying in size, some as much as 0.2 mm. long. Within again are fine longitudinal fibres. The pericarp, several cells thick, is mainly formed of small cells longitudinally aligned. Three- to five-loculed, three- to five-seeded, the seeds lying in the angles made by the septa which diverge from a stout fibrous upward tapering axis. Septa flat, thin and fibrous, the cells and fibres being longitudinally aligned. Length of fruit about 4 mm.; breadth about 2.8 to 3.25 mm.

Seed: Probably anatropous with dorsal raphe, ovate in outline, triangular in transverse section the dorsal face being somewhat convex, and the two ventral faces usually inclined at an angle which varies in size with the number of locules so as to fit exactly into the locules. There is a median longitudinal furrow on the ventral angle of the seed which corresponded with the axis of the fruit and so was widest at the base (Pl. 28, fig. 20). In transverse section the seed shows a seed-body, sub-oval in section with its longer diameter tangential to the surface of the fruit. Covering the body on the ventral side is a stiff wing-like appendage continued around the apex and sides of the body (Pl. 28, fig. 15). Dorsal face of body as revealed by abrasion of the dorsal part of the testa, obovate in outline (Pl. 28, fig. 13) having a median longitudinal groove (raphe groove?) which is continued to the apex of the wing.

The seed-coats are as follows passing from within outwards: (1) An inner coat (the tegmen?) formed of a single layer of small square or oblong cells, 0.016 mm. broad, which are aligned in longitudinal rows; they also have a marked tendency to be concentrically aligned around the apex (chalaza?) of the seed-body. (2) An outer coat which appears to differ in character on the dorsal and ventral faces. It forms a wing-like appendage or thickening on the ventral side and around the apex and lateral margins of the seed. On the ventral face the cells are elongate, some measuring as much as 0.6 or 0.9 mm. in length and 0.05 mm. in diameter, they are everywhere aligned at right angles to the surface of the seed-body consequently at the apex of the seed the alignment is upwards (Reid & Chandler, 1933, pl. 23, figs. 2, 3); at the margin of the dorsal surface they are slightly recurved. The cells although very large are close-set and compacted, being hexagonal in cross-section. Sometimes the thickness is formed by a single cell, sometimes by two or three cells placed end to end (Reid & Chandler, 1933: 427, text-fig. 16). Over the whole ventral surface they are so compacted and of such appropriate lengths that the ventrolateral faces of the seeds fit into the angular spaces between the septa. The cells taper to a point rather suddenly at their free ends. Their lateral surfaces show conspicuous oblique markings due to spiral ridges. On the dorsal face of the seed there may be an external layer of large cells but the cells which form the main thickness of this coat are smaller, almost equiaxial in diameter, aligned transversely in the inner layers. The coat on this side is about five or six cells deep, and about 0.15 mm. thick. Towards the lateral margin these cells become elongate where they are

adjacent to the coarse elongate cells of the ventral side. Length of seed, 4 mm.; breadth of dorsal face, 2.33 mm.; greatest dorsiventral thickness, 1.7 mm. Length of seed-body, 2 mm.; breadth, 0.6 mm.; thickness, 0.3 mm.

REMARKS AND AFFINITIES. Nine fruits or seeds. The fossil species *Palaeoeucharidium cellulare* was founded on a four-loculed four-seeded fruit from Minster. Four three-loculed, three-seeded specimens and one five-loculed, five-seeded fruit have since been found at Bognor; their discovery has necessitated slightly amending the original diagnosis and description.

Reid & Chandler (1933: 427) gave reasons for referring the four-loculed specimen to the family Onagraceae, together with reasons for allying it to *Eucharidium* while distinguishing it from that genus. In the family Onagraceae the fruits are typically but not invariably two- to four-partite. The discovery of three- and five-partite specimens throws doubt on the ascription to this family, but no more likely relationship can be suggested at present. The specific identity of the new material with the type of *Palaeoeucharidium* cannot be doubted.

- V.30381 Figured Pl. 28, fig. 13. A much abraded three-loculed fruit with three seeds. Now fractured.
 V.30382 Figured Pl. 28, figs. 14, 15. A fruit now fractured to show the structure. Two out of three seeds were preserved, the third has fallen away. Remains of the fruit wall and basal-scar are seen. One seed is fractured transversely and figured (Fig. 15) to show the testa in section.
 V.30383 Figured Pl. 28, figs. 16-18. A five-loculed, five-seeded fruit.
 V.30384 Figured Pl. 28, fig. 19. A three-loculed fruit with exocarp partly preserved, now fractured to show the seeds.
 V.30385 Figured Pl. 28, fig. 20. Detached seed now fractured transversely. The seed was 4 mm. long, 2.75 mm. wide, 1.25 mm. thick. It has a shallow broad longitudinal groove at the middle of the ventral face, and the cells of the ventral surface (0.025 to 0.05 mm. long by 0.05 mm. broad) are longitudinally aligned.
 V.30386 Two four-loculed fruits, one abraded showing the seeds with their coarse cells.
 V.30387 A detached seed showing the longitudinal cells on the dorsal surface covering the coarse cells at right angles to the seed-body. Also a second seed.
 V.30388 A three-loculed fruit fractured to show the structure of the seeds.
 All the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family CORNACEAE

Section MASTIXIOIDEAE

Genus MASTIXIA Blume

Mastixia cantiensis Reid & Chandler

Plate 28, figs. 21-26

1933 *Mastixia cantiensis* Reid & Chandler, p. 448, pl. 25, figs. 1-6.

- V.30389 Figured Pl. 28, figs. 21, 22. An endocarp covered on one side by about half the exocarp. The specimen, about 21.5 mm. long, the breadth incomplete, is fractured in such a manner as to show the dorsal concavity of the locule-cast. Apex incomplete. Externally four or more longitudinal strands of fibres are preserved; the surface is somewhat worn and polished so that the cell-structure of the epicarp is obscure, but in places equiaxial cells, about 0.05 mm. in diameter, can be seen probably representing a layer immediately beneath the epicarp. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.30390 Figured Pl. 28, fig. 23. A worn endocarp (valve and infold missing).
 V.30391 Figured Pl. 28, figs. 24-26. A worn endocarp fractured transversely.
 V.30392 A locule-cast showing impressions of the testa cells.

- V.30393 A locule-cast and two worn endocarps fractured transversely.
 V.30394 A valve from a large endocarp. Also a smaller endocarp, now fractured transversely, and a larger one fractured longitudinally to show the side of the seed-cast.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30395 A locule and seed-cast with remains of endocarp, small, but probably referable to this species. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30396 A seed or locule-cast much water worn. *D. Ramwell Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30397 Two fruits fractured, with exocarp preserved. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Mastixia parva Reid & Chandler

Plate 28, figs. 27-31

1933 *Mastixia parva* Reid & Chandler, p. 451, pl. 25, figs. 10-17.

A few additional endocarps from old localities are figured because they show very beautifully the rugose endocarp which was not preserved so well in the specimens originally described. An endocarp from the new locality at Bognor is also figured.

- V.30398 Figured Pl. 28, fig. 27. An endocarp with rugose carbonaceous endocarp well preserved when photographed but since decayed. *A. G. Davis Coll.* Warden Point, Sheppey.
 V.30399 Figured Pl. 28, figs. 28, 29. A relatively unworn endocarp. The median infold has begun to split longitudinally and is filled with pyrites. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
 V.30400 Figured Pl. 28, figs. 30, 31. An endocarp fractured transversely to show the U-shaped locule-cast. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30401 An endocarp. *A. G. Davis Coll.* Royal Oak (six feet above high water mark), Sheppey. *In situ.*
 V.30402 A small endocarp which has begun to split along the median infold, the crack having become filled with pyrites. Length, 8.25 mm.; breadth, 5 mm. *G. F. Elliott Coll.* Warden Point, Sheppey.
 V.30403 Part of a locule-cast 11 mm. long, enclosing a seed. *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31).
 V.30404 A locule-cast partially abraded to show the seed within. The substance of the valve is preserved in the dorsal hollow.
 V.30405 Five locule-casts, some with remains of endocarp; two smaller casts may also belong to this species, or possibly to *Portnallia* (see p. 285).
 V.30406 Two endocarps, one fractured transversely, the other longitudinally.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

?*Mastixia* sp.

Plate 28, figs. 32, 33; Text-fig. 40

DESCRIPTION. *Carpel*: One-loculed, one-seeded, bisymmetric (distorted in fossilization), elongate-ovate in outline, dorsiventrally compressed, somewhat angled medianly on the dorsal surface, gently convex on the ventral which bears four low, rounded, longitudinal ridges, two near the middle, two at the margins. A roughened area at the more pointed end on the ventral side suggests an organ (Pl. 28, fig. 32). Walls woody, outer part of thick-walled parenchyma, inner of several layers of transverse fibres. Ventral wall about 0.03 mm. thick; dorsal wall greatly thickened and infolded to form a plug of tissue chiefly of equiaxial cells which fills the dorsal hollow of a U-shaped seed (Text-fig. 40). It may form a germination valve as in *Mastixioideae*. In the dorsal wall are several strands of stout longitudinal fibres, one median, and one at least between the middle and the margin on each side.

Length of carpel, 9.5 mm.; breadth, 4 mm.; dorsiventral thickness, 2.75 mm.

Seed: U-shaped in transverse section as in *Mastixia* but the U shallow with wide open arms (Text-fig. 40). The drawing in of the tegmen cells suggests a chalaza at the broader end. Tegmen cells transversely elongate and aligned as in Cornaceae or Nyassaceae, the transverse striae formed by them about 0.016 mm. apart.

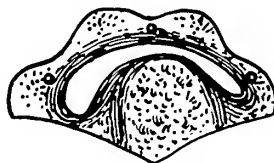


Fig. 40. ? *Mastixia* sp. Transverse section of endocarp.

REMARKS AND AFFINITIES. A single carpel. The relationship is undoubtedly with Mastixioideae and perhaps with the genus *Mastixia* itself. The specimen is clearly distinguished from *M. cantiensis* and *M. parva* by its compressed form (apparently original), longitudinally ribbed external surface, wide shallow U-shaped locule and seed as seen in transverse section.

It does not appear to agree more closely with any other known allied genus living or fossil and is therefore provisionally named *Mastixia* sp. pending new evidence from further fossil material.

V.30407 Figured Pl. 28, figs. 32, 33; Text-fig. 40. A carpel. *A. G. Davis Coll.* Warden Point, Sheppey.

Genus LANGTONIA Reid & Chandler, 1933:453

Langtonia bisulcata Reid & Chandler

1933 *Langtonia bisulcata* Reid & Chandler, p. 453, pl. 25, figs. 18-27.

V.30408 An endocarp. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ.*

V.30409 A locule-cast. *J. E. Cooper Coll.* Herne Bay, Kent.

Genus BECKETTIA Reid & Chandler, 1933:455

Beckettia mastixioides Reid & Chandler

Plate 28, figs. 34, 35

1933 *Beckettia mastixioides* Reid & Chandler, p. 456, pl. 25, figs. 28-36.

V.30410 Figured Pl. 28, fig. 34. A two-loculed endocarp, fractured to establish identity. The transversely striate tegmen was clearly seen in one locule. At the apex between the tips of the valves there is a transverse furrow giving a four-partite effect, two segments appearing blunt, and two pointed, as in a specimen illustrated by Bowerbank under the name *Cupressinites Comptonii* (1840: 57, pl. 10, fig. 34), later referred doubtfully by Reid & Chandler (1933: 96) to *Cupressinites curtus*. Possibly this specimen should have been referred to *Beckettia*, but the evidence is incomplete. Length of endocarp, 14 mm.; breadth, 11 mm. *G. F. Elliott Coll.* Sheppey.

V.30411 Figured Pl. 28, fig. 35. An endocarp, 13 mm. long, 12 mm. broad, showing two germination valves narrowed to the apex separated by massive bands of carpel wall. Although superficially resembling *Dunstania etttingshauseni* (p. 289) the specimen is readily distinguished by the attenuated apices of the

valves which extend to the apex instead of ending bluntly and short of the apex with which they are connected by conspicuous furrows for the funicles (cf. Reid & Chandler, 1933, pl. 25, figs. 41, 42 and contrast with fig. 29). *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

- V.30412 A second endocarp, 12 mm. long, fractured longitudinally, the fracture passing through one locule and along the edge of another. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30413 An abraded endocarp with a locule-cast exposed.
- V.30414 An endocarp, fractured to show the structure. Possibly referable to this species. The specimen is two-loculed.
The above two specimens *J. E. Cooper Coll.* Herne Bay, Kent.

Genus LANFRANCIA Reid & Chandler, 1933:457

Lanfrancia subglobosa Reid & Chandler

Plate 28, figs. 36-38

1933 *Lanfrancia subglobosa* Reid & Chandler, p. 457, pl. 25, figs. 37-40.

- V.30415 Figured Pl. 28, fig. 36. A three-loculed endocarp with carbonaceous wall preserved (now decaying). *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30416 Figured Pl. 28, figs. 37, 38. An abraded three-loculed endocarp. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30417 A four-loculed fruit (now fractured). *D. J. Jenkins Coll.* Dump 1, Clapham Common (see p. 31).
- V.30418 A four-loculed fruit with two valves broken away, now fractured longitudinally and transversely.
- V.30419 A rather large fruit fractured to show the structure, probably referable to this species, but the tendency to split into cocci is obscured (if present) by pyrites cement, a common result of fossilization in London Clay fruits.
- V.30420 A several- (probably four-) loculed fruit with much of the exocarp preserved. East Cliff shore.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.

Genus PORTNALLIA nov.

DIAGNOSIS. Endocarps sub-globular to ovoid, multilocular, syncarpous, germination valves each with a single infold, locule and seed C- or U-shaped in cross-section, septa formed of parenchyma. Related to Mastixioideae but smaller than *Lanfrancia* or *Beckettia*.

TYPE SPECIES. *Portnallia bognorensis* n. sp.

Portnallia bognorensis n. sp.

Plate 28, figs. 39-44

DIAGNOSIS. Endocarp sub-globular to ovoid, usually three-loculed, sometimes two- or four-loculed, length about 3.5 to 6 mm. (as preserved); breadth about 3 to 5 mm.

HOLOTYPE. V.30421.

DESCRIPTION. *Endocarp*: Sub-globular to ovoid, commonly three-loculed, sometimes with two or four locules, syncarpous. Sometimes, although probably not invariably, with rather broad, shallow, external, longitudinal furrows alternating with the locules and with short median longitudinal depressions over the middle of the locules. A simple median longitudinal infold on the dorsal wall of each locule corresponds with its external depression and makes the locule C- or U-shaped in transverse section. The infold is borne on the inner face of a dorsal germination valve which extends the full length of the locule. The dorsal wall of the carpel is

thin, its substance is woody, the septa are formed of equiaxial cells, the inner layers of the endocarp are fibrous, the fibres being transversely aligned on the dorsal side. The outer walls are usually abraded. Length of endocarp (as preserved), 4 to 4.5 mm., occasionally 5.5 to 6 mm.; breadth, 3 to 4.5 mm., occasionally 4.5 or 5 mm.

Seed: Conforming to the locule in shape; pointed oval in outline, narrowed at both extremities but more sharply pointed and thinner dorsiventrally at the proximal end which lies adjacent to the apex of the fruit (Pl. 28, figs. 39, 40), U-shaped in transverse section being convex on the ventral face, concave on the dorsal. Tegmen cells (seen only on small patches of the seed-cast) large, flat, thin-walled, accurately aligned in transverse rows. Length of seed approximately 3 to 4.5 mm.; breadth, 1.75 to 2.5 mm.

REMARKS AND AFFINITIES. Five specimens from Bognor and one, probably of this species, from Sheppey. They show considerable variation in size. In most the outer wall is abraded exposing the locule casts, but one three-loculed endocarp from Bognor originally had its outer wall preserved in carbonaceous substance although it is now flaking away (V.30425), and one from Sheppey (Pl. 28, figs. 43, 44) with two locules was also originally perfect. They showed the superficial characters described above. The structure, form of locules and seeds, and tegmen cells, all point clearly to relationship with the section Mastixioideae of the family Cornaceae. In the multilocular character the species recalls the extinct *Beckettia* and *Lanfrancia* (Reid & Chandler, 1933: 456, 457, pl. 25, figs. 28-40) but it differs from both in its much smaller size (*Beckettia*, length 13 to 15 mm.; *Lanfrancia*, length 12 mm.). It seems necessary, therefore, to institute a new generic name, *Portnallia*, as a tribute to Mrs. E. M. Venables (née Portnall) who found many of the fossils in the Bognor 'Upper Fish Tooth Bed'. Possibly *Portnallia* should be regarded as a form-genus for small multilocular Mastixioideae without clearly defined generic characters. In spite of the variation in size of the few specimens available, careful comparison of the structure in detail suggests that all belong to a single species about half the size of *Beckettia* and *Lanfrancia*. A somewhat similar but apparently distinct species will next be described under the name *P. sheppeyensis*.

- V.30421 Holotype, figured Pl. 28, figs. 39, 40. An abraded three-loculed fruit with locule-casts exposed.
 V.30422 Figured Pl. 28, fig. 41. A second three-loculed specimen with part of the external walls preserved.
 V.30423 Figured Pl. 28, fig. 42. A four-loculed fruit abraded so that the locule-casts are exposed and in one locule the seed-cast also. Length (as preserved), 5.5 mm.; breadth, 4 mm.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30424 Figured Pl. 28, figs. 43, 44. A two-loculed fruit with external walls preserved, much pyritized. *G. F. Elliott Coll.* Warden Point, Sheppey.
 V.30425 A three-loculed fruit with carbonaceous endocarp originally perfect, now flaking away. The carbonaceous coat shows three shallow furrows between the locules, and three median depressions corresponding with the infolds of the locules. *E. M. Venables Coll.*
 V.30426 An abraded four-loculed fruit. *E. M. Venables Coll.*
 V.30427 A three-loculed fruit abraded to show the locule-casts. *J. G. Turner Coll.*
 The three specimens above from the 'Upper Fish Tooth Bed': Bognor, Sussex.

Portnallia sheppeyensis n. sp.

Plate 28, figs. 45, 46; Pl. 29, figs. 1-3

DIAGNOSIS. Endocarp sub-globular or broadly ovoid with shallow longitudinal furrows between its locules, probably two- to four-loculed. Length about 6 to 7.5 mm.; breadth, 4.5 to

7.5 mm. A distinctly larger species than *P. bognorensis*, smaller and relatively broader than the genus *Lanfrancia* with seeds broader at the upper end.

HOLOTYPE. V.30428.

DESCRIPTION. *Endocarp*: Sub-globular or ovoid, two to four-loculed with shallow rounded longitudinal furrows between the locules which may be unequally developed. Syncarpous, having a simple median longitudinal infold on the dorsal wall of each locule giving a C-shaped cross-section. Carpel wall woody (much abraded so as partially or completely to expose the locule-casts) formed of parenchyma (cells 0.025 to 0.03 mm. in diameter) and fibres; the exact arrangement of the tissues is obscure owing to the condition of the specimens but transverse fibres form the inner layers of the ventral wall. Seeds solitary in the locules. Length of a four(?) -loculed fruit (as preserved), 7.5 mm.; breadth, 6.5 mm. Length of a second similar fruit, 6.5 mm.; breadth, 7.5 mm. Length of a two-loculed fruit, 6.5 mm.; breadth, 4.5 mm. Length of a three-loculed fruit from Sheppey (now decayed) about 6 mm.; breadth about 4.25 mm.

Seed: Represented by locule-casts which show the impressions of a testa formed of equiaxial cells, 0.05 to 0.1 mm. in diameter. Length of locule-cast, 5.5 mm.

REMARKS AND AFFINITIES. Six fruits, three from Sheppey (one now decayed) and three from Herne Bay, have been examined. They show the characters of Mastixioideae. None of the existing specimens is perfect. They have been compared carefully with *Portnallia bognorensis* to which they bear a general resemblance, but it does not seem reasonable to refer them to that species on account of their marked difference in size. A distinct specific name *P. sheppeyensis* has therefore been given provisionally. The decayed specimen from Sheppey (Bowerbank Collection) showed evidence of a dorsal germination valve and revealed a tendency (as in *Lanfrancia*) for the fruit to split into cocci as a result of decay. *P. sheppeyensis* is intermediate in size between *P. bognorensis* and *Lanfrancia*. From *Lanfrancia* it differs in the relatively broader, commonly sub-globular form, also in the seeds which appear to be relatively broader at the upper end than those of *Lanfrancia*. The dorsal infold in *P. sheppeyensis* may also be shallower and broader and there is a tendency for the endocarp to have shallow longitudinal external furrows between the locules. The two-loculed specimen (Pl. 29, figs. 1, 2) resembles a very small *Beckettia* in its sub-globular form and broad parenchyma bands between the locules.

Should more abundant material become available in the future, the validity of *Portnallia sheppeyensis* as a species should be reviewed and a comparison with *P. bognorensis* and *Lanfrancia* should again be made. But as far as it is possible to judge on existing material, *P. sheppeyensis* represents a distinct form.

- V.30428 Holotype, figured Pl. 28, figs. 45, 46. A much abraded four-loculed endocarp. *G. F. Elliott Coll.* Sheppey.
 V.30429 Figured Pl. 29, figs. 1, 2. A two-loculed endocarp like a small *Beckettia*, locule-casts exposed by abrasion. *J. G. Turner Coll.* Sheppey.
 V.30430 Figured Pl. 29, fig. 3. A three-loculed endocarp, somewhat abraded, showing remains of longitudinal furrows between the locules, unequal development of locules, and valves beginning to gape at the apex. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.
 V.30431 A four (?) -loculed endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.
 V.30432 A four-loculed endocarp showing locule-casts exposed by abrasion. *D. J. Jenkins Coll.* Hampton shore, Herne Bay, Kent.

Section CORNOIDEAE

Genus DUNSTANIA Reid & Chandler, 1933:459

Dunstania multilocularis Reid & Chandler

Plate 29, figs. 4-11

1933 *Dunstania multilocularis* Reid & Chandler, p. 462, pl. 26, figs. 1-15.

- V.30433** Figured Pl. 29, fig. 4. A five-loculed fruit seen in cross-section embedded in a shelly septarian fragment. The section shows that one locule is abortive, the wall is thick and woody, formed in part at least of elongate curved cells variously aligned. Many large ovoid secreting cavities are visible. Transversely aligned cells or fibres can be seen surrounding the locules. Large cells with sinuous walls, 0.1 mm. or more in diameter, line the secreting cavities. The sutures of the large dorsal germination valves are clearly seen in section. The smooth locule-lining is formed of transversely aligned cells with sinuous walls. The diameter of the endocarp is 7.5 mm. Length buried in matrix.
- Although the specimen is only partially exposed the small size (as compared with *Dunstania ettingshausenii*), five-locules, and very numerous secreting cavities indicate *D. multilocularis*. *A. G. Davis Coll.* Modiola Beds: Down Mill Brickyard, Bracknell, Berkshire.
- V.30434** Figured Pl. 29, figs. 5-7. A five-loculed endocarp showing apical depression, germination valves and (where the wall is broken) secreting cavities. Five narrower pyrites-filled slits are exposed by abrasion alternating with the locules at the base. Length of endocarp, 14 mm., diameter, 12 by 13 mm.
- Figured Pl. 29, fig. 8. A five-loculed endocarp much abraded and partly encrusted with pyrites shows the apical depression and one of the germination valves. The surface is so worn over the valve and adjacent carpel wall that the casts of the numerous ovoid glandular cavities in the thickness of the wall are exposed; these casts show impressions of the sinuous cells which lined the cavities. Length of fruit (as worn), 12.5 mm.; breadth, 8.5 mm. Specimen now completely decayed.
- Figured Pl. 29, fig. 9. An elongate-oval locule- and seed-cast, terete at the chalaza end, flattened dorsally at the hilar end where formerly overlain by the valve. The cast shows numerous dimples, the impressions of the ovoid secreting cavities in the endocarp; on the dorsal side it is worn so as partly to expose the dorsal median raphe on the enclosed anatropous seed within. On the ventral side the thin film of the locule-cast is chipped away, so as to show the seed-cast clearly with its characteristic angular more or less equiaxial tegmen cells 0.025 to 0.05 mm. in diameter. There is a marked tendency for these cells to be transversely aligned, a fact overlooked in studying the original specimens. Length of cast, 9.25 mm.; dorsiventral diameter, 3.75 mm.; width of dorsal facet, 2.25 mm. Specimen now completely decayed.
- The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30435** Figured Pl. 29, figs. 10, 11. An endocarp fractured to show the locules and secreting cavities. Wall carbonaceous and only very slightly impregnated with pyrites. Locules filled with soft mud cemented by fine granular pyrites. The specimen is soft and readily fractured. *A. G. Davis Coll.* Bawdsey, Suffolk.
- There can be little doubt from the distinctive preservation of this specimen that it is one of two which were detached from their labels when the British Museum (Natural History) was bombed in 1940. The preservation is markedly different from that of the Sheppey and Herne Bay fruits. The other Bawdsey specimen, similarly preserved, is *Iodes davisi* (p. 220).
- V.30436** Four fruits and one locule-cast.
- V.30437** Half a fruit fractured longitudinally to show locule-casts and secreting cavities. Also a second abraded fruit showing the cast of the apical depression (one locule broken away).
- Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30438** A small apparently five-loculed endocarp, 10 mm. long by 10 mm. in diameter, partly covered by a pyrites incrustation, showing two valves beginning to break away. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30439** A much abraded five-loculed endocarp with ovoid secreting cavities exposed in profusion. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.
- V.30440** A worn endocarp with exposed glandular cavities. *A. G. Davis Coll.* Warden Point, Sheppey. *In situ*. In addition, two much decayed specimens from Dump 1, Clapham Common (see p. 31) have now completely disintegrated.

Dunstania ettinghauseni (Gardner) Reid & Chandler

1933 *Dunstania Ettingshauseni* (Gardner) Reid & Chandler, p. 459, pl. 25, figs. 41-47.

V.30462 An endocarp, possibly referable to this species, embedded in pyrites and dissected out by abrasion so as to expose internal structures not usually seen. *J. E. Cooper Coll.* Herne Bay, Kent

Family CORNACEAE ?

Genus ?

Plate 32, figs. 37-39

DESCRIPTION. *Endocarp*: Ellipsoid although slightly blunter at one end than at the other. Surface with a few longitudinal furrows in which stout fibres are embedded. At the less pointed end (apex?) there are five(?) tiny apertures arranged in a ring round the axis of the specimen, hence there may be five locules. Length of endocarp, 11 mm.; diameter, 10 mm.

REMARKS AND AFFINITIES. The endocarp recalls *Beckettia* and *Dunstania*, but without fracturing it its identity is doubtful. There is no definite evidence that it dehisced by longitudinal dorsal valves or that secreting cavities were present in the wall. There is also some superficial resemblance to *Hightea*.

The importance of the specimen lies in its origin at Bawdsey, Suffolk. It has a reddish shining surface and appears to have been found in the Basement Bed of the Red Crag. Nevertheless it is almost certainly derived from the London Clay. Other Bawdsey specimens actually found in the London Clay were dull grey in colour. The endocarp was sent for examination by Mr. H. E. P. Spencer and is now in the Ipswich Museum.

Family EPACRIDACEAE

Section STYPHELIEAE

Genus LEUCOPOGON R. Br.

Leucopogon quadrilocularis Reid & Chandler

Plate 29, figs. 12-16

1933 *Leucopogon quadrilocularis* Reid & Chandler, p. 464, pl. 26, figs. 18-20; text-fig. 17a, b.

V.30441 Figured Pl. 29, figs. 12, 13. An endocarp somewhat imperfect so that all four locules are exposed on the fractured surface. *A. G. Davis Coll.* Frinton, Essex.

V.30442 Figured Pl. 29, figs. 14-16. A fruit with two locules exposed by the removal of the dorsal wall; diameter, 4.75 mm.

V.30443 A fruit, now fractured longitudinally. It shows a locule-cast with characteristic cell-structure. Also four adherent locule-casts with the outer fruit wall abraded. This second specimen is small, but probably belongs to the same species.

Both the above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30444 Three specimens; one a complete endocarp, one an endocarp with one valve removed, the third half an endocarp fractured longitudinally so as to show two locule-casts.

V.30445 An endocarp. *In situ*.

The above *A. G. Davis Coll.* Warden Point, Sheppey.

Family SYMPLOCACEAE

Genus SYMPLOCOS Jacquin

Symplocos trilocularis Reid & Chandler

Plate 29, figs. 17-19

1933 *Symplocos trilocularis* Reid & Chandler, p. 473, pl. 27, figs. 5-9.

Note. The discovery of additional material necessitates the amendment of the original diagnosis and description of this species, especially in regard to the number and form of the locules.

AMENDED DIAGNOSIS. Endocarp ovoid or globular, three- or four-loculed, with many irregular cavities in the wall; locules sub-cylindric below, inflated above. Length of endocarp about 7.5 mm.; diameter about 7.5 to 9 mm.

HOLOTYPE. V.23068.

DESCRIPTION. *Endocarp*: Ovoid or sub-globular, three- or four-loculed, locules sub-cylindric below, expanded above on the external (dorsal) side, the expanded area delimited from the cylindrical by a sharp angle. Seeds pendulous, one fully developed in each locule, the expanded region at the apex being occupied by one or more closely appressed seeds (Pl. 29, fig. 19). External surface abraded, apex with a shallow circular depression (Pl. 29, fig. 17), 4.5 by 5 mm. in diameter in one specimen, with circular apertures leading into the locules. Walls thick, formed of compacted masses of parenchyma (cells 0.01 to 0.016 mm. in diameter) with scattered ill-defined cavities throughout (now filled with pyrites). There are also smooth ovoid secreting cells, 0.05 to 0.15 mm. in diameter, sometimes scattered, sometimes occurring in isolated patches. Immediately around the locules the parenchyma is closely compacted with small radially arranged cells producing a thin columnar coat. Locule-lining finely striate, the striae oblique or transverse at the apical end. Length of fruit, 6 to 7.5 mm.; breadth, 5.25 to 9 mm.

Seed: Sub-cylindrical, constricted at the proximal end where it is overlapped by abortive seeds; chalaza at the distal end, hence the seed must be anatropous although the raphe has not been seen. Testa formed of elongate parallel-sided cells about 0.025 to 0.05 mm. broad, and about five or six times as long as broad, having a general longitudinal alignment although sometimes slightly sinuous, often faceted at the ends. Tegmen formed of equiaxial cells, 0.016 to 0.025 mm. in diameter, with a slight tendency to transverse alignment. Length of seed about 5.75 to 6.5 mm.

REMARKS AND AFFINITIES. Three newly discovered specimens are probably referable to *Symplocos trilocularis*. All are much worn, one is apparently three-loculed, the others four-loculed. One shows the apical depression now filled by pyrites so that the openings leading to the locules are hidden. The size and substance of the endocarp, the form of the seed, and cells of the testa all agree with those of *S. trilocularis*.

V.30446 Figured Pl. 29, figs. 17, 18. A three-loculed endocarp, now fractured to show the seeds and substance. G. F. Elliott Coll. Sheppey.

- V.30447 Figured Pl. 29, figs. 19. A four-loculed endocarp, so abraded that the locule-casts are more or less completely exposed showing the expanded part above where the abortive pendulous seeds lay. *D. J. Jenkins Coll.* Sheppey.
- V.30448 A much worn endocarp, probably referable to this species. *A. G. Davis Coll.* Warden Point, Sheppey.

Symplocos sp.

Plate 29, fig. 20

DESCRIPTION. *Endocarp*: Truncate-ovoid (somewhat compressed in fossilization), truncate at the apex, rounded below, smooth externally, four-loculed, two locules apparently abortive, two containing shrivelled pendulous seeds. Locules opening at the apex by circular apertures. Central canal clearly seen. Wall woody, with sub-globular ill-defined cavities, formed of equiaxial cells 0.016 mm. in diameter. Locule-lining obscured by pyrites. Structure of shrivelled seeds obscure but showing elongate cells. Length of endocarp, 6 mm.; diameter (compressed), 3 by 5.5 mm.

REMARKS AND AFFINITIES. The characteristic endocarp with apical apertures, central axis and pendulous seeds is undoubtedly a species of *Symplocos*. It differs in its size and form from other London Clay species, but its imperfect condition makes specific diagnosis unwise in the absence of further material.

- V.30449 Figured Pl. 29, fig. 20. A broken endocarp. *A. G. Davis Coll.* Warden Point, Sheppey.

Symplocos(?) *bognorensis* n. sp.

Plate 29, figs. 21-23; Text-fig. 41

DIAGNOSIS. Fruit four?-loculed, sub-globular, with endocarp columnar in section, 0.5 mm. thick. Seeds oval, laterally compressed. Length of fruit (somewhat incomplete above), 4.3 mm.; transverse diameter, 4.5 mm. Length of seed, 2.5 mm.; breadth, 1.5 mm.; thickness about 0.5 mm.

HOLOTYPE. V.30450.

DESCRIPTION. *Fruit*: Syncarpous multi- (probably four-) loculed, sub-globular, inferior with thick accrescent calyx (now abraded at the apex for about one-quarter of the length). Mesocarp thin near the apex, thickened considerably at the base. Endocarp thick, 0.5 mm. thick as seen in section, columnar, formed of small radially arranged cells. Locule-lining transversely or obliquely striate (except at the apex where the striae are longitudinal), striae formed by small square cells about 0.012 mm. in diameter. Seeds solitary, pendulous. There may have been a central canal but the evidence is not preserved. Length of fruit (as abraded at apex), 4.3 mm.; transverse diameter, 4.5 mm.

Seed: Oval, laterally compressed. The form suggests that it is anatropous. Testa of equiaxial cells irregular in size and shape, producing a somewhat netted surface. There are also large, black, shining (secreting?) cells, 0.025 to 0.03 mm. in diameter. Length of seed, 2.5 mm.; breadth, 1.5 mm.; thickness about 0.5 mm.

REMARKS AND AFFINITIES. One fruit only, abraded so that the apex is incomplete and the locule-casts are exposed as four transversely striate projections. The seeds and columnar endocarp were only seen after the specimen had been fractured longitudinally.

The character of this inferior syncarpous multilocular fruit with its columnar endocarp, transversely striate locule-lining and pendulous seeds suggests relationship with *Symplocos*,

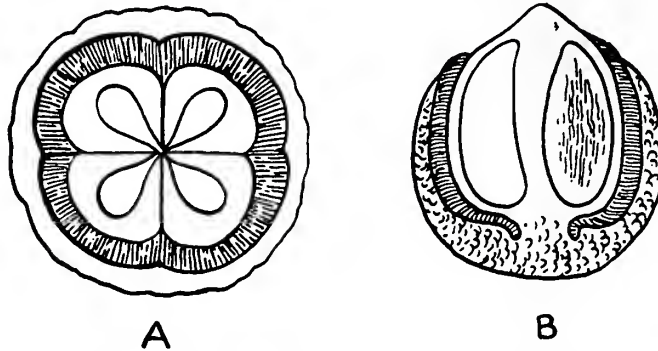


Fig. 41. *Symplocos?* *bagnorensis* n. sp. A, diagrammatic transverse section showing locules and seeds. B, diagrammatic longitudinal section showing columnar endocarp and seeds.

but in the absence of further material the determination is regarded as doubtful for there is no clear evidence of apical apertures, nor of a central canal. The small size of the fruit and its much compressed locules distinguish the specimen very clearly from other species of *Symplocos* described, the specific name *bagnorensis* serves to denote its derivation from the London Clay of Bognor.

V.30450 Holotype, figured Pl. 29, figs. 21-23; Text-fig. 41. A fruit, now fractured, showing seeds, and endocarp in section. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Genus DURANIA Kirchheimer, 1936:223

Durania stonei (Reid & Chandler) Chandler

Plate 27, figs. 15-30; Text-fig. 42

1933 *Carpolithus stonei* Reid & Chandler, p. 515, pl. 30, figs. 34-37.

AMENDED DIAGNOSIS. Fruit narrowly or broadly sub-obovoid, inferior, syncarpous, two- or three-loculed, tapering into the peduncle, longitudinally angled. Pericarp splitting into eight to ten longitudinal valves lunate in transverse section and cavernous within. Sepals persistent, arising from the margin of the perianth disc, four to five. Placentation axile, seeds solitary, pendulous. Locule-lining (or outermost layer of testa) of irregular interlocking cells. Seeds anatropous with dorsilateral raphe and a coat of irregularly hexagonal cells. Length of fruit, 16 to 29 mm.; breadth about 6.5 to 22 mm. Length of seed, 11 to 11.25 mm.; breadth (distal end), 1.75 by 2.25 mm.

HOLOTYPE. V.6467.

DESCRIPTION. *Fruit*: Inferior, syncarpous, two- or three-carpelled, narrowly to broadly sub-obovoid, tapering into a stalk (often incomplete at the base), terminating in a more or less flat or distinctly conical disc (often obscured by pyrites) at the apex, sometimes curved, always longitudinally angled, the surfaces between the eight or ten angles flat or slightly concave

and formed of smooth irregular polygonal cells 0.025 mm. in diameter. The accrescent calyx terminates against the apical disc which bears four or five small, rounded, free sepals at its margin. Four or five of the longitudinal angles of the fruit correspond with the margins of the sepals, the other four or five with their midribs (Pl. 27, fig. 15). Beneath the accrescent calyx at each angle lies a stout longitudinal strand of fibres and between the angles are transverse somewhat sinuous fibres. Transverse sections of the fruit show two or three locules one of which may be abortive. There is also a central canal (often displaced through unequal development of locules) which may be irregular or triangular in cross-section; it carries the axial strand of fibres to the sub-apical placentas. The fruit wall surrounding the locules, as seen in the transverse section, appears to be formed of eight or ten lunate areas which correspond with the concave or flat surfaces of the fruit (Pl. 27, figs. 18, 19; Text-fig. 42). Along the edges of these

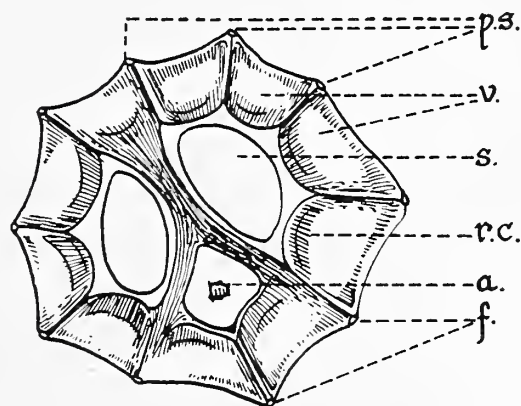


Fig. 42. *Durania stonei* (Reid & Chandler). Diagrammatic transverse section of fruit showing two locules and seeds and displaced axis. *a*, displaced axis and axial canal; *f*, fibres in section; *ps*, planes of splitting; *rc*, coat of radial cells (thickness exaggerated); *s*, seed in locule; *v*, valves.

areas, i.e. along the angles of the fruit, there is a marked tendency, at least in fossilization, for splitting to occur so that the wall may divide into longitudinal valves which are lunate in transverse section. The surfaces of dehiscence show a layer of large tortuous cells. The interior of each valve is cavernous but sub-divided by thin transverse or oblique irregularly spaced dissepiments at frequent intervals. The dissepiments are so fragile as to be but rarely preserved. When present they owe their preservation to embedding in amorphous pyrites (Pl. 27, figs. 26, 27). The inner layers of the wall around the locules (endocarp?) are formed of transverse fibres which pass into and form the septa (Text-fig. 42). Next come other transverse fibres which give off radial branches to the angles of the fruit. It is along these radial fibres that splitting occurs when the valves separate. The fibres also sweep transversely over the outer surface of each valve so that each is completely embraced by them. Within each segment, as seen in transverse section, there is also a coat of radially aligned cells embraced by the transverse fibres and abutting on the cavernous central region from which it is clearly differentiated. This coat is thick on the ventral side of the segments, and very thin on the dorsal side.

The locule-lining (or perhaps it is the outermost layer of the testa) is formed of interlocking cells of irregular shape with coarse digitations (diameter of the cells about 0.1 to 0.15 mm.). It adheres very closely to the carpel wall, is 0.05 mm. thick, and in section produces a coarse columnar effect. The seeds are solitary and pendulous. Length of a perfect fruit measured along the curved axis, 24 mm.; breadth, 10 mm. Length of other specimens, 16 to 29 mm.; breadth, 6.5 to 22 mm. in normally mature specimens.

Seed (Pl. 27, fig. 20): Anotropous with dorsilateral raphe, elongate, agreeing with the locule in shape, roundly triangular in section at the distal end; somewhat flattened at the proximal end. Integument fused with the coat of digitate cells described above at least in the fossil state (possibly owing to a cementing film of pyrites), its surface formed of irregularly hexagonal cells, 0.05 mm. in diameter, within which are several layers of finer cells 0.025 to 0.05 mm. in diameter. Length of seed, 11 to 11.25 mm.; diameter at distal end, 1.75 mm.; dorsiventral thickness, 2.25 mm.

REMARKS. Sixteen additional specimens from Herne Bay. The holotype (V.6467) catalogued in 1933 was from Watford Heath. The original diagnosis and description have been amended in accordance with information based on the new material. The carpels are two to three, not five, while the valves into which the pericarp splits divide down the median line so as to form eight to ten segments.

The significant diagnostic characters appear to be the inferior syncarpous character of the fruit with four- to five-partite calyx, two or three locules, central canal, pendulous anotropous seeds, and dorsilateral raphe. The splitting into valves may be either the result of prolonged maceration or of germination. Such places of weakness, which may be very apparent in fossil material, are often extremely difficult to detect in ungerminated living fruits as for example in *Mastixia*.

The genus *Halesia* L. shows certain characters in common. Thus it has inferior syncarpous fruits, an accrescent calyx four or occasionally five-partite above, ribbed, winged or angled pericarp with longitudinal fibre strands beneath the wings or angles, and three locules, some of which may be abortive.

A coat of transverse fibres forms the septa and inner layers of the locule-wall and is succeeded by a hard coat of fibres and parenchyma of which the innermost layers are transversely aligned and the outer much thicker layers are radially aligned; the radial coat thickens considerably at the angles of the fruit but no planes of weakness suggestive of splitting can be detected. The locule-lining (or testa?) of *Halesia* is formed of interlocking sinuous cells, is fused with the carpel wall, and is identical in character with the corresponding coat of the fossil. The seed coats within are also similar to those of the fossil. No germinated fruits of living *Halesia* have been seen, but so far as present evidence goes the indehiscent character of the woody endocarp appears to separate the fossil from *Halesia*.

It appears probable that fruits from the Oligocene Brown Coal referred at first to a new unnamed genus of Symplocaceae, and later named *Durania ehrenbergi* (Kirchheimer, 1935: 77, pl. 11, figs. 31a-f; 1936: 233, pl. 14, figs. 3a-i; 1937: 94-96, fig. 114a-c) are generically identical with these fossils, although in the London Clay material no apical apertures are visible owing to adherent pyrites, but the presence of such an aperture associated with a locule is suggested in Pl. 27, figs. 24, 25. Identical structures are shown in Kirchheimer's excellent figures. However *Durania ehrenbergi* appears to be distinct from *D. stonei*, as it may be much

larger, up to 5 cm. long (e.g. Rhineland material) although it is sometimes comparable with the London Clay fossil in size (e.g. 26 mm. long—Brown Coal of Lausitz).

- V.30451 Figured Pl. 27, fig. 15. A perfect fruit showing apex, calyx and stalk. East Cliff shore.
- V.30452 Figured Pl. 27, figs. 16–20. A fruit fractured to show valves, locule-casts and seeds. The three-angled axial canal is clearly seen in section and there are two mature locules.
- V.30453 Figured Pl. 27, figs. 21–25. A curved worn fruit, 20 mm. long, 14 mm. wide, fractured to show locule-casts and seeds.
- V.30454 Figured Pl. 27, figs. 26, 27. A small fruit fractured to show locule-casts. It shows the cell-structure in the pericarp segments, notably the rarely preserved transverse and oblique thin-walled dissepiments embedded in amorphous pyrites. Swale Cliff.
- V.30455 Figured Pl. 27, fig. 28. An exceptionally broad short fruit with five valves. The trigonous apex crowning the perianth disc is preserved. There is a furrow down the middle of each facet of the fruit apex. Length (including trigonous apex), 29 mm.; breadth, 22 by 18 mm. Diameter across perianth disc, 2.5 mm. In clay at low tide some 40 feet from cliff face, Swale Cliff.
- V.30456 Figured Pl. 27, fig. 29. A small abortive fruit, now fractured to prove its identity.
- V.30457 Figured Pl. 27, fig. 30. A curved fruit which showed two locule-casts through a fracture on one side. It has since been broken to show the internal structure.
- V.30458 A perfect fruit but with stalk broken (pyrites adhering to one side). East Cliff shore.
All the above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30459 Two endocarps, one being broken at the base. Swale Cliff.
- V.30460 A fruit fractured to show the hard endocarp and two locule-casts. A cast of the central canal is also exposed in the middle of which is an axial strand of fibres embedded in pyrites. The pericarp is poorly preserved.
- V.30461 A fruit showing some of the segments separating and clear evidence at the apex of three locules.
The above *J. E. Cooper Coll.* Herne Bay, Kent.

Family CUCURBITACEAE

Genus CUCURBITOSPERMUM Chesters, 1957:56

Cucurbitospermum sheppeyense n. sp.

Plate 29, figs. 24–26

DIAGNOSIS. Seed obovate in outline, plano-convex, two lateral margins slightly asymmetric. Without marginal rim. Length about 6 mm.; breadth about 5 mm.; thickness about 2.75 mm.

HOLOTYPE. V.30463.

DESCRIPTION. Seed obovate in outline, plano-convex, with one lateral margin somewhat more convex than the other. A small oval depression or hilar scar, into which the hilum and micropyle open, truncates the more pointed end of the seed slightly obliquely (Pl. 29, fig. 25). Anatropous with marginal raphe continued almost completely round the circumference, the chalaza marked by a thickening of the raphe at the rounded end of the seed from which a few fine fibres diverge for a short distance on the convex surface. Testa smooth externally without any trace of a marginal rim, surface of equiaxial cells, 0.016 mm. in diameter near the hilum. In section woody, as much as 0.8 mm. thick in parts, cells seen in section equiaxial, 0.03 to 0.04 mm. in diameter; varying in size in different parts, always smaller near the hilum and chalaza. Tegmen cells about 0.05 mm. in diameter. Length of seed, 6 mm.; breadth about 5 mm.; thickness about 2.75 mm. Length of a seed-cast, 5.25 mm.; breadth, 4.5 mm.

REMARKS AND AFFINITIES. Eleven seeds or seed-casts. Form and structure point to relationship with Cucurbitaceae, although normally in this family the seeds are bisymmetric, the two broad surfaces corresponding exactly, whereas in the fossil one surface is flat and the other convex. The small size and unrimmed form are also unusual in the family but occur in *Escallonia* which is the most comparable genus yet seen; its seeds are more narrowly oval than the fossil and show the typical biconvex section. The fossils are referred for the time being to the form-genus *Cucurbitospermum*.

- V.30463 Holotype, figured Pl. 29, fig. 24. A perfect seed with testa preserved. *G. F. Elliott Coll.* Warden Point, Sheppey.
 V.30464 Figured Pl. 29, figs. 25, 26. A perfect seed-cast showing tegmen, raphe and chalaza.
 V.30465 Four seeds, some with testa preserved, one now fractured to expose the internal structure. The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
 V.30466 Two seeds. *In situ*.
 V.30467 Two seeds, one much encrusted with pyrites. The above *A. G. Davis Coll.* Warden Point, Sheppey.
 V.30468 A seed fractured to show the thick testa. *F. M. Wommacott Coll.* Warden Point, Sheppey.

Cucurbitospermum equilaterale n. sp.

Plate 29, figs. 27, 28

DIAGNOSIS. Seed broadly oboval in outline, plano-convex, the two margins more or less symmetrical, with a thickened flange at the hilar end on each margin. Length of seed, 6.25 to 7.5 mm.; breadth, 5 to 5.5 mm.; thickness, 2 to 2.25 mm.

HOLOTYPE. V.30469.

DESCRIPTION. *Seed*: Broadly oboval in outline, plano-convex, a little more attenuated towards the hilar end than at the opposite end where the chalaza occurs. Micropyle close to the hilum sunk in a small oval hilar scar. The breadth at the hilar end is due to a thickened rather rounded flange on both sides of the hilum which gradually dies out towards the middle of the symmetrical lateral margins. Surface smooth, close and compact, having a coat of looser textured parenchyma within (seen in section) the cells being about 0.025 mm. in diameter. Thickness of testa as seen in section, 1.1 mm. on the flat surface of the seed, 1.2 mm. on the convex surface. Germination by marginal splitting. Dimensions of a perfect seed: length, 7.5 mm.; breadth, 5 mm.; thickness, 2 mm. Length of a second smaller specimen (testa thinned by abrasion?), 6.25 mm.; breadth, 5.5 mm. Length of a seed with testa abraded at the hilar end, 6.5 mm.; breadth, 4.5 mm.; thickness, 2.25 mm.

REMARKS AND AFFINITIES. Three specimens, one a perfect seed, another much polished and partly abraded(?). The third with testa partly preserved but so abraded at the hilar end that casts of the hilar and micropylar canals are visible as two adjacent projections.

The form and position of the organs indicates the family Cucurbitaceae but as in the case of *Cucurbitospermum sheppeyense* the unusual plano-convex form occurs instead of the typical biconvex bisymmetric form usual in the family. The evidence for determination is perhaps somewhat slender, but the species is clearly distinguished from *C. sheppeyense* by the greater symmetry of the two margins, and the thickened flange on each side of the hilum giving a broader form to the seed at the hilar end. Marginal splitting is indicated by the presence of pyrites within the sutures as seen in section.

- V.30469 Holotype, figured Pl. 29, fig. 27. A perfect seed.
 V.30470 Figured Pl. 29, fig. 28. A seed (now fractured transversely to show the testa) abraded at the hilar end so that the pyrites casts of the hilar and micropylar canals are exposed. Probably referable to this species.
 V.30471 A somewhat smaller seed.
 All *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Cucurbitospermum cooperi n. sp.

Plate 29, figs. 29, 30

DIAGNOSIS. Seed narrowly sub-oval in outline, bisymmetric, one margin almost straight the other convex, without marginal rim, hilar scar markedly oblique truncating the narrower end of the seed. Testa 1.5 mm. thick in the plane of splitting. Tegmen transversely striate. Length of seed (incomplete), 8.5 mm.; breadth, 4 mm.; breadth of seed-cavity about 1.5 mm.

HOLOTYPE. V.30472.

DESCRIPTION. *Seed*: Bisymmetric as evidenced by the equal curvature of its two surfaces seen in section at the broken chalazal end, narrowly sub-oval in outline but with one margin almost straight, the other convex (incomplete at the broader end), splitting into equal valves in the plane of symmetry (one valve alone preserved). Somewhat inflated, without marginal rim so far as can be seen. Anotropous, hilum terminal at the narrower end, the oval hilar scar truncating this end of the seed very obliquely (Pl. 29, figs. 29, 30). Raphe marginal indicated by fibres in the plane of symmetry around the lateral margins of the narrow compressed seed-body (probably originally continuous over the now broken chalazal end). Micropyle terminal, adjacent to the hilum within the oblique hilar scar. Testa thick especially in the plane of symmetry where it is about 1.5 mm. broad across the suture (Pl. 29, fig. 30). Surface much abraded, smooth, formed of equiaxial cells, surface of suture of coarse angular cells measuring up to 0.1 mm. in diameter. Testa as seen in section elsewhere of finer cells. Tegmen transversely striate, the striations due to somewhat sinuous transversely aligned and elongate cells, about 0.012 mm. broad (as in *Ecballium*), which envelop the seed-body. Outside the tegmen, between it and the woody testa described above, there is a thin coat of equiaxial cells, 0.025 mm. in diameter, in which the raphe lies. Length of seed (incomplete), 8.5 mm.; breadth, 4 mm.; thickness of valve, 1.5 mm. in plane of splitting; breadth of seed-cavity about 1.5 mm.

REMARKS. The form of the seed somewhat recalls a seed to be described from Lake, Dorset, but the obliquity of the Herne Bay species is less marked, the cell-structure is coarser, the seed is also much larger and more inflated.

- V.30472 Holotype, figured Pl. 29, figs. 29, 30. One valve of a seed, imperfect at the chalazal end. *J. E. Cooper Coll.* Herne Bay, Kent.

Cucurbitospermum triangulare n. sp.

Plate 29, fig. 31

DIAGNOSIS. Seed obovate in outline, narrowing sharply towards the hilar end, valves equal so that the seed is bisymmetric. Margin rimmed. Length about 7 mm.; breadth, 5.5 mm.; thickness, 2.5 mm.

HOLOTYPE. V.30473.

DESCRIPTION. *Seed*: Bisymmetric, splitting around the margin in the plane of symmetry into equal valves, obovate in outline, pointed at the hilar end, rounded at the opposite end,

broad surfaces gently convex with a flat marginal flange 0.75 mm. broad. Raphe apparently marginal, its canal exposed towards the base by abrasion, chalaza not seen. Testa smooth, its structure in surface view and in section obscure, its thickness about 0.3 to 0.4 mm. Length of seed estimated at about 7 mm. (testa broken at the chalazal end); breadth, 5.5 mm.; thickness, 2.5 mm.

REMARKS AND AFFINITIES. One seed with testa preserved except over the rounded apex where it is abraded exposing part of the seed-cast although a film remaining obscures the chalaza. The form and general arrangement so far as seen point to relationship with Cucurbitaceae. The specimen shows bisymmetry of the two valves typical of this family and is distinguished by this character and by the flanged margin all round the circumference of the seed from *Cucurbitospermum sheppeyense* and *C. equilaterale*.

V.30473 Holotype, figured Pl. 29, fig. 31. A seed splitting marginally at the pointed hilar end, abraded at the opposite end so that the raphe canal and part of the seed-cast are exposed. *J. G. Turner Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Family?

Genus JENKINSELLA Reid & Chandler, 1933:481

AMENDED DIAGNOSIS. Fruit ovoid, pointed at both ends, one-loculed, many-seeded. Seeds attached along a ventral suture, lying transverse to the length of the fruit, piled one upon another in two rows. Exocarp with many stout longitudinal strands of fibres with transversely aligned cells between them. Length of fruit, 8 to 11.4 mm.; diameter, 4 to 6 mm. Seeds winged, surface smooth, finely striate. Length of ripe seeds about 3.5 to 4.25 mm.; breadth about 1.1 to 1.5 mm.

TYPE SPECIES. *Jenkinsella apocynoides* Reid & Chandler

Jenkinsella apocynoides Reid & Chandler

Plate 30, figs. 1-7; Text-fig. 43

1933 *Jenkinsella apocynoides* Reid & Chandler, p. 481, pl. 28, figs. 1-5.

?1939 *Cercidiphyllum arcticum* (Heer): Brown, p. 492, pl. 54, figs. 12, 13.

DIAGNOSIS. That of the genus.

HOLOTYPE. V.23088.

DESCRIPTION. *Fruit*: As originally described in 1933, to which can be added that it is many-seeded with seeds arranged in two longitudinal rows side by side. They lie transverse to the length of the fruit and are attached along the ventral suture. One to two rows of placentae on each side of the suture are represented by small circular scars, described in 1933, p. 482. Length of fruits, 8 to 11.4 mm.; diameter, 4 to 6 mm.

Seed: When fully developed the seeds are approximately hemispherical or slightly sickle-shaped in outline, the straight or scarcely concave margins lie contiguous to one another at the middle of the locule along its greatest transverse diameter. The convex margins are adjacent to the external wall (Pl. 30, fig. 2; Text-fig. 43C). The broad surfaces of the seeds in each row are flattened and contiguous with the seeds immediately above and below. The seed-body is

slightly thickened, straight, and oblique to the longest axis of the seed lying at the lower end of the convex margin. It occupies about one-third of the total surface or less (Pl. 30, fig. 3; Text-fig. 43A, C). The outer margin of the seed, where it lies against the locule wall, is flattened.

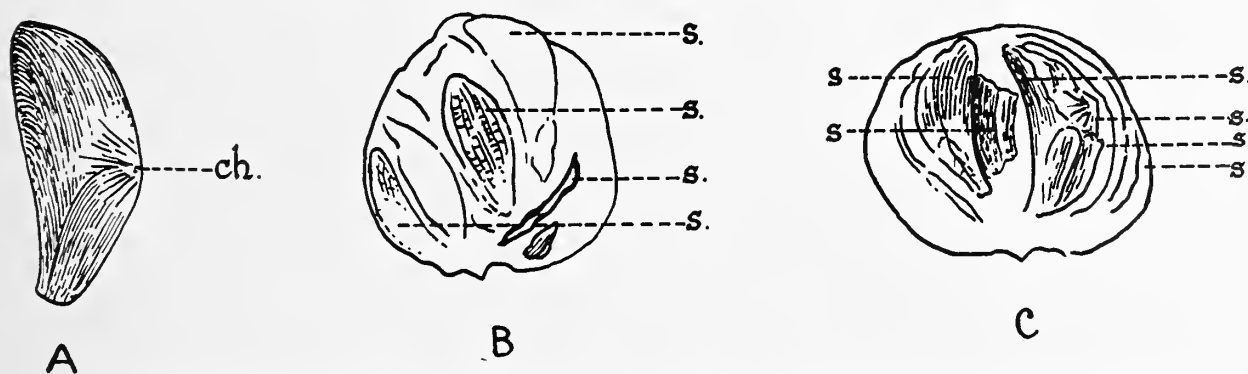


Fig. 43. *Jenkinsella apocynoides* Reid & Chandler. A, seed with wing. Seed-body as shown. *ch*, chalaza at upper end of seed-body. B, diagrammatic transverse section of fruit with seeds (*s*, *s*). C, diagrammatic transverse section of fruit with seeds (*s*, *s*). Cf. Pl. 30, figs. 2, 3.

The seed is anatropous, with the hilum at one end indicated by a small truncation of the body with a circular pit, and by the convergence of the surface cells at this point. The chalaza is at the other extremity of the body almost half way along the convex margin of the seed. It is indicated by a radiation of coarser cells which form an inner integument and by a convergence of the surface cells (Text-fig. 43A). The raphe appears to be represented by a median longitudinal fibre on one broad surface of the body and has been seen on at least two seeds. The testa is superficially striate, the striae being longitudinal over the body but diverging over the wing towards the straight margin. Along the convex margin they lie parallel with it. There are also several thickened fibres or ridges parallel with and adjacent to this margin. Cells of an inner integument (seen on the body) are aligned along its axis except at the chalazal end as described above. They are of irregular form but are mostly quadrilateral and about 0.036 mm. in diameter.

Length of typical seeds, 3.5 to 4.25 mm.; maximum breadth, 1.1 to 1.5 mm. Breadth of a body about 0.57 mm. Seeds at the end of the fruit are small and probably abortive.

REMARKS AND AFFINITIES. More than twenty specimens have been found at Herne Bay since 1933, and there is one from Division 2 beds at Frinton, Essex. There are two specimens from Basement Beds; a perfect locule-cast from North Harrow and an incomplete cast from Harefield, Middlesex (see p. 113). The fruit also occurs in the Reading Beds (p. 84).

Two of the recently found Herne Bay specimens show the external characters of the fruit (Pl. 30, figs. 5, 6). Two were locule-casts showing superficial impressions of a seed which has become detached and was lying loose in the locule in each case (Pl. 30, figs. 1, 4). One of these casts (Pl. 30, fig. 1) also shows the seeds in the position of growth both on its surface and when fractured transversely (Pl. 30, figs. 2, 3). Some of the seeds had either been shed, or were not preserved, as one end of the locule-cast shows no seeds at all but is filled with pyrites which had infiltrated into the cavity.

The superficial impressions mentioned above represent in one case a whole seed with its wing (Pl. 30, fig. 1) and in the other probably a somewhat immature seed, perhaps the body only (Pl. 30, fig. 4). The raphe may be indicated by a conspicuous groove in this specimen; the

longitudinal striae on the surface of this seed are formed by quadrangular cells, 0.016 to 0.025 mm. in diameter. It is truncate at one end. It is difficult in photographs to do justice to the cell-structure of the seeds, but it is very apparent under the microscope.

Brown (1939: 492, pl. 54, figs. 12, 13) identified as *Cercidiphyllum arcticum* a number of fruits, winged seeds and inflated seed-casts from the Palaeocene (Fort Union Formation) of Coal Harbour, North Dakota. His fruit-casts appear to be identical with *Jenkinsella*, as he himself recognized, but his seeds are sometimes more curved with a more oblique seed-body than the seeds of *Jenkinsella apocynoides* described above. It should be noted that Brown himself had 'no distinct proof of winged seeds within the pods'. Pods and seeds were merely associated in the deposit (Brown, 1939: 487).

While no definite opinion on Brown's specimens can be expressed it is quite impossible to identify *Jenkinsella* from the London Clay with *Cercidiphyllum*. The evidence both from the fruits and the contained seeds is against such a relationship. The fruits in *Cercidiphyllum* are described on p. 87 (Text-figs. 5, 6). They are narrower and more curved than *Jenkinsella*, and while showing no trace of equidistant, thick, conspicuous longitudinal fibres in their outer layers, they have a smooth outer coat with branching transverse nerves arising from a marginal fibre not seen in *Jenkinsella*. The seeds of *Cercidiphyllum* are suspended in two rows from the ventral suture and lie longitudinally in the pod overlapping one another. But in *Jenkinsella* they are piled transversely in two rows as described. *Cercidiphyllum* seeds have a peculiar honeycomb structure due to coarse cells with raised walls quite unlike the finely striate surface of wing and seed in *Jenkinsella*. Whatever *Jenkinsella* may be, therefore, it is not *Cercidiphyllum*. It was originally referred to the family Apocynaceae (Reid & Chandler, 1933: 481, 482). But the winged seeds now known to occur in the pods do not support this relationship. In Apocynaceae the seeds normally carry a pappus of straight hairs at the apex of a straight body in the many-seeded genera.

Fruits of similar appearance are figured by Seward & Edwards (1941: 175, pl. 3, figs. 3-6) under the name *Cercidiphyllum* sp. from beds regarded as of Early Eocene age from East Greenland, but apparently no internal characters or seeds were known. The fruits may well be generically identical with *Jenkinsella* but proof of this is wanting.

- V.30474** Figured Pl. 30, figs. 1-3. A locule-cast with impression of a winged seed, now fractured transversely so as to show the two rows of seeds placed horizontally in the pod, and the winged seeds and cell-structure. *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30475** Figured Pl. 30, fig. 4. A similar specimen with the impression of a less well-developed seed.
- V.30476** Figured Pl. 30, fig. 5. A fruit with carpel wall preserved, now fractured transversely.
- V.30477** Figured Pl. 30, fig. 6. A fruit broken on one side to show the locule-cast, but perfectly preserved in the region of dehiscence.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30478** Figured Pl. 30, fig. 7. A locule-cast. *A. G. Davis Coll.* Frinton, Essex.
- V.30479** Three locule-casts with remains of carbonaceous wall rapidly peeling away. East Cliff shore.
- V.30480** A fruit with carpel wall preserved. East Cliff shore.
The above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30481** Five specimens, two with carpel wall preserved. *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30482** Three locule-casts. *C. D. P. Smith Coll.* Herne Bay, Kent.

Family ? (SPARGANIACEAE or TYPHACEAE)

Genus POLYCARPELLA Reid & Chandler, 1933:486

Polycarpella caespitosa Reid & Chandler

Plate 30, figs. 8, 9

1933 *Polycarpella caespitosa* Reid & Chandler, p. 486, pl. 28, figs. 13-21.

Another portion of a fruiting head suggests that the capitulum was globular. Part of the receptacle is preserved and shows radially elongate cells which have an equiaxial transverse section 0.05 mm. in diameter.

The seeds seem to be sub-fusiform, pointed at the upper micropylar end around which the cells are both concentrically and radially aligned. The wedge shape formerly described as the micropylar end was probably due to adherent pyrites. The bracts or fibres which surround the fruit are longitudinally striate formed of longitudinally aligned cells. Whereas the holotype (V.23097) was found at Sheppey, the present specimen is from Herne Bay.

V.30483 Figured Pl. 30, figs. 8, 9. Part of a fruiting head. *f. E. Cooper Coll.* Herne Bay, Kent.

Family ?

Genus LEYRIDA Reid & Chandler, 1933:488

Leyrida bilocularis Reid & Chandler

Plate 30, figs. 10-13

1933 *Leyrida bilocularis* Reid & Chandler, p. 488, pl. 28, figs. 22-32.

V.30484 Figured Pl. 30, fig. 10. A fruit with the dorsal valve removed.

V.30485 Figured Pl. 30, fig. 11. Another fruit with the dorsal valve removed; a seed-cast is preserved. Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30486 Figured Pl. 30, figs. 12, 13. An endocarp showing the form and structure of *L. bilocularis*, but having a third abortive locule (Pl. 30, fig. 13, where it shows rather obscurely at *al*).

V.30487 An endocarp apparently showing a fibrous axis. Possibly it should be referred to *Symplocos*. Both the above *f. E. Cooper Coll.* Herne Bay, Kent.

Genus NEURORAPHE Reid & Chandler, 1933:491

Neuroraphe obovatum Reid & Chandler

Plate 30, figs. 14, 15

1933 *Neuroraphe obovatum* Reid & Chandler, p. 491, pl. 28, figs. 37-42.

V.30488 Figured Pl. 30, figs. 14, 15. A seed, possibly referable to this species, with testa contracted and cracked into short pieces, the whole embedded in a coat of pyrites which gives the specimen the appearance of a somewhat shrivelled berry, 13 mm. long, 10.5 mm. broad. Seed-coat as seen in these patches, 0.3 mm. thick, formed of angular equiaxial cells 0.025 to 0.05 mm. in diameter. Seed-cast (8 mm. long, 7.5 by 5.5

mm. broad) with longitudinally elongate cells forming the tegmen, 0.025 to 0.03 mm. broad, longitudinally aligned. Chalaza large, sub-circular, about 3 mm. in diameter; micropylar end distorted, obtusely pointed, divergent cells indicating the micropyle, longitudinal flutings and furrows arising at the margin of the chalaza probably indicate the former position of vascular bundles such as are seen in the typical specimens previously described.

V.30489 A seed with testa.

Both the above *J. E. Cooper Coll.* Herne Bay, Kent.

V.30490 A seed with remains of testa. The seed-cast shows the large chalaza. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Genus LAGENELLA Reid & Chandler, 1933:497

Lagenella alata Reid & Chandler

Plate 30, figs. 18, 19; Text-fig. 44

1933 *Lagenella alata* Reid & Chandler, p. 497, pl. 29, figs. 28-34.

REMARKS. Well-preserved specimens of *Lagenella alata* have been found at Bognor which suggest that the fibrous strands previously described (Reid & Chandler, 1933: 498) as connected with the style at the apex of the fruit, are actually the stalk and hence at the base; for in these specimens they are unusually stout and well developed. If this be the correct interpretation then the diagnosis and description previously published need amending as indicated below by the words in *italics*.

One pair of opposite faces being *ovate* in outline, concave transversely, convex longitudinally; the other pair being *obovate*, convex both transversely and longitudinally. The locules are *obovate-lanceolate* in outline while the longitudinal fibres which form the third coat of the wall (passing outwards) surround the attenuated *base* of each locule. A strand of fibres *passes from the base* of each locule towards the periphery of the fruit, reaching the exterior by a pair of oval apertures one at the *base* of each *ovate* face. These strands appear to *unite to*

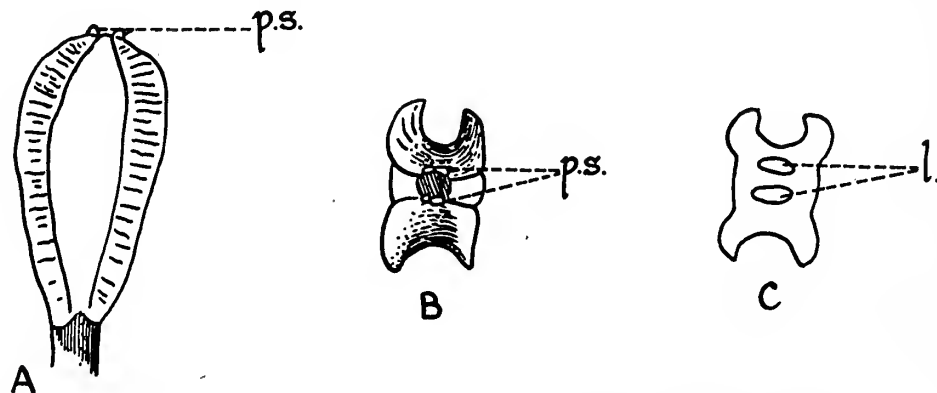


Fig. 44. *Lagenella alata* Reid & Chandler. Diagrammatic drawings of fruit. A, side. B, apex. C, transverse section. *l*, locules; *ps*, perianth segments.

form the stalk. The fibrous bands are embedded within a mass of parenchyma which is particularly thick on the tumidities of the *obovate* faces. Breadth of *ovate* face, 7 mm.; of *obovate* face, 6, 7, 4.25 and 5 mm. respectively in four specimens. Four minute projections at the apex of the fruit suggest a superior 4-fid perianth.

The seed is *obovate*-lanceolate in outline, the chalaza lies near the *apex* on one of the narrow margins, hence the seed may be erect and anatropous (but no trace of raphe is preserved) or pendulous and orthotropous.

Figured Pl. 30, figs. 18, 19. A fruit with the basal end and peduncle particularly well-preserved. The specimen has now completely disintegrated.

V.30499 Another specimen showing the same feature.

V.30500 A fruit abraded at the base (or apex) to show the locule-casts. Also two other specimens, one fractured transversely.

V.30501 A fruit with one locule-cast exposed.

The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30502 A fruit. *A. G. Davis Coll.*

V.30503 A fruit much encrusted with pyrites. *G. F. Elliott Coll.*

Both the above from Warden Point, Sheppey.

V.30504 A fruit somewhat encrusted with pyrites. *D. J. Jenkins Coll.*

V.30505 A small fruit abraded at the apex and a second incomplete fruit. *J. E. Cooper Coll.*

Both the above from Herne Bay, Kent.

Genus CARPOLITHUS Linnaeus

Carpolithus scalariformis Reid & Chandler

Plate 30, fig. 20; Text-fig. 45

1933 *Carpolithus scalariformis* Reid & Chandler, p. 518, pl. 31, figs. 7-14.

There is nothing new to add to the description of this species beyond the fact that perfect valves have now been found ranging from 18 to 23 mm. in length and that one incomplete valve shows the arrangement of nerves on or just beneath the external surface (Text-fig. 45).

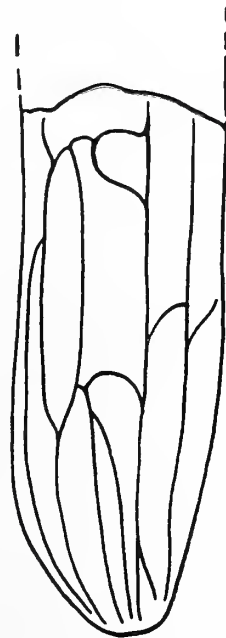


Fig. 45. *Carpolithus scalariformis* Reid & Chandler. Diagrammatic drawing of valve exterior showing branching of nerves.

- V.30506 Figured Pl. 30, fig. 20. A perfect valve showing the elongate form. Length, 23 mm.; breadth, 4.35 mm.
 V.30507 A valve.
 The above *G. F. Elliott Coll.* Warden Point, Sheppey.
 V.30508 Four specimens; one a complete valve from which the seeds have been largely abraded, 18 mm. long, 5 mm. broad; two are halves of valves with seeds preserved, one of which shows the arrangement of the nerves near the surface of the valve (Text-fig. 45); one is a much abraded fragment showing carpel wall and casts of seeds. *A. G. Davis Coll.* Warden Point, Sheppey.

Carpolithus pusillus (Reid & Chandler)

1933 *Palmospermum pusillum* Reid & Chandler, p. 115, pl. 1, figs. 32-34.

Since the publication of the London Clay Flora in 1933 further material of the species named *Palmospermum pusillum* has been found in better condition. The new evidence suggests that the ascription to Palmae can no longer be maintained. There is no clear embryo-scar in any specimen, the mark so described originally was rightly regarded as doubtful and was seen in one cast only. The beak-like projection at one end on both carpel and seed strongly suggest the beak associated with a radicle and cannot be matched in any species of palm examined.

A well-defined circular chalaza scar at the base of the ventral hollow of the seed-cast is unlike the chalaza of any palm seen and is comparable with the chalaza scar in species of Sabiaceae and Anacardiaceae although other characters in these families are dissimilar.

The somewhat boat-shaped form of the seed suggests relationship with Menispermaceae, but again no sharply defined circular scar occurs in that family nor is the ventral hollow occupied by a thickened plug of parenchyma. *Schizandra* (Magnoliaceae) is distinguished by the form, the structure of coats, character of chalaza, and the relative positions of the micropyle and ventral aperture; also the difference in the form of the ventral aperture seems to debar any real relationship here.

Pending further discoveries the specimens hitherto described as *Palmospermum pusillum* are transferred to the form-genus *Carpolithus*.

There now appears to be clear evidence of more than one species or variety of this plant. Probably at least three can be distinguished. In order to indicate their common relationship until the systematic position becomes clear, the distinct forms hereafter defined are all designated as varieties of *Carpolithus pusillus* (Reid & Chandler).

Carpolithus pusillus var. *latus* nov.

Plate 30, figs. 21-29; Text-fig. 46

1933 *Palmospermum pusillum* Reid & Chandler, p. 115, pl. 1, figs. 32, 34

DIAGNOSIS OF VARIETY. Beak large, formed by the gradual tapering of the sides of the fruit and seed. Channel between beak and ventral plug relatively broad and shallow flanked by low rounded tumidities. Dorsal surface when abraded showing a median furrow. External surface ornamented with short sinuous concentric ridges. Dorsal surface of seed smooth and rounded without ridge or furrow. Length of carpel, 4.3 mm.; breadth, 3.65 mm.; thickness, 3 mm.

DESCRIPTION. *Carpel*: Sub-globular, bisymmetric about a dorsiventral plane, somewhat flattened on the ventral surface where a median hollow is filled by a plug of parenchyma

about 1 mm. in diameter; pierced by fibro-vascular strands, carpel rounded on the dorsal surface, produced into a beak at one end in the plane of symmetry.

From the margin of the plug to the point of origin of the beak there is a shallow channel flanked on each side by a low rounded tumidity.

External surface irregularly and intermittently rippled by short sinuous concentric ridges about 0.9 mm. long and 0.25 mm. apart (measured from crest to crest). On both surfaces they have a more or less horse-shoe shaped alignment, the limbs of the shoe directed towards the beak. The epidermis is formed of obscure, irregular, polygonal cells, 0.012 to 0.016 mm. in diameter. Within is a surface of elongate cells aligned longitudinally over the middle of the dorsal face but directed obliquely outwards from the pointed end over the rest of this surface and then converging on the ventral face towards the plug.

In section the coat is formed of laminate cells at right angles to the surface so that a radial fracture may produce either an irregular columnar or a step-like structure. On the dorsal surface the coat is 0.1 mm. thick. Next comes a coat of about four layers of flat cells aligned parallel to the surface, the cells of the outermost of these layers are oblong (0.025 by 0.04 mm. in diameter where measured near the pointed end of the fruit) and are aligned with their longer axes transverse so as to produce transverse striae. The inner layers appear to be longitudinally aligned but they have not been seen in surface view. Within again are angular cells,

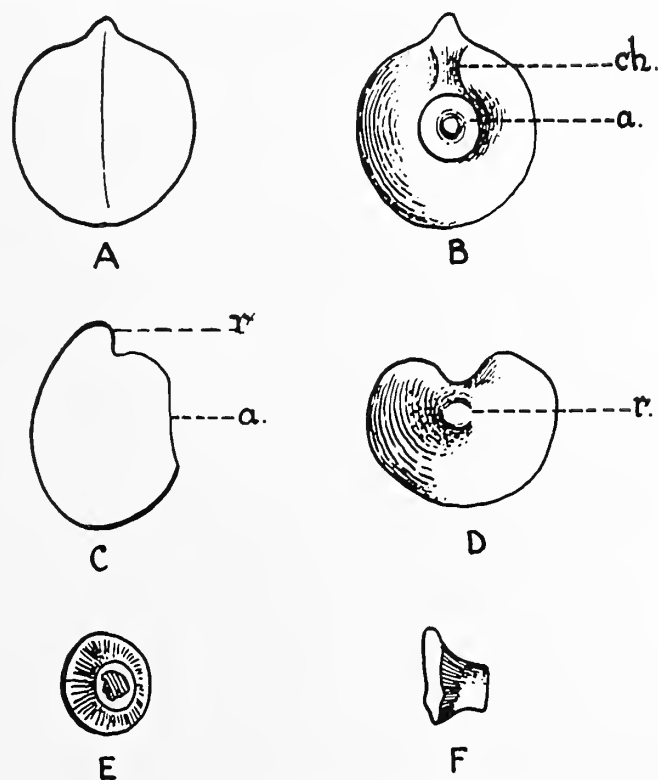


Fig. 46. *Carpolithus pusillus* var. *latus* nov. A, carpel, dorsal. B, the same, ventral, showing plug in aperture (*a*) and channel (*ch*). C, side. (*r*), radicular prominence; ventral aperture is to the right at (*a*). D, same end view with radicular prominence at (*r*). E, plug removed from endocarp, inner surface. F, plug removed from endocarp side, with inner surface to the left.

very variable in shape, with black contents, somewhat elongate longitudinally or diagonally, typical cells measuring 0.06 by 0.025 mm. There is evidence in some specimens of a longitudinal median ridge on the dorsal side which appears as a furrow on one of the abraded specimens (Pl. 30, fig. 29). Length of a typical carpel, 4.3 mm.; breadth, 3.65 mm.; thickness, 3 mm.

Seed: Solitary, agreeing with the locule in shape, the beak-like prominence almost certainly associated with the micropyle, the dorsal surface smooth and rounded (Pl. 30, figs. 26, 27), the ventral hollow larger and with a larger aperture than that of the locule, the channel between it and the micropyle broader and shallower than the corresponding channel on the carpel (Pl. 30, fig. 25). Surface showing a fine network of dark lines formerly interpreted as ruminations, but this explanation of their nature seems unsatisfactory.

Testa formed of equiaxial cells about 0.02 mm. in diameter. Length of seed about 4.1 mm.; breadth, 3.5 mm.; thickness, 2.5 mm.

REMARKS. One beautifully preserved carpel from Sheppey, more perfect than specimens previously described, all of which were locule-casts much polished by abrasion and showing no trace of the integuments outside the testa. The carpellary coats of the new specimen ultimately flaked away and after their removal the perfect cast of the seed was exposed. The description given above is based largely on this specimen. Another more abraded seed-cast from Sheppey, and one from Bognor, Sussex have similar features. The Bognor specimen (Pl. 30, figs. 28, 29) retains the inner layers of the carpel wall and shows the longitudinal furrow on the dorsal surface of the cast. V.22032 evidently belongs to this variety.

- V.30509 Holotype, figured Pl. 30, figs. 21-27. A carpel with coats originally well preserved, subsequently the coats flaked away leaving the perfect seed (Pl. 30, figs. 25-27). *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30510 Figured Pl. 30, figs. 28, 29. A locule-cast with remains of inner layers still adhering. It shows the longitudinal dorsal furrow. Now fractured longitudinally. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30511 A seed-cast with testa largely abraded. *J. G. Turner Coll.* Sheppey.

Carpolithus pusillus var. *elongatus* nov.

Plate 30, figs. 30-35

1933 *Palmospermum pusillum* Reid & Chandler, p. 115, pl. 1, fig. 33.

DIAGNOSIS OF VARIETY. Carpel narrow-ovoid in outline, tapering gradually into the sharply-pointed beak. Dorsal surface with median longitudinal furrow pierced by a row of small rounded openings. Channel between the beak and ventral plug broad and shallow especially on the seed. Dorsal furrow seen also on the seed which has a broad, deep, ventral hollow. Length of seed-cast, 3.5 mm.; breadth, 2.5 mm.; thickness, 1.5 mm. Length of a carpel (broken at beak), 3.75 mm.; breadth, 2.6 mm.; thickness, 1.75 mm.

HOLOTYPE. V.30512.

DESCRIPTION. *Carpel*: Narrow-ovoid in outline, tapering gradually into the pronounced sharply-pointed beak. Dorsal surface with a median longitudinal furrow pierced by a row of small rounded apertures. External surface showing elongate narrow cells arranged in lines which diverge obliquely from the dorsal furrow and converge towards the ventral hollow, ornamented with sinuous rounded ridges as in *C. pusillus* var. *latus* previously described. Ventral opening small, about 1.5 mm. across. Channel between the beak and ventral plug

broad and shallow. Length of a specimen with carpel wall preserved about 3.75 mm. (extreme tip of beak broken); breadth, 2.6 mm.; thickness, 1.75 mm.

Seed: Agreeing with the locule in shape but with deeper, broader, ventral hollow with larger aperture and broader channel between it and the beak. Longitudinal dorsal furrow with slightly sinuous margins corresponding with the apertures in the carpel wall. A sharply defined, circular chalaza (Pl. 30, fig. 30), 0.8 mm. in diameter, can be seen in the centre of the ventral hollow around which the testa cells are radially aligned. Cells equiaxial, 0.016 to 0.025 mm. in diameter, over most of the surface, except in the longitudinal dorsal furrow where they are somewhat elongate and about 0.04 to 0.05 mm. Length of a well-preserved seed, 3.5 mm.; breadth, 2.5 mm.; thickness, 1.5 mm.

REMARKS. One fruit with carpel preserved (Pl. 30, figs. 33-35) and a well preserved seed-cast (Pl. 30, figs. 30-32). The specimen figured by Reid & Chandler (1933, pl. 1, fig. 33) appears to belong to this variety.

- V.30512 Holotype, figured Pl. 30, figs. 30-32. A seed-cast showing the chalaza in the ventral hollow and the groove on the dorsal surface.
 V.30513 Figured Pl. 30, figs. 33-35. Carpel with carbonaceous coat preserved. It shows the dorsal groove with its row of rounded apertures.
 V.30514 Two locule-casts.
 V.30515 Locule-cast, broken on one side.
 The above *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus pusillus var. *ornatus* nov.

Plate 31, figs. 1-7; Text-fig. 47

DIAGNOSIS OF VARIETY. Beak much smaller than in var. *latus*, arising rather abruptly out of the general surface. Channel between beak and ventral plug deeper and narrower, flanked by more prominent tumidities. Dorsal surface having a conspicuous median ridge flanked by about six obliquely directed ridges on each side which pass on to the ventral surface. Length of carpel, 4.5 to 6.4 mm.; breadth, 4.5 to 6.4 mm.; thickness, 3 to 3.65 mm.

HOLOTYPE. V.30516.

DESCRIPTION. Beak-like prominence smaller than in var. *latus*, arising rather abruptly out of the rounded surface. Channel between the beak and the ventral plug deeper and narrower, flanked by more prominent tumidities. Dorsal surface with a conspicuous median longitudinal ridge on each side of which there are about six ridges which diverge obliquely from the base of the terminal beak and pass over on to the ventral surface where they converge towards the plug. These ridges are crossed at right angles by fine, rounded, sinuous ridges. The ventral hollow appears to be larger than in var. *latus* and is filled by a plug of tissue finely columnar in section. The carpel wall, as seen in section, is coarsely and somewhat irregularly columnar, columns frequently about 0.05 mm. broad. Length of holotype, 4.5 mm.; breadth, 4.5 mm.; thickness, 3 mm. Length of a larger more abraded specimen, 6.4 mm.; breadth, 6.4 mm.; thickness, 3.65 mm.

Seed: Only partly visible. In the holotype the micropylar end projects as a small snout through the locule-cast. It shows small equiaxial cells which diminish in size towards the point of the snout. In the larger specimen the seed is seen in longitudinal section, a slight carbonaceous thickening formed of equiaxial cells 0.025 mm. in diameter marks the chalaza at the middle of the ventral hollow.

REMARKS. Two specimens. The smaller was originally almost perfect with carbonaceous endocarp preserved. It showed clearly the external features described. The plug of tissue in the ventral hollow is partly abraded and shows as a horse-shoe shaped band of tissue with

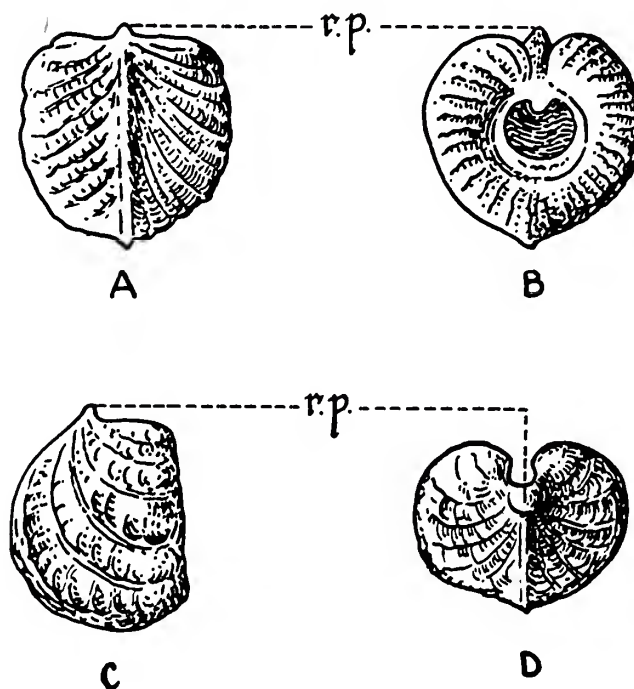


Fig. 47. *Carpolithus pusillus* var. *ornatus* nov. A, carpel, dorsal. B, ventral, showing aperture and scar of attachment. C, lateral, the ventral aperture is to the right. D, apical view, ventral aperture above. *rp*, radicular prominence.

arms open towards the beak (Pl. 31, fig. 1). The larger specimen has undergone much polishing by abrasion and the tip of the beak-like prominence is broken. Although larger and more compressed dorsiventrally it probably belongs to the same variety.

- V.30516 Holotype, figured Pl. 31, figs. 1-4. A carpel with the tip of the seed exposed at the micropyle. The external carbonaceous coat was originally preserved over the whole surface but has now largely flaked away exposing the locule-cast.
- V.30517 Figured Pl. 31, figs. 5-7. A carpel with much abraded surface. The specimen is now longitudinally fractured. The beak-like prominence has been broken by abrasion.
- Both the above *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30518 A poorly preserved specimen, now fractured, possibly referable to this variety. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus thunbergioides Reid & Chandler

1933 *Carpolithus thunbergioides* Reid & Chandler, p. 505, pl. 30, figs. 9-13.

- V.30519 A much compressed carpel. *D. J. Jenkins Coll.* Herne Bay, Kent.

Carpolithus gracilis (Bowerbank) Chandler

Plate 31, fig. 8

1840 *Tricarpellites gracilis* Bowerbank, p. 82, pl. 11, figs. 37, 38.

A syncarpous three-lobed and apparently three-loculed fruit, elongate-ovoid (or obovoid), bluntly rounded at one end, attenuated to a point at the other, broadest at about one-third of the length from the rounded end, sometimes slightly curved at the narrow end, septa extremely thin. Walls in part at least of coarse irregular cells at right angles to the surface, seen in a specimen from Herne Bay. External surface much abraded, the outer layers preserved only in the furrows between the lobes where there are longitudinal strands of fibres. Within the external coat there was evidently a coat of fine transverse cells crossed by longitudinal furrows, seen in a specimen from Bognor, and within again a coat of coarser transverse fibres preserved in the same specimen on the surface of the cast. Length of specimen from Bognor, 11 mm.; transverse diameter, 4.25 mm. Length of a specimen from Herne Bay, 15 mm.; breadth, 7 mm.

These specimens more nearly resemble Bowerbank's *Tricarpellites gracilis* than does *Carpolithus* sp. 33 (Reid & Chandler, 1933: 526, pl. 31, fig. 40) which was formerly compared with it. *Carpolithus* sp. 33 had not the marked attenuation at one end, and its greatest breadth was about the middle of the fruit. The smaller specimen from Bognor corresponds closely in size with Bowerbank's specimens. The other specimen from Herne Bay, although larger, appears to be indistinguishable from it.

The number of seeds is not known, the form suggests that there were numerous small seeds. Relationship not discovered.

V.30520 Figured Pl. 31, fig. 8. A three-lobed cast. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

V.30521 A larger but similar cast, slightly curved at the narrower end. *J. E. Cooper Coll.* Herne Bay, Kent.

Carpolithus sp. 33 (? *C. gracilis*)

Plate 31, figs. 9-11

1933 *Carpolithus* sp. 33 Reid & Chandler, p. 526, pl. 31, fig. 40.

V.30522 Figured Pl. 31, figs. 9-11. A three-lobed cast, now fractured transversely. Three septa diverging from a median axis are seen on the fractured surfaces. The septa have compact well-defined surfaces now separated by a pyrites-filled cavity perhaps indicating septicial splitting or the decay of less compact internal tissue. The locules are filled with pyrites embedded within which are ill-preserved possibly unripe seeds attached to the axis; traces of coarse cells are seen on the testa. Length of cast, 10.4 mm.; diameter, 5 mm. *D. J. Jenkins Coll.* Herne Bay, Kent.

Carpolithus sp. 341933 *Carpolithus* sp. 34 Reid & Chandler, p. 526, pl. 31, figs. 41, 42.

V.30523 Bivalved endocarp split to show the small locule-cast. *D. J. Jenkins Coll.* Warden Point, Sheppey.

Carpolithus sp. 381933 *Carpolithus* sp. 38 Reid & Chandler, p. 528, pl. 32, figs. 4-9.

V.30524 A fruit fractured longitudinally; the first record of this species from Herne Bay. *J. E. Cooper Coll.* Herne Bay, Kent.

- V.30525 A fruit closely resembling *Carpolithus* sp. 38 in outward appearance and inward structure. It shows the same spongy coarse-celled coat 2 (Reid & Chandler, 1933: 528) which appears to merge gradually into the pyrites filling the locule. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp. 49

1933 *Carpolithus* sp. 49 Reid & Chandler, p. 534, pl. 32, figs. 28-31.

V.30526 A fruit. *G. F. Elliott Coll.*

V.30527 A fruit with carbonaceous coat preserved, now cracking away. *G. F. Elliott Coll.*

V.30528 A fruit, 8 mm. long, 6.75 mm. in transverse diameter. Remains of a carbonaceous coat of fine digitate cells cover the locule-cast, the surface of which is finely transversely striate. A longitudinal suture extends from base to apex along one side of the cast indicated by a ridge of pyrites which originally occupied a fissure presumably associated with dehiscence. On fracture a single seed was revealed with rough testa formed of rounded or angular cells. *A. G. Davis Coll.*
The above from Warden Point, Sheppey.

V.30529 A much abraded and polished specimen showing the five-angled base and the apical scar. It also shows a pair of depressions just below this scar in the plane of symmetry. This specimen was fractured longitudinally but was merely a pyrites locule-cast. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Carpolithus sp. 50

Plate 31, figs. 12-15

1933 *Carpolithus* sp. 50 Reid & Chandler, p. 535, pl. 32, figs. 32, 33.

Fruit: One-loculed, one-seeded, bisymmetric, splitting along a marked ridge or angle in the plane of symmetry into equal valves, sub-ovoid. Surface smooth, wall about 0.05 mm. thick, compact, woody, formed externally of a layer (about 0.05 mm. thick) of coarse cells aligned at right angles to the surface; within are a few layers of coarse thick-walled equiaxial cells, 0.012 to 0.025 mm. in diameter; the innermost layers are of rectangular cells, parallel with the surface of the locule, producing longitudinal striations on that surface. Placentation obscure, seed probably pendulous. Length of fruit (incomplete at the base), 9.5 mm.; breadth in plane of symmetry, 7.5 mm.; thickness at right angles to plane of symmetry, 8.5 mm.

Seed (Pl. 31, fig. 15): Sub-ovoid (somewhat distorted and crumpled), obscurely bisymmetric, pointed at the hilar-micropylar end, truncate at the opposite end by a large, sub-elliptical, slightly convex chalaza-scar about 5.5 by 5 mm. in diameter with an obscure median angle in the plane of symmetry of the seed and rather a rough surface. Surface of seed largely decayed, smooth where preserved, formed of rectangular or elongate cells with oblique or bevelled ends, 0.02 mm. broad; testa thin, inner integument shining, of equiaxial cells. Length of seed, 8 to 8.3 mm.; breadth, 5 to 6.3 mm.

V.30530 Figured Pl. 31, figs. 12-15. A fruit, originally almost perfect, now fractured to show the seed. *J. E. Cooper Coll.* West Cliff, Herne Bay, Kent.

Carpolithus sp.

Plate 31, figs. 16, 17

Long, narrow, loculicidal valves with axile seeds. Externally longitudinally and irregularly rugose; septa thick, transversely striate superficially, locules flat. Length of one specimen,

22.5 mm.; breadth across the external surface, 5 mm.; radius, 4.5 mm. Seeds ovoid, 5 mm. long, about 2.5 mm. broad. Structure obscure. Relationship not discovered.

V.30531 Figured Pl. 31, figs. 16, 17. A valve slightly imperfect at one end, with impressions of three seeds in one locule (Pl. 31, fig. 17) and of one seed in the other. *A. G. Davis Coll.* Warden Point, Sheppey.

V.30532 A valve with seed impressions. *J. E. Cooper Coll.* Herne Bay, Kent.

V.30533 A valve with somewhat similar external cell-structure and marginal fibres, also impressions of seeds similar in size and type to V.30531. Too poorly preserved to yield more information. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

Carpolithus sp.

Plate 31, figs. 18–21

A bisymmetric, obovoid, woody endocarp with a tendency to split indicated by a groove in the plane of symmetry is difficult to interpret. It has a downward-curved transverse placenta-like aperture on the groove about one-third of the length from the apex (Pl. 31, fig. 19). The walls are thick and woody, sometimes as much as 0.6 mm. thick, formed of equiaxial sinuous cells, 0.025 to 0.03 mm. in diameter. On fracture the specimen showed two plano-convex seed-like bodies lying one above the other, separated by an oblique septum and apparently suspended marginally from the 'placenta' (Pl. 31, figs. 20, 21). The surface of these bodies is formed of inflated equiaxial cells 0.03 mm. in diameter; on fracture they are seen to consist throughout of a solid mass of coarse tissue diverging from the margin adjacent to the placenta, many of the cells measuring as much as 0.1 by 0.2 mm. in diameter. Length of endocarp, 5.5 mm.; breadth, 4.5 mm.; thickness, 4.5 mm.

The specimen is puzzling. The seed-like solid bodies may be galls within locule-cavities. Relationship not known.

V.30534 Figured Pl. 31, figs. 18–21. A fruit fractured to expose two gall-like structures. *G. F. Elliott Coll.* Warden Point, Sheppey.

Carpolithus sp.

Plate 31, figs. 22, 23; Text-fig. 48

Fruit: Two-loculed, truncate-fusiform, somewhat bilobed owing to a pair of median longitudinal furrows on opposite sides marking the margins of the septum. Apex with a shallow

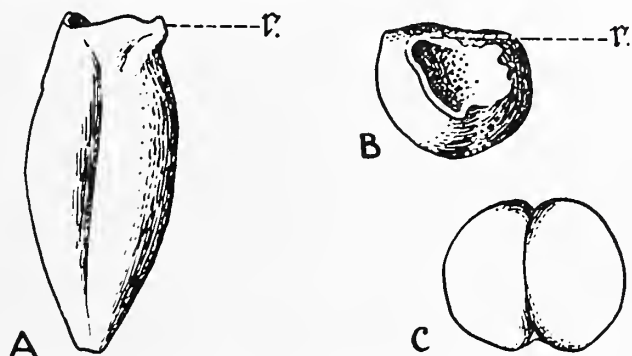


Fig. 48. *Carpolithus* sp. A, side view. B, truncate end with upstanding rim. C, transverse section showing two locules. *r*, rim.

depression causing the truncation, surrounded by a marginal uneven rim, base pointed, one locule somewhat larger at this end than the other. Surface black and shining, structure obscure, coat generally less than 0.1 mm. thick but largely chipped away exposing the somewhat rough surface of the internal cast with obscure cells which tend to be transversely aligned. Length of fruit, 7.25 mm.; breadth, 3.5 mm.; thickness, 2.75 mm. The relationship has not been determined.

V.30535 Figured Pl. 31, figs. 22, 23; Text-fig. 48. A fruit fractured to show the two locules in section side by side. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 31, figs. 24, 25

A single carpel derived probably from a two-carpelled syncarpous fruit. Oboval (or oval?) in outline, concavo-convex, the dorsal surface being convex both longitudinally and transversely, the ventral slightly concave longitudinally. On the ventral face at the apex (or base?) is the remains of a fibrous axis. Dorsal surface smooth, the exocarp about 0.1 mm. thick, formed of parenchyma, terminating at the lateral margin. Ventral surface formed of coarse highly contorted cells, in section the coat which forms this surface is about 0.3 mm. thick and is close and compact in texture. Locule lined by rather irregular longitudinally aligned cells about 0.012 mm. broad, varying considerably in length. Seed solitary, tegmen formed of equiaxial irregular cells transversely aligned giving a somewhat uneven transverse striation, the striae being 0.016 mm. apart.

V.30536 Figured Pl. 31, figs. 24, 25. A detached carpel with adherent remains of median axis of fruit. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 31, figs. 26, 27; Text-fig. 49

A detached carpel or locule-cast from a two-carpelled fruit from which the other valve or carpel has disappeared. The appearance is suggestive of an abortive carpel of *Bursera*ceae, but the details of cell-structure, so far as these can be observed, do not bear out this relationship. The carpel is broadly oval in outline, much compressed, slightly convex on the dorsal side, more or less flat on the ventral side. The dorsal surface has a deep longitudinal furrow at the more pointed end extending for more than half the length, flanked by two very short ridges which quickly die out (Pl. 31, fig. 26). The ventral surface (probably representing the septum) has a stout median ridge, perhaps associated with a central axis. Two small knobs on each side of the ridge just above (or below?) the middle may represent placentae (Pl. 31, fig. 27). Both surfaces are much obscured by a film of pyrites. In transverse section one flattened seed

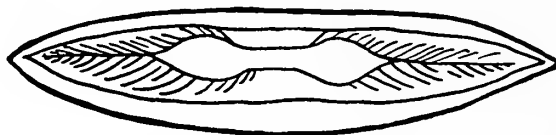


Fig. 49. *Carpolithus* sp. Diagrammatic transverse section.

is seen, having a cavity, rounded at each end, narrow in the middle, which occupies about half the breadth (Text-fig. 49). It is delimited by a thin wall of transverse cells or fibres prolonged medianly on each side as a rib flanked by and enclosed within a wing-like expansion formed of sinuous cells tapering towards the lateral margins of the carpel.

In longitudinal section the seed-body at once narrows into a laminate prolongation flanked, in part at least, by a continuation of the wing, while near one end, that adjacent to the placental knobs, a thickened circular disc suggests a chalaza. The relationship of this specimen awaits discovery but it is readily recognizable.

Length of carpel (or locule-cast), 7 mm.; breadth, 6.5 mm.; thickness through the median ridge, 2.5 mm.

V.30537 Figured Pl. 31, figs. 26, 27; Text-fig. 49. A carpel or locule-cast broken to show the structure in section and the single seed. *A. G. Davis Coll.* Warden Point, Sheppey.

Carpolithus sp.

Plate 31, fig. 28

V.30538 A sub-ovoid bisymmetric cast with basal aperture, having a longitudinal ridge in the plane of symmetry on both faces and several minor ridges and flutings at the base. The aperture suggests a chalaza, or the basal scar of a berry. The specimen would probably be recognizable if more and somewhat differently preserved fruits were found. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 31, figs. 29-31

Endocarp: Sub-hemispherical, ventral margin scarcely convex, dorsal margin semi-circular in profile, bisymmetric, one-loculed, one-seeded. Wall thick, woody, of equiaxial much pyritized cells. Attachment area obscured by pyrites, evidently long and narrow leading into a long and narrow aperture at the base of which lies the long thickened chalaza (Pl. 31, figs. 30, 31). Seed curved, rounded on the dorsal surface, having a long narrow hollow on the ventral surface at the bottom of which the chalaza is situated. Testa thin, formed of long narrow cells only visible in a few small patches. Length of endocarp, 9 mm.; breadth, 7.75 mm.; thickness, 6.25 mm.

The form, ventral hollow of the seed, and thickened ventral chalaza at first suggested a Palm seed, but such a relationship is probably excluded by the absence of columnar structure in the endocarp as seen in section. The structure of the endocarp is also unlike that of the fibrous endocarps of Menispermaceae. The relationship is not known.

V.30539 Figured Pl. 31, figs. 29-31. An endocarp fractured longitudinally to show the seed and chalaza. *J. E. Cooper Coll.* Herne Bay, Kent.

Carpolithus sp.

Plate 31, fig. 32

A small pointed sub-ovoid specimen appears to be the internal cast of a locule. It showed longitudinal rugosities on its external surface but on fracture no further details of structure could be seen. Length of specimen, 7.75 mm.; diameter, 6 by 4.5 mm.

V.30540 Figured Pl. 31, fig. 32. A cast, now fractured transversely. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Carpolithus sp.

Plate 31, figs. 33, 34; Text-fig. 50

A syncarpous three-loculed fruit with several, possibly many seeds in each locule is represented by two three-lobed internal casts. The carpel wall, largely abraded, is preserved as a coat of fine cells aligned at right angles to the surface, overlain by scanty remains of longitudinally aligned cells. Dehiscence was probably septicidal as suggested by a median plane of weakness in the septa where seen in transverse fractures of the fruit. The cast is elongate sub-ellipsoid, the longitudinal grooves between the three lobes extending from end to end. Within them are the remains of the septa. Locule lined by fine transverse or oblique fibres. On the casts impressions of coarse longitudinally aligned cells are also seen which appear to be due to impressions of seeds. Placentation may be parietal as there is no clear evidence of an axis. About four seeds are visible around the circumference of the locules in a median transverse fracture. Seeds situated in the lower part of the fruit appear to overlap those above. The seeds are elongate with a long straight cylindrical body, about 3.2 mm. long, 0.5 mm. broad, partially embraced by a wing or thickening of the testa which is formed of large inflated elongate cells about 0.05 mm. broad and sometimes as much as 0.8 mm. long. At one end (apex?) of the seed they form a broad flat wing-like expanse of coarse cells about 0.03 mm. broad (Pl. 31, fig. 34; Text-fig. 50). These cells diverge from the end of the seed-body as from a chalaza, they are

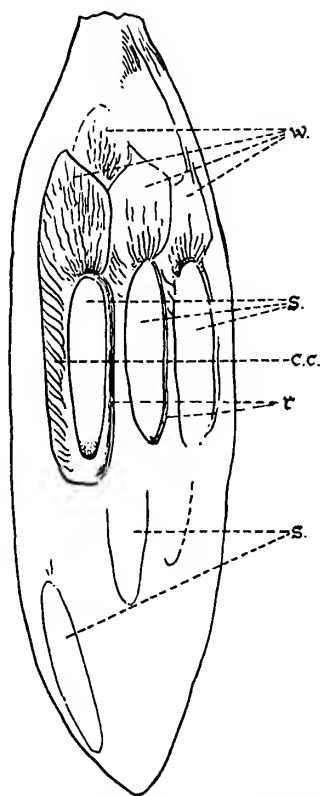


Fig. 50. *Carpolithus* sp. Diagrammatic longitudinal section of fruit. Cf. Pl. 31, fig. 34. *cc*, coarse cells around circumference of seed; *r*, raphe; *s*, seed-body; *w*, wing.

then aligned more or less longitudinally over the wing surface, often dovetailing into one another. Along one lateral margin of the seed the cells are relatively short and diverge obliquely from the body forming a narrow flange (Text-fig. 50). The opposite margin is delimited by a stout longitudinal fibre (possibly a raphe?) and appears not to have carried a wing. The opposite extremity of the seed to that described above is pointed, and the divergence of cells from this point may indicate a hilum or micropyle. The tegmen or inner layers of the testa are formed of small quadrangular cells 0.025 mm. in diameter. Length of fruit, 16 mm.; breadth, 7.5 mm. Length of seed about 5.8 to 6.5 mm.; breadth, 1.1 to 1.5 mm.

REMARKS. The relationship of this fruit with its distinctive winged seeds has still to be discovered. The exact form of the seeds is difficult to ascertain in this pyritized material but it is clear that the cylindrical body is enveloped above and on one side at least by a coarse-celled wing, the wings filling the locule-cavity and lying adpressed to one another.

The fruit resembles *Carpolithus* sp. 33 (Reid & Chandler, 1933: 526, pl. 31, fig. 40) but is almost twice as large.

V.30541 Figured Pl. 31, figs. 33, 34. A three-lobed cast now fractured to show remains of seeds. *J. E. Cooper Coll.* Herne Bay, Kent.

V.30542 A cast (16 mm. long, 7.5 mm. broad) with seeds. *C. E. Hollis Coll.* Swale Cliff, Herne Bay, Kent.

Carpolithus sp.

Plate 31, fig. 35

Fruit: Woody, bisymmetric, splitting into two valves in the plane of symmetry. Sub-oval in outline, somewhat compressed at right angles to the plane of symmetry so as to be lentiform in section. Slightly emarginate at the base with sunk attachment, having a marginal flange on each side of the attachment projecting as a rounded ridge which may have continued to the apical style in the plane of symmetry. Carpel wall thick, formed of cells with irregular deeply sinuous outlines. Seed solitary in the locule, apparently erect. Locule-lining of longitudinally elongate cells with dovetailed ends, about 0.03 to 0.05 mm. broad. Length of fruit about 16 mm.; breadth and thickness incomplete.

Seed (locule-cast:) Ovate in outline, lenticular in transverse section, orthotropous; testa and tegmen thin, cell-structure rather obscure, but apparently of longitudinally elongate cells similar to those of the locule-lining but with slightly sinuous walls possibly represented by a coat of fine, longitudinally aligned cells, about 0.02 mm. broad, seen in a few patches only. Length of seed about 14 mm.; breadth, 8 mm.; thickness, 6 mm.

REMARKS AND AFFINITIES. A single specimen, much battered and abraded so that the fruit wall has disappeared except around the margin, the locule-cast and seed-cast being exposed over the broad surfaces. Marginal dehiscence has begun, the gap between the sutures of the valves being filled with pyrites which cements the two valves together. The relationship has not been discovered. One of the rare specimens from Frinton Cliffs.

V.30543 Figured Pl. 31, fig. 35. A seed with remains of fruit adherent around the margin. *A. G. Davis Coll.* Frinton Cliffs, Essex.

Carpolithus sp.

Plate 31, fig. 36

A sub-ovoid endocarp truncate at one end which is partially closed by a thick carbonaceous plug. A gaping aperture adjacent to the plug appears to be accidental, it lies wholly within the pyrites locule-cast and has no structural significance.

Carpel as preserved, 0.3 mm. thick, formed of compact equiaxial cells 0.03 mm. in diameter. There is a single pendulous seed which fills the cavity showing the impressions of equiaxial angular cells of the testa, 0.02 mm. in diameter. Length of endocarp, 7.25 mm.; transverse diameter, 4.75 mm.

V.30544 Figured Pl. 31, figs. 36. An endocarp. *J. E. Cooper Coll.* Herne Bay, Kent.

Carpolithus sp.

Plate 31, figs. 37, 38; Text-fig. 51

The specimen appears to be a seed-cast of a conspicuously ruminant seed without evidence of cell-structure or of integuments. The form and appearance suggest a one-loculed, one-seeded fruit.

The cast is elongate-ellipsoid, slightly compressed (perhaps in fossilization). The ruminations produce conspicuous, superficial, longitudinal, finely crenulate and sinuous ridges. In transverse section they are seen to be radially arranged separated to varying depths by radial furrows (Pl. 31, fig. 38; Text-fig. 51). Some of the furrows extend to the centre where they

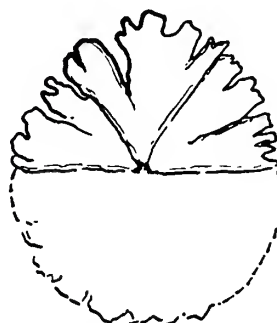


Fig. 51. *Carpolithus* sp. Diagrammatic transverse section of ruminant albumen. Half only drawn.

merge with one another in an axial canal, but between the deeper furrows are some short ones which subdivide the wedges of albumen (about six in number) produced by the deeper furrows. Length of cast, 17.5 mm.; transverse diameter, 6 by 4.5 mm.

The relationship of this species is not known but its distinctive appearance should make it readily recognizable if comparable material were available.

V.30545 Figured Pl. 31, figs. 37, 38; Text-fig. 51. The cast of a ruminant seed, now fractured transversely. *D. J. Jenkins Coll.* Swale Cliff, Herne Bay, Kent.

Carpolithus sp.

Plate 32, fig. 1

Fruit: Obovoid, but somewhat compressed as preserved, broken at one end so that the broken seed-cast protrudes, with a longitudinal sub-marginal furrow on one surface, and a longitudinal ridge on the other. Surface much abraded so as to show rather irregular elongate cells, 0.03 mm. in breadth, aligned on the whole longitudinally but sometimes arranged so as to produce a tortuous effect. A thick longitudinal strand of fibres lies within the wall beneath the sub-marginal furrow and longitudinal ridge. Inside is a considerable thickness of transversely aligned fibres or elongate cells, 0.012 mm. broad. The locule-lining is of fine cells with bevelled ends varying in breadth, often 0.012 mm. broad, with a general transverse alignment. Length of incomplete fruit, 6.25 mm.; breadth, 5 mm.; thickness, 2.7 mm.

Seed: Solitary, agreeing with the fruit in shape, anatropous, the raphe a strong cord of fibres lying in a groove of the testa and encircling the seed longitudinally, passing across the base, but asymmetrically placed on both faces so as to be nearer one margin than the other (probably owing to distortion of the seed). Testa of several thicknesses of polygonal cells, some secreting, measuring 0.025 mm. in diameter; the innermost layer (represented by a glistening pyrites surface) shows convex impressions of concave cells, 0.05 mm. in diameter, directed obliquely from the raphe, but converging towards the broken tip as seen on the seed-cast, indicating that one organ at least lay at this end when perfect.

REMARKS. One specimen. It was fractured in the hope of determining its relationship and the anatropous seed with encircling raphe was then exposed. The affinities have not been discovered.

V.30546 Figured Pl. 32, fig. 1. A fruit broken at one end, enclosing a seed-cast, also broken. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, figs. 2-4

Endocarp: Sub-obovoid but bisymmetric with a sharp angle in the plane of symmetry, attachment near one extremity marked by a transverse ridge of pyrites on the marginal angle at one end. Lateral faces much inflated with one or two rounded longitudinal folds or puckers at the rounded end. Carpel wall woody, about 0.4 mm. thick at its maximum thickness, formed of compact equiaxial cells very obscure and difficult to measure, but about 0.03 mm. in diameter. Seed solitary, seen only in section except over the large rounded triangular chalazal scar which is exposed by fracture (Pl. 32, fig. 4). This thickened scar is about 4.5 mm. broad, 3 mm. long, it lies beneath the marginal angle of the endocarp at about the middle. The cells over the chalaza are equiaxial, 0.016 mm. in diameter. Length of endocarp, 9.25 mm.; breadth in plane of symmetry, 6.5 mm.; breadth at right angles to plane of symmetry, 7 mm. Relationship unknown.

V.30547 Figured Pl. 32, figs. 2-4. A carpel. *D. J. Jenkins Coll.* Warden Point, Sheppey.

Carpolithus sp.

Plate 32, fig. 5

A sub-globular fruit now much compressed with a small, transversely elongate, terminal projection (style?). A sharp longitudinal angle extends almost from the style to the base along one side. It is a pyrites cast covered by a few scanty remains of a carbonaceous coat (exocarp?), 0.1 mm. thick, compact and obscure in structure but definitely not columnar in section, a fact which excludes relationship with Lauraceae. The surface of the cast is beset by numerous short blunt-ended tubercles representing the infillings of short radial canals in the exocarp. No seed can be seen although the specimen was fractured to expose a transverse section. Dimensions (as compressed), 10 by 9 by 5.5 mm.

V.30548 Figured Pl. 32, fig. 5. A crushed fruit now fractured transversely. *A. G. Davis Coll.* Warden Point, Sheppey.

Carpolithus sp.

Plate 32, figs. 6, 7

Carpel oval in outline, compressed, having one locule exposed by the removal from the ventral surface of a valve or smaller abortive locule forming a valve. The lateral limits of this ventral area have smoothly finished edges. The external surface is much abraded showing obscurely a few longitudinal strands of fibres traversing the whole length (Pl. 32, fig. 7). Wall, as seen in section, formed of equiaxial cells 0.016 mm. in diameter. The valve, septum, or differentiated ventral surface is thin (largely broken away) and formed superficially of fine transverse fibres. An adherent patch of tissue at the apex of the ventral surface may mark a placenta. The locule-wall is incurved at the base so that the locule-cast appears basally emarginate. Length of carpel, 14.5 mm.; breadth, 12.5 mm.; thickness as preserved, 7 mm.

The form of the carpel and locule-cast recalls Burseraceae, but the cell-structure does not support this relationship.

V.30549 Figured Pl. 32, figs. 6, 7. A carpel. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, figs. 8, 9; Text-fig. 52

Fruit: Pear-shaped with a depression (attachment?) at the narrow end and five small rounded apertures in a ring at the broad end (some seen obscurely in profile in Pl. 32, fig. 9) surrounding a group of minute scars or holes (perhaps associated with a superior perianth). Surface wrinkled on one side owing to oblique distortion of the specimen, suggesting that it was a fleshy fruit, a hypothesis borne out by the coarse cells (now indurated with pyrites). Epidermis abraded. Pericarp of angular cells more or less equiaxial in transverse section, 0.05 to 0.1 mm. in diameter, as exposed on the abraded surface of the fruit. In sections of the fruit, whether transverse or longitudinal, they are seen as elongate, turgid, radially aligned cells. Number of carpels uncertain, perhaps five as suggested by the apical apertures. One carpel only appears to have been fully developed in the only specimen seen, the bisymmetric locule tapering above and terminating in a narrow canal which appears to communicate with

one of the apical apertures (Pl. 32, fig. 9). Below, the locule is rounded rather abruptly, and laterally it is angled in the plane of symmetry along the broadest diameter. A second abortive locule appears to be represented by a narrow canal parallel with the fertile locule communicating with another of the apical apertures.

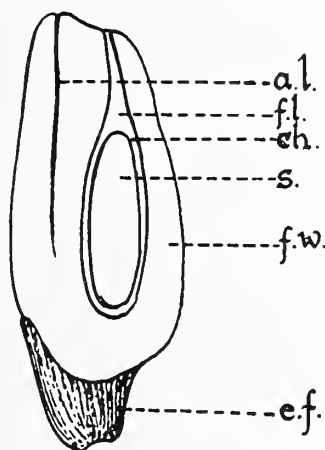


Fig. 52. *Carpolithus* sp. Diagrammatic longitudinal section of fruit. *al*, abortive locule; *ch*, chalaza; *ef*, exterior of fruit; *fl*, fertile locule; *fw*, fruit wall in section; *s*, seed.

The fertile locule is surrounded by a compact coat of small equiaxial rounded cells, 0.03 mm. in diameter. It encloses a single seed with a large terminal scar towards the broad end of the fruit (chalaza) (Pl. 32, fig. 9; Text-fig. 52). Other characters are not visible.

Length of fruit, 9.5 mm.; breadth, 6 by 4 mm. Length of locule without attenuated apex, 6.5 mm.; breadth, 1.5 by 2 mm., the broader diameter in the plane of symmetry.

The fruit has not been determined. It is, however, a readily recognizable form.

V.30550 Figured Pl. 32, figs. 8, 9; Text-fig. 52. A single fruit now fractured to show the internal structure. *J. E. Cooper Coll.* Herne Bay, Kent.

Carpolithus sp.

Plate 32, figs. 10–12

Two triangular pyramidal bodies with two equal triangular flat faces, and one very slightly concave triangular face all of which meet in a point at the apex. Part of the external wall is preserved, and in section is 0.1 mm. thick, formed of small polygonal cells radially arranged. On fracture one specimen showed several more or less compressed longitudinally aligned bodies lying closely appressed to one another. In section these appear to be made up throughout of parenchyma, in surface view they show elongate longitudinally aligned cells, 0.016 mm. in breadth. The nature of these specimens is obscure, but they may represent a bud with bracts or a flower with stamens. Length of fractured specimen, 3.5 mm.; breadth of widest face, 2.3 mm.

V.30551 Figured Pl. 32, figs. 10–12. A specimen, now sectioned.

V.30552 A second specimen, 4.75 mm. long, 3.25 mm. broad, doubtfully referable to the same species. Both *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, figs. 13, 14

An obovate seed narrowed to the base with an oval chalaza (Pl. 32, fig. 14) near the middle of the dorsal(?) surface. The lower margin of the chalaza is 3 mm. from the base of the seed, 2 mm. from the apex.

The superficial cells over the middle of the ventral surface are longitudinally aligned, 0.016 mm. broad; the surface is crumpled or ruckled. Within is a coat of transversely aligned cells or fibres, 0.016 mm. apart. Within again is a horse-shoe shaped seed-cast(?) with a surface formed of polygonal equiaxial cells 0.016 to 0.02 mm. in diameter. Length of specimen, 5 mm.; breadth, 3.2 mm.; thickness, 2 mm.

V.30553 Figured Pl. 32, figs. 13, 14. A seed. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, fig. 15

A sub-ovoid internal cast of a one-loculed, probably one-seeded, fruit showing a deep longitudinal furrow on one face (ventral?) and a shallower longitudinal furrow at about one-third of the circumference from the first furrow. The furrows extend almost throughout the length of the cast. About twenty-four evenly spaced transverse ripple-like ridges extend from furrow to furrow throughout the length; transversely aligned oblong cells are impressed on the surface of the cast. At one end there is a small circular scar of attachment from which a few short inconspicuous longitudinal ridges diverge. Length of cast about 4 mm.; breadth about 2.5 mm. The external characters are unknown.

V.30554 Figured Pl. 32, fig. 15. A fruit-cast. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, fig. 16

An ovoid fruit or seed (now compressed) with smooth surface and thin outer coat, much worn and completely abraded at one end, showing the internal cast of an inner coat. Structure of outer coat loose-textured but obscure. The coat within is also loose-textured, smooth superficially, several cells thick, formed of elongate cells, sometimes 0.15 mm. long, 0.037 mm. broad, with irregularly thickened walls. Over the main body of the specimen the form of the cells is much confused by longitudinal crumpling. At the narrow end, from which this coat has been abraded, the internal cast shows elongate cells of approximately uniform breadth producing fine longitudinal ribbing which diverges from a terminal opening (micropyle?). At the broad end of the seed the coat is greatly thickened, the cells becoming smaller, more numerous, and with a tendency to be equiaxial. An outgrowth of the cells at this end appears to form a tuft of hairs or tags; these structures probably indicate the chalaza within. Length of seed, 5.25 mm.; breadth, 3.75 mm.; thickness, 1.5 mm.

The specimen was fractured so as to expose the coats; the inner coat appears to represent the testa, but it is not clear whether the outer coat represents an aril or a fruit; it is separated by a thick layer of pyrites from the supposed testa.

V.30555 Figured Pl. 32, fig. 16. A fruit or seed now fractured to expose the coats. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, fig. 17

An elongate-ovoid endocarp with remains of a prominent style at the apex from which a few much abraded fibrous ribs diverge, syncarpous, two-loculed, with fibrous central axis. Locules sub-cylindrical; outer coat of endocarp formed of radially directed parenchyma which also fills the angles between the locules; within is a coat of fibres on the whole transversely aligned, it surrounds the locules and passes to the exterior so as to form planes of weakness most apparent near the base; these planes may mark the limits of a pair of valves, one opposite each locule. The innermost layer of transverse fibres appears to form the locule-lining. Seed represented by testa(?) formed of angular or square cells, about 0.03 mm. in diameter, aligned transversely or obliquely, and by a shining coat (tegmen?) the cells of which are obscure.

V.30556 Figured Pl. 32, fig. 17. An endocarp, now broken into three pieces. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, figs. 18, 19; Text-fig. 53

Fruit: A somewhat rounded triangular pyramid with large flat circular base seated on a shallow cupule (or much expanded peduncle or calyx) through the middle of which a gap or

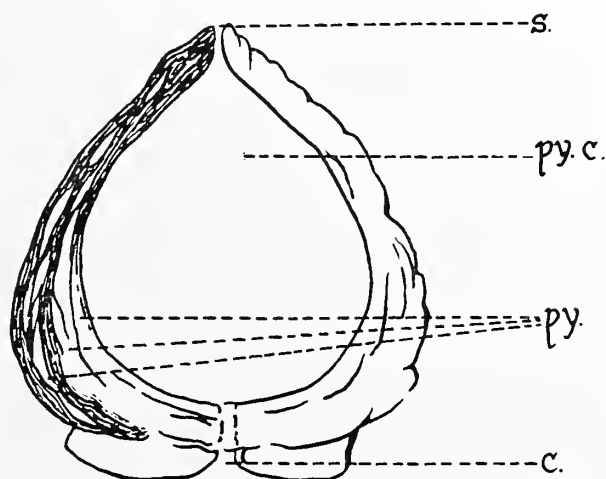


Fig. 53. *Carpolithus* sp. Diagrammatic longitudinal section of fruit showing the style (*s.*), pyrites cast of seed or locule (*py. c.*), pyrites filling cavities (*py.*) and the canal (*c.*).

short canal for the nutrient fibres can be traced in section. An apical stylar canal is also seen (Text-fig. 53). Each triangular surface of the fruit is slightly convex and has four conspicuous flattened ridges extending from base to apex separated by narrower shallow furrows.

Surface shining, close textured, showing no details of structure. There is perhaps some indication near the apex where the ribs are broken (Pl. 32, fig. 19) that they belong to a pair of two-ribbed valves overlying each triangular face. In section these valves, if valves they are, appear to be thin, with a hollow interior now filled with pyrites.

In longitudinal section there is a carbonaceous fruit wall of cells aligned longitudinally, parallel with the surface and thickest at the base of the fruit. Three or four distinct layers can be traced near the base, the outer overlapping the inner (Text-fig. 53), with a film of pyrites cementing together adjacent layers. Length of fruit, 18 mm.; breadth, 17 by 15 mm.; diameter of basal cupule or thickened calyx, 11 by 12 mm.

Seed: Seen only in longitudinal section as represented by the locule-cast, probably solitary, broadly ovoid with pointed apex passing into the stylar canal of the fruit, base rounded. Length, 11 mm.; breadth, 8.5 mm.

One fruit only has been seen. It shows no columnar coat in section so that it probably does not belong to the Lauraceae.

V.30557 Figured Pl. 32, figs. 18, 19; Text-fig. 53. A fruit, now fractured longitudinally to show the single seed or locule-cast. *D. J. Jenkins Coll.* Hampton shore (below tide), Herne Bay, Kent.

Carpolithus sp.

Plate 32, figs. 20, 21

Fruit: One-loculed, one-seeded, bisymmetric, sub-oval in outline, much inflated, rounded below, sharply angled in the plane of symmetry above, the angle on one margin appreciably sharper than that on the other. There are two or three more or less longitudinal ridges on the rounded surfaces which die out above and below, and a basal scar of attachment suggesting a small cupule or swollen peduncle (Pl. 32, fig. 21).

The outer coat is largely abraded. Where preserved it is compact and its structure is obscure. Its removal has exposed a coat of flat angular cells, 0.025 to 0.03 mm. in diameter, equiaxial over the basal scar, but with a tendency to be elongate on the sides and to diverge from the margin of the scar. Length of fruit (as preserved), 4 mm.; breadth in the plane of symmetry, 3.5 mm.; breadth at right angles to this plane about 3.25 mm. Diameter of basal scar about 2.75 mm.

Seed: Longitudinally striate owing to elongate cells about 0.016 mm. broad, having a large chalazal scar corresponding with the scar of attachment of the fruit. Seen only incompletely.

REMARKS. The relationship of this solitary fruit has not been determined. It somewhat resembles Lauraceae, but no columnar coat has been seen in section and the angled apex and consequent bisymmetry are more marked than is usual in that family.

V.30558 Figured Pl. 32, figs. 20, 21. A fruit, chipped to show the seed within. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Carpolithus sp.

Plate 32, fig. 22

A small sub-globular berry wrinkled through shrinkage or contraction, about 2.25 mm. in diameter. Surface as preserved, formed of small equiaxial cells, 0.025 mm. in diameter. The berry encloses a single lentiform seed covered by a network of slightly convex areas, 0.1 to 0.15 mm. in diameter, impressed upon a surface formed of equiaxial cells 0.012 to 0.016 mm. in diameter. Exocarp formed of elongate cells of comparable breadth, or of cells aligned at right angles to or oblique to the surface.

V.30559 Figured Pl. 32, fig. 22. A wrinkled one-seeded berry. *E. M. Venables Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.

Woody Gall or Swollen Rootstock

Plate 32, figs. 23, 24

Specimen ovoid, pitted all over with deep circular pits about 1 mm. in diameter and about the same distance apart. The pits are now filled with pyrites surrounded by a cylinder of elongate cells; they may represent true pits or hollow hairs or bristles or rootlets which have been abraded level with the surface, their embedded bases alone remaining; their inner ends are swollen like the hair-bases of *Stizocarya* (Reid & Chandler, 1933: 337, text-fig. 8).

Thickness of wall (= remaining length of hairs) about 2 mm. Walls formed of elongate cells, about 0.1 mm. long and 0.05 mm. broad, arranged approximately radially. The inner surface of the wall is ill-defined, it merges into the substance and structure of the interior which is very difficult to interpret. A system of fibres tapering and branching above arises from the base and occupies most of the interior; the tips of these fibres sometimes appear to pass into the wall outside cutting obliquely across the radial cells and in a few cases they appear to pass into a hair-base. Between the branching fibres there is a mass of loose-textured tissue. The whole cavity as preserved is impregnated with amorphous pyrites. There is slight evidence at one place among the fibres of a carbonaceous mass of coarse cells and a fragment of a shining surface is also seen.

A basal circular area seems to be delimited by a sharp, shining, smooth, radially striate surface, the cells between the striae 0.01 mm. in diameter. There are no pits or hairs on this area. The specimen may be a hairy gall or a short rootstock with remains of rootlets.

Length of specimen, 15.5 mm.; diameter, 13 mm.

V.30560 Figured Pl. 32, figs. 23, 24. A specimen now fractured longitudinally to show the internal structure. *J. E. Cooper Coll.* Herne Bay, Kent.

Wood, Stems, Tubers etc.

Plate 32, figs. 30-33

Pyritized twigs and other woody fragments are perhaps the most abundant fossils at Sheppey and Herne Bay and also occur at Bognor. In many of them the internal structure is fairly well preserved, and often shows clearly on polished surfaces. The investigation of this

material is a highly specialized line involving a wide knowledge of the stem and twig structure of Recent woody dicotyledons. This must be left to future researchers, but a few specimens of woody nodules, some of which may be tubers, are figured or noted here. On a superficial examination some of them might be mistaken for fruits or seeds.

- V.30561** Figured Pl. 32, fig. 30. A much macerated transverse section of a stem showing radiating medullary rays. *A. G. Davis Coll.* Warden Point, Sheppey.
- V.30562** Figured Pl. 32, fig. 31. A tuber or piece of bored wood, crushed from end to end. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30563** Figured Pl. 32, fig. 32. A pod-shaped body, laterally compressed, bluntly pointed at one end, attenuated into a 'stalk' at the other, is not a pod of Zingiberaceae as its form suggests, but a tuber or nodule of wood. It has a black, shining, longitudinally striate skin now rapidly flaking and a small central cavity (now flattened) surrounded by a thick wall of radially elongate and aligned coarse cells. Length along the convex margin, 67 mm.; breadth from edge to edge, 21.5 mm.; thickness in the direction of compression, 10 mm. The specimen has been broken transversely to show the internal structure. *D. J. Jenkins Coll.* Hampton shore, Herne Bay, Kent.
- V.30564** Figured Pl. 32, fig. 33. A compressed hollow body sub-circular in outline, about 4.25 mm. in diameter, has a chitinous semi-translucent skin, showing on its outer surface cracks and areas of concentric puckering like the skin of potato. Inside there is a pyrites cast on the surface of which small circular depressions can be seen corresponding with small depressions with raised rims somewhat resembling 'eyes', or root-scars, on the external surface of the skin. It may represent a tuber, or an insect egg. Similar organisms have been found at Sandbanks, Lake and Hordle (Lower Bagshot to Upper Eocene). Relationship not known. *H. E. Taylor Coll.* 'Upper Fish Tooth Bed': Bognor, Sussex.
- V.30565** A tuber or gall fractured longitudinally to show the pear-shaped core.
- V.30566** A tuber or woody nodule with thick black wrinkled skin, hollow inside. Swale Cliff. Both the above *D. J. Jenkins Coll.* Herne Bay, Kent.
- V.30567** A woody nodule, spindle-shaped and ribbed, simulating a fruit (cf. Reid & Chandler, 1933, pl. 33, fig. 16). *J. E. Cooper Coll.* Herne Bay, Kent.

Incertae Sedis

Plate 32, figs. 34-36

Some pyritized turbinate bodies may be, but probably are not, plants. They occur infrequently and so far as can be seen show no cell-structure but they appear to be formed of solid pyrites and hence are difficult to fracture. They are partially sub-divided by more or less regular radial furrows which penetrate for some depth into the specimens. The radii between the furrows may in their turn be further sub-divided by finer shallower furrows. All furrows may be partially covered and concealed by a layer of pyrites.

They bear some resemblance to corals, but their true nature awaits discovery.

- V.30568** Figured Pl. 32, figs. 35, 36. A specimen about 21 mm. long and 20 mm. in diameter. *J. E. Cooper Coll.* Herne Bay, Kent.
- V.30569** Figured Pl. 32, fig. 34. A specimen with the outer crust of pyrites largely broken away so that the radial furrows and intervening rays are more fully exposed. Length (incomplete), 19 mm.; diameter, 22.5 mm. *D. J. Jenkins Coll.* East Cliff shore, Herne Bay, Kent.

APPENDIX TO LONDON CLAY FLORA

The Flora of Nursling, Southampton

In 1955 Mr. D. Curry discovered a small exposure of London Clay below the gravel in a pit at Nursling belonging to Thomas Patterson & Son, Ltd., Lea Lane. (Map reference SU 362170.) He kindly invited the writer to visit the pit with him and supplied specimens he had collected.

A few inches only of London Clay were exposed in the north-east corner of the pit. By the use of pick and spade a reasonably large and clean exposure was prepared. The clay yielded *Lingula* and an abundance of *Glycymeris brevisrostris* together with a characteristic London Clay fauna which will be described in due course by the finder. During digging two hard shelly bands were pierced. Between and above them in the more sandy seams black specks of vegetation could be seen with the unaided eye. The sifting of some hundredweights yielded a number of fruits and seeds, although many are represented by mere fragments. They belong to a limited number of genera and species hereafter described.

In spite of the smallness of this flora it is of considerable importance, for Nursling is an entirely new locality for London Clay fruits and seeds within the Hampshire Basin. Moreover, the section was available for a limited time only, the whole area being due for levelling in 1956. Another important fact to note is that the Nursling plant remains are more comparable with the plants in post-Yprésian deposits than are the Bognor, Sheppey and Herne Bay specimens. There is closer agreement both in size and manner of preservation. As a result, for the first time (if *Nipa burtini* be excluded) species have been found common to the London Clay and younger beds. This discovery suggests that the apparent difference between these floras may at least to some extent be due to differences in the type of preservation and to differential sorting owing to the greater weight and size of the usual pyritized London Clay fruits and seeds.

At Nursling the fruits are carbonaceous as in the Lower Bagshot of Lake and Arne, the Freshwater Beds of Bournemouth, and so on. While they are to some extent impregnated with pyrites they do not show replacement of the cell contents cell by cell as, for example, at Sheppey. When pyrites seed-casts are present, they are of soft amorphous pyrites which readily deteriorates and more rarely reproduces beautiful cell impressions.

Among some fifteen recognizable species, *Anemia poolensis* Chandler occurs in the Lower Bagshot and Bournemouth Freshwater Beds of the Hampshire Basin. *Myrica boveyana* (Heer) appears to be indistinguishable from the Bovey Tracey (Oligocene) species. *Palaeococculus lakensis* n. gen. & sp., represented by one endocarp is characteristic of Lake and also occurs at Arne. It is represented by a fragment in the Bournemouth Marine Beds of Honeycomb Chine. *Vitis pygmaea* Chandler is common and also occurs abundantly in the Lower Bagshot (Lake,

Arne) as well as in the Freshwater Beds of Bournemouth. It may be represented in Palaeocene strata of Tooting (see p. 78). *Myrtospermum variabile* Chandler occurs throughout Eocene deposits up to and including the Lower Headon of Hordle, and a species of *Myrtospermum* apparently agrees with one awaiting description from the Cliff End Beds, Mudeford.

These records, few though they be, raise the question whether there really is any intrinsic change in the flora, at least throughout the period represented by the London Clay, Lower Bagshot and Bournemouth Freshwater Beds or whether apparent variations are due to the kind of preservation and to the variable selection of plant remains by natural agencies.

There are a few other London Clay plants which may give further support to the suggestion that conditions remained constant for long periods. Thus *Wetherellia variabilis* occurs in the Lower Bagshot (Arne). *Meliosma sheppeyensis* probably occurs in the Lower Bagshot (Lake). *Palaeobursera bognorensis* is closely comparable with a species from the Lower Bagshot (Lake) and the Bournemouth Freshwater Beds. *Palaeophytocrene foveolata* is probably present in the Lower Bagshot (Lake). *Tinospora excavata* is comparable with a spiny species of *Tinospora* present in the Lower Bagshot at Lake and Arne. *Mastixia cantiensis* may occur in the Lower Bagshot (Arne).

The specific name *clausentium* has been applied in one or two instances as a general indication of locality. Clausentium was the name of the Roman fort near Southampton which served the capital on the site of Winchester in the days of the Emperor Claudius.

The list of Nursling species is:

- Anemia poolensis* Chandler.
- Myrica boveyana* (Heer).
- Palaeosinomenium pulchrum* n. gen. & sp.
- Palaeococculus lakensis* n. gen. & sp.
- ?*Tinospora excavata* Reid & Chandler
- Menispermicarpum rariforme* n. sp.
- Menispermicarpum* sp.
- Bursericarpum clausentium* n. sp.
- Vitis pygmaea* Chandler.
- Vitis obovoidea* Chandler.
- Tetrastigma* sp. (?*T. sheppeyensis* Chandler)
- Myrtospermum variable* n. sp.
- Myrtospermum* spp.
- Ehretia clausentia* n. sp.

In addition to these indigenous plants a number of derived spores were found. These are being examined by Mr. N. Hughes of Cambridge.

In a letter dated 8.1.57 the late A. G. Davis expressed his opinion that the beds seen at Nursling are probably very high in the formation.

I am greatly indebted to Mr. D. Curry for giving me the opportunity of examining the site of these specimens and supplying information about the exposure and its fauna.

Family SCHIZAEACEAE

Genus ANEMIA Swartz

Anemia poolensis Chandler

Plate 34, figs. 32-35; Text-fig. 54

1955 *Anemia poolensis* Chandler, p. 295, pl. 32, figs. 1-10; pl. 33, figs. 14-22, 24-31; pl. 34; pl. 35, fig. 41; pl. 36, figs. 54-58; text-figs. 1, 2.

Fertile pinnules, sporangia and spores were described and figured in much detail in 1955.

A typical recurved pinnule and a small, less readily recognizable pinnule fragment were found in the London Clay at Nursling. The foliose jagged segments still bore sporangia on the lower surface. A few of them were well developed and had split along the longitudinal stomium. These had shed almost all of their ripe spores. The single row of straight-sided cells of the annulus is about 125μ in length. Below the annulus the sporangial wall had shrivelled or been disrupted but fragments can be seen on the slides. Chloroplasts are preserved in places within the cells. Some of the remaining sporangia were clearly very small and immature containing masses of small immature spores adherent to one another. In a few cases the sporangium wall has disappeared, the sporangia being represented by equivalent rounded masses of shining, mostly unripe, spores.

A few ripe spores were examined but could not be permanently mounted. They are typical of the species—trilete, tetrahedral-globose, non-striate, smooth and glistening, often split along the triradiate mark, 50 to 62.5μ in diameter. Less mature specimens were similar, 37.5 to 43.75μ .

Paraphyses were present still adhering to the lower surface of the pinnules, sub-ovoid to ellipsoid, about 106 to 112.5μ in length, often about 66μ in transverse diameter.

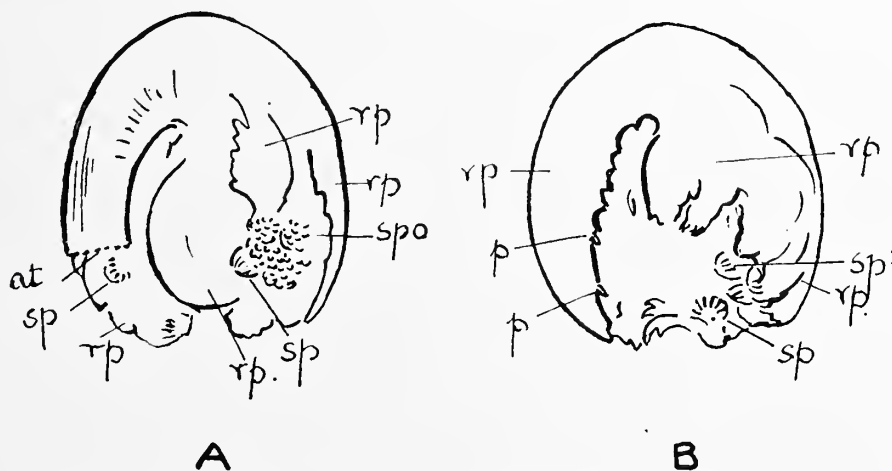


Fig. 54. *Anemia poolensis* Chandler. Diagrammatic drawings of fertile pinnule and sporangium. A, fertile pinnule showing broken stipe (*at*) and recurved segments (*rp*) forming a compact "body". Sporangia are visible on the inner faces of the segments at (*sp*). Masses of spores (*spo*) were released by the decay of the sporangium walls and lay in position of growth. B, opposite side of same pinnule. Lettering as above with addition of (*p*) paraphyses.

The condition of the material is much poorer than that from Lake and Bournemouth. The epidermis of the pinnules appears not to have been preserved and the whole structure showed impregnation with pyrites grains. For this reason and because of the limited amount available it was more difficult to make satisfactory preparations. The best pinnule was drawn before treatment showing the characteristic form and stipe (Text-fig. 54A, B).

The reflexed pinnules and large smooth spores place the specimens beyond doubt in *Anemia poolensis*.

The species is an important link between the London Clay on the one hand and the Lower Bagshot and (?) Lutetian Beds on the other. If, as appears more and more probable, *Anemia subcretacea* Sap. is the barren foliage of *A. poolensis*, then a single species of *Anemia* must have persisted from the Cretaceous upwards at least to the Bournemouth Freshwater Beds as Gardner himself believed.

V.34618 Figured Pl. 34, fig. 32. Slide with remains of sporangia and scattered paraphyses prepared from a much twisted pinnule fragment. *D. Curry Coll.*

V.34617 Figured Text-fig. 54A, B. Fertile pinnule with recurved segments, slightly altered after drawing by treatment to release spores preserved on slides.

Slides **V.34620-23** show spores; slides **V.34619-20** paraphyses. Remains of the annulus are also preserved. *M. E. J. Chandler Coll.*

The above from Nursling, Southampton.

Family MYRICACEAE

Genus MYRICA Linnaeus

Myrica boveyana (Heer) pars.

Plate 33, figs. 1-4

1862 *Carpolithes boveyanus* Heer pars., p. 1077, pl. 70, figs. 7-14 (in part).

1957 *Myrica boveyana* (Heer) pars: Chandler, p. 90, pl. 12, figs. 45-48.

DESCRIPTION. *Fruit:* Only preserved in part having a fleshy glandular pericarp with a few embedded branching fibres.

Endocarp: Sub-ellipsoid to broadly ellipsoid or ovoid in general form, one-loculed, slightly bisymmetric, dehiscing into equal valves in the plane of symmetry. There is a very slight tendency for a flange to develop in the plane of symmetry. Styler canal at the apex which is sometimes slightly mucronate. Funicular canal basal, short (Pl. 33, fig. 3). Locule-cavity compressed, urceolate, gradually tapering to the apical style. Seed not seen. Surface of endocarp rough, somewhat abraded so that the cells are obscure, sometimes showing a few longitudinal fibres. Cells of locule surface also obscure but equiaxial about 0.02 to 0.03 mm. in diameter. Inner surface of valves after splitting for germination showing wide marginal sutures which are broadest at about one-quarter of the length from the apex. Maximum width of a suture about 0.45 mm. Dimensions of several fruits: (1) Length, 2 mm.; breadth, 1.75 mm.; thickness, 1 mm. (2) Length, 2.75 mm.; breadth, 2 mm.; thickness, 1.25 mm. (3) Length, 2.25 mm.; breadth, 2 mm.; thickness, 1.25 mm. (4) Single valve—length, 2.25 mm.; breadth, 2 mm. (5) Single valve—length, 2.25 mm.; breadth, 1.75 mm.

REMARKS AND AFFINITIES. The one-loculed endocarp with basal attachment and apical style indicates *Myrica*. Different species differ in the size of their endocarps and in the degree of inflation. Thus *Myrica gale* has somewhat compressed endocarps with peculiar float-like thickenings forming a pair of projections on the broader surfaces. *M. cerifera* is larger and more inflated without projections. *M. aethiopica* is of the same size as *M. cerifera* but almost globose. The genus is distributed throughout the Northern Hemisphere. It also occurs in the Andes, the West Indies and South Africa. It is a highly characteristic subtropical form with extensions into tropics and high latitudes.

M. altenburgensis Kirchheimer is a much larger fossil (4 to 5.3 mm. long). The Nursling fossils compare in size and appearance with some of the smaller endocarps from Bovey. Work on the Bovey deposits suggests that two different genera were included by Heer in his *Carpolithes boveyanus*, one being *Carpinus* and the other *Myrica* (Chandler, 1957: 90).

V.34576 Figured Pl. 33, fig. 1. An endocarp.

V.34577 Figured Pl. 33, figs. 2, 3. A valve of a fruit showing adherent pericarp.

V.34611 Figured Pl. 33, fig. 4. A more elongate endocarp.

V.34612 Six valves.

D. Curry Coll. Nursling, Southampton.

Family MENISPERMACEAE

Genus PALAEOSINOMENIUM Chandler (see p. 159)

Palaeosinomenium pulchrum n. sp.

Plate 33, figs. 5-7

DIAGNOSIS. Endocarp horse-shoe shaped, more obliquely curved than *P. venablesi*. Radial prominences terminating abruptly about half-way across the marginal flange. Area between limbs concave. Elongate foramen between the limbs oblique, its lower end well above a line drawn between the extremities of the limbs of the endocarp. The endocarp considerably smaller than that of *P. venablesi*. Diameters 3.25 by 2.2 and 3 by 2.2 mm.

HOLOTYPE. V.34585.

DESCRIPTION. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate on germination in the plane of symmetry. Obliquely sub-gibbous in outline, ventral margin slightly excavated with a gentle convexity at the middle. A broad marginal horse-shoe shaped flange (about 0.8 mm. broad) narrows towards the extremities and especially towards the end of the cotyledonary limb. Within the flange is an upstanding oblique horse-shoe shaped ridge grooved along its crest. On the outer side of the ridge are prominent, regular, blunt-ended, radially arranged ridges separated by deep furrows. The blunt ends terminate abruptly about half-way across the flange beyond which the marginal area is only slightly fluted. The inner side of the horse-shoe ridge also bears blunt-ended ridges or tubercles shorter and less conspicuous than those on the outer side. The large area between the limbs of the horse-shoe is concave. It is pierced near the ventral margin by a narrow oblique foramen (about 0.45 mm. long) situated nearer to the stylar than to the other limb, and about half-way between the stylar limb and a median canal for the funicle. Its lower end is well above a line

drawn between the extremities of the two limbs of the horse-shoe. Surface much abraded, fibrous. There is a short triangular condyle internally between the middle of the ventral margin and the styler end of the curved locule-cavity.

Diameter of endocarp: (1) 2.25 mm. along the oblique axis between the limbs, 3.25 mm. across the two limbs. (2) 2.2 by 3 mm. respectively; thickness in both, 1 mm. Seed not seen.

REMARKS AND AFFINITIES. Two endocarps, one considerably abraded, and several fragments. For relationship see p. 160. *P. pulchrum* is distinguished from *P. venablesi* by its smaller size, the greater obliquity of the horse-shoe form, and the relatively smaller space between the limbs. It differs also in the slight convexity at the middle of the ventral margin and the greater concavity of the whole median area between the limbs.

V.34585 Holotype, figured Pl. 33, fig. 5. A well-preserved endocarp. *M. E. J. Chandler Coll.*

V.34586 Figured Pl. 33, fig. 6. A more abraded endocarp. *D. Curry Coll.*

V.34587 Figured Pl. 33, fig. 7. Fragment of one valve of another endocarp; probably this species. *D. Curry Coll.* All from Nursling, Southampton.

Genus PALAEOCOCCULUS nov.

DIAGNOSIS. Endocarp as in Cocculinae, curved, locule approximately horse-shoe shaped with limbs separated by a condyle. External surface with broad marginal rim associated with a broad internal suture, inflated ridged surface overlying the locule; median depression comma-shaped; internal condyle markedly elongate.

TYPE SPECIES. *Palaeococcus lakensis* n. sp.

Palaeococcus lakensis n. sp.

Plate 33, figs. 8-10

DIAGNOSIS. That of the genus. Dimensions 1.5 to 3.5 mm.

HOLOTYPE. V.34584, from the Lower Bagshot of Lake, Dorset, to be described in a later monograph.

DESCRIPTION. A much crushed endocarp from Nursling. It is undoubtedly identical in character with beautifully preserved material from the Lower Bagshot awaiting publication. It shows the broad marginal rim with very slight fluting such as is seen occasionally in endocarps from Lake. There is an obscure continuation on to the rim of ribbing overlying the horse-shoe shaped locule. The ribs over the locule are few and transverse to its length. The cotyledonary end of the ribbed locule area is slightly incurved and rounded. The styler end is pointed. The depression between the limbs is comma-shaped. Diameter, 2.75 by 2.75 mm.

REMARKS AND AFFINITIES. Only one crushed endocarp has been found. It has been compared with endocarps from the type locality at Lake and is undoubtedly identical with them. The endocarp is now cracking and shows through the gap a cracked pyrites cast on the smooth surface of which elongate cell impressions are visible. The record of this species is of especial interest in that it is one of the few plants recognized in the London Clay which also occur in younger Tertiary strata.

V.34583 Figured Pl. 33, figs. 8, 9. A crushed endocarp, now cracking. *M. E. J. Chandler Coll.* Nursling, Southampton.

Genus TINOSPORA Miers

?Tinospora excavata Reid & Chandler

Plate 33, figs. 13-15

1933 *Tinospora excavata* Reid & Chandler, p. 165, pl. 4, figs. 7-10; text-figs. 3, 4. See also p. 152 of present work.

Broken fragments appear to represent *T. excavata* and are undoubtedly *Tinospora*. There is some resemblance to a species to be described from the Lower Bagshot, but *T. excavata* appears to have been larger, and to be distinguished from that species by a broad, scarcely tubercled area around the ventral infold. On the dorsal surface the tubercles in the two species are similar and similarly distributed. The ventral surface, so far as it has been seen in the Nursling endocarp, is more like that of *T. excavata* (see p. 152). The largest fragment seen is 3.75 mm. long and 3 mm. deep from ventral infold to dorsal margin.

V.34588-89 Figured Pl. 33, figs. 13, 14. Two fragments of endocarp. The fragment in Fig. 15 has broken and decayed. *D. Curry Coll.*

V.34616 Several fragments of endocarp. *M. E. J. Chandler & D. Curry Coll.*
All from Nursling, Southampton.

Genus MENISPERMICARPUM Chesters, 1957:42

Menispermicarpum rariforme n. sp.

Plate 33, figs. 11, 12

DIAGNOSIS. Endocarp as in Cocculinae, semi-lunate, the locule having an open curve with long straight stylar limb and very slightly incurved cotyledonary limb. Ventral margin straight. Surface over locule and marginal flange ornamented by radial ridges. Foramen elongate terminating close to the ventral margin. Diameter, 3.5 by 2 mm.

HOLOTYPE. V.34573.

DESCRIPTION. *Endocarp*. Bisymmetric (approximately) the two valves being somewhat unevenly developed and laterally flattened. The valves which separate on germination are more or less semi-lunate in outline with the stylar limb more elongate and straighter than the cotyledonary limb. Ventral margin straight. Locule having an open shallow curve with the cotyledonary limb slightly incurved. A ridge corresponding with the curve of the locule overlies it on each valve. The ridge bears a very slight furrow. Owing to the unequal development of the valves or to distortion of the endocarp the ridge lies nearer to the margin on one valve than on the other. Radial ridges diverge over the locule area on both sides of the curved ridge described above. They may be alternate or opposite to one another. There is a marginal flange beyond the curved locule area which varies in breadth on the two valves owing to unequal development or distortion as described for the ridge overlying the locule. This flange is also ornamented with radial ridges which extend to the margin. They are fewer in number than those over the locule and have a tendency to arise between rather than opposite to the locule ridges. On the flatter valve each of the three concentric transversely ridged areas occupies

about one-fifth of the total height of the endocarp (Pl. 33, fig. 11). Area between the limbs of the curve somewhat concave. It is pierced by an elongate foramen (0.68 mm. long) somewhat nearer to the stylar than to the other limb. The lower end of the foramen is close to the ventral margin of the endocarp. Surface much abraded, but cell-structure obscure. Locule not seen. Maximum diameter (i.e. across the two limbs), 3.5 mm.; diameter at right angles to the last, 2 mm., thickness, 0.75 mm.

REMARKS AND AFFINITIES. The unequal development (or distortion) of the valves is an unusual (perhaps an individual) feature as is the open curve of the locule. No similar living genus has been seen but form and ornamentation indicate Cocculinae. Three concentric rows of transversely ridged ornament may be seen in *Cissampelos* Linn. which, however, differs considerably from the fossil in shape.

V.34573 Holotype, figured Pl. 33, figs. 11, 12. An endocarp. *D. Curry Coll.* Nursling, Southampton.

Menispermicarpum sp.

Plate 33, figs. 16-18

DESCRIPTION. Endocarp curved as in Cocculinae, outline too imperfect for description. Locule overlain by two lateral curved crested ridges one on each valve. There is a marginal flange with radially arranged cells and fine tubercles. The lateral ridges are ornamented with a complicated pattern of transverse ridges terminating in conspicuous recurved teeth. The ridges are continued at their inner ends for a short distance on to a sunk median area between the limbs of the curved seed and crested ridge. This median area is slightly convex in one fragment, concave in another. On it is an elongate foramen, 0.68 mm. long, which terminates a short distance from the very slightly concave ventral margin. The dorsal margin of the endocarp appears to be entire but very little of it is preserved. The limbs of the seed were evidently broad as they were separated by only a short triangular condyle at the ventral margin on the inner surface as in *Menispermum*. Endocarp formed of criss-cross fibres.

One fragment represents the base and part of the stylar limb and median area. Breadth of base actually preserved, 2 mm.; diameter of fragment at right angles to base, 2.5 mm.

Menispermicarpum serratum from Oldhaven has recurved serrations on the lateral curved ridges, but also on the dorsal margin which appears to be entire in specimens from Nursling, not serrate, so far as can be seen. The material is too incomplete for satisfactory determination.

V.34574 Figured Pl. 33, figs. 16, 17. A basal fragment of an endocarp.

V.34575 Figured Pl. 33, fig. 18. A fragment showing the micropylar limb.
D. Curry Coll. Nursling, Southampton.

Family BURSERACEAE

Genus BURSERICARPUM Reid & Chandler, 1933:275.

Bursericarpum clausentium n. sp.

Plate 34, figs. 1-4

DIAGNOSIS. Endocarp: Sub-oval in outline, germination valve extending for about six-sevenths of the length. Ventral angle occupying about four-fifths of the length. Length, 2 to 2.75 mm.; breadth, 1.75 to 2.5 mm.; thickness, 0.5 to 1.2 mm.

HOLOTYPE. V.34604.

DESCRIPTION. *Endocarp*: Sub-oval in outline, sometimes pointed at the apex, narrowly elliptical in the lower fifth in transverse section and narrowly triangular in the upper four-fifths. Dorsal surface almost entirely occupied by the large germination valve which extends for about six-sevenths of the length. Ventral surface with a wide median longitudinal angle which forms a sharp ridge extending for about four-fifths of the length from the apex, hence the narrow triangular section described in this region. The facets which flank the ridge are flat or slightly concave. Surface rounded in the lowest fifth. A transverse elongate aperture (concave upwards) for the funicle at the junction of the rounded and angled surfaces marks the position of the ventral placenta. Surface much abraded but the best preserved endocarp shows a superficial coat of regular equiaxial hexagonal cells 0.028 to 0.038 mm. in diameter. There is an inner coat of fine parenchyma but the cell outlines are somewhat obscure.

Dimensions: (1) Length, 2.25 mm.; breadth, 1.8 mm.; thickness, 0.5 mm. (2) Length, 2 mm.; breadth, 1.75 mm.; thickness, 1.2 mm. (3) Length, 2.75 mm.; breadth, 2.5 mm.; thickness, 1 mm. (4) Length, 2 mm.; breadth, 1.75 mm.; thickness, 1.2 mm.

REMARKS AND AFFINITIES. Four endocarps. The largest has burst along the median angle. It shows clearly the funicular aperture, and the superficial equiaxial cells. Unfortunately no seeds are displayed so that the character of the chalaza and length of the raphe are not known. In the absence of these characters the specimens are referred to the form-genus *Bursericarpum*.

The species is more broadly ovate in outline than *B. ovale* Chandler and less inflated dorsiventrally, while the germination valve occupies a relatively greater length of the dorsal surface.

V.34604 Holotype, figured Pl. 34, fig. 3. A large endocarp which is bursting along the ventral angle.

V.34567-68 Figured Pl. 34, figs. 1, 2. Two typical endocarps.

V.34605 Figured Pl. 34, fig. 4. A fourth specimen. All *M. E. J. Chandler Coll.* Nursling, Southampton.

Family VITACEAE

Genus VITIS Linnaeus

Vitis pygmaea Chandler (see p. 77)

Plate 34, figs. 5-11

The diagnosis of this species is given on p. 77. The Nursling specimens are all small examples of the species but are exactly comparable with the smaller specimens from the

Lower Bagshot of Lake, the type locality. The absence of larger seeds is probably due to sorting in transport, for the great majority of Nursling seeds are small.

Typical seeds from the locality show the following dimensions: (1) Length, 2.75 mm.; breadth, 1.7 mm. (2) Length, 2.5 mm.; breadth, 1.5 mm. (3) Length, 2.25 mm.; breadth, 1.75 mm. (4) Length, 2.25 mm.; breadth, 1.5 mm. (5) Length, 2.25 mm.; breadth, 1.5 mm. (6) Length, 2 mm.; breadth, 1.25 mm. (7) Length, 2.28 mm.; breadth, 1.25 mm.

Some specimens have the carbonaceous testa preserved around an amorphous pyrites cast from which it sooner or later flakes and disintegrates.

V.34591-97 Figured Pl. 34, figs. 5-11. Seven seeds (the one in Fig. 9 has now collapsed). *D. Curry & M. E. J. Chandler Coll.* Nursling, Southampton.

Vitis obovoidea Chandler (see p. 247)

Plate 34, figs. 12, 13

A solitary seed showing the characteristics of *V. obovoidea*. These are the obovoid shape with smooth contours, convex dorsal face, parallel-sided raphe ridge, longitudinal infolds close together and almost parallel but very slightly divergent at their upper ends. They occupy the lower three-quarters of the length of the seed. The chalaza is oval, median; there is an obscure groove both above it and below. The margin of the seed is obscurely angled. This specimen is slightly narrower in relation to its length and somewhat less inflated than the two seeds described from Bognor. Length of seed, 5.75 mm.; breadth, 3.5 mm.; thickness, 2 mm.

V.34590 Figured Pl. 34, figs. 12, 13. A seed. *D. Curry Coll.* Nursling, Southampton.

Genus TETRASTIGMA Planchon

Tetrastigma sp. (?*T. sheppeyensis*)

Plate 34, figs. 14, 15

DESCRIPTION. *Seed*: Originally elongate-obcordate (now broken at the pointed hilar end), deeply emarginate at the apex, much inflated. Dorsal surface rounded, grooved between apex and chalaza and below the chalaza which is small, median and oval. Ventral surface sharply angled and faceted, raphe ridge sharp, broadening rapidly in the uppermost third of the seed. Ventral infolds approximately straight below, diverging markedly where the raphe-ridge broadens. Surfaces with a few slight flutings diverging from the chalaza and ventral infolds. Length of seed, 3.75 mm. (incomplete at the base); breadth, 2.4 mm.; thickness, 2 mm.

REMARKS AND AFFINITIES. The most comparable species hitherto described is *Tetrastigma sheppeyensis* Chandler (p. 255; Pl. 25, figs. 26, 27 in present work), but this solitary specimen is too imperfect for certain determination.

Figured Pl. 34, figs. 14, 15. A seed, broken at the hilar end; originally with carbonaceous coat and exposing an amorphous pyrites internal cast. *D. Curry Coll.* Nursling, Southampton. The specimen has now disintegrated.

Family MYRTACEAE

Genus MYRTOSPERMUM Chandler

Myrtospermum variable Chandler (see p. 80)

Plate 34, figs. 16-18

This species is based on seeds to be described in a forthcoming monograph on the Bournemouth Freshwater Beds. Four typical seeds have been found ranging in diameter from 0.75 to 1.75 mm. There is also an internal cast which has lost the testa; it shows the curved seed-cavity with its two limbs. It almost certainly belongs to this species. *M. variable* is one of the commonest Eocene fossils. Records from a wide range of localities in the Hampshire Basin await publication. The earliest occurrence known is in the Woolwich and Reading Beds of Tooting Broadway.

V.34580-81, V.34613 Figured Pl. 34, figs. 16-18. Three seeds.

V.34614-15 A seed and internal cast of another (probably this species). *M. E. J. Chandler & D. Curry Coll.* Nursling, Southampton.

Myrtospermum n. sp.

Plate 34, fig. 19

DESCRIPTION. *Seed*: Transversely oval in outline, now somewhat crushed but originally lenticular in section. Outline emarginate at the hilum which is sunk in a shallow elliptical depression about 0.5 mm. in maximum diameter. Internal surface not seen but the seed-cavity is clearly U-shaped as indicated by the form of the seed and alignment of the coarse superficial pits. Pits often about 0.05 to 0.1 mm. in diameter over most of the surface, becoming smaller towards and over the condyle between the limbs where they may be only 0.028 mm. in diameter. There is some evidence that the pits are themselves formed of small parenchymatous cells, 0.028 to 0.038 mm. in diameter. These probably also form the thickness of the wall as in other species of *Myrtospermum*. Diameter of seed across the two limbs, 2.5 mm.; diameter between the two limbs, 1.8 mm.

REMARKS AND AFFINITIES. This solitary seed is much larger than the abundant seeds of *Myrtospermum variable* (diameter commonly 0.8 to 1.25 mm.; rarely 1.4 to 1.75 mm.) which occur freely throughout the Eocene beds of the Hampshire Basin. It is unfortunate that there is only one good specimen of this larger species, hence its possible range of variation is not known. But it may be noted that as the variation both in size and shape of *M. variable* is considerable, some seeds being triangular, some broadly oval, and others more or less subcircular in outline, the same may apply to this second species.

The most comparable species known appears to be a seed from Cliff End to be described as a new species of *Myrtospermum* in a monograph on the Bournemouth Marine Beds. Its diagnosis is as follows: 'Seed approximately lenticular, about 2.5 mm. in diameter, 1.25 mm.

thick. Maximum thickness of testa, 0.4 mm.; surface pits, 0.05 to 0.075 mm. apart, separated by thick ridges.'

V.34578 Figured Pl. 34, fig. 19. A single somewhat crushed seed.

V.34579 A second distorted seed which may belong to this species.
D. Curry Coll. Nursling, Southampton.

Myrtospermum sp.

Plate 34, fig. 20

Remains of a curved seed evidently belonging to Myrtaceae. More or less complete on the dorsal margin and micropylar limb but broken at the end of the other limb. Within the margin are four concentric rows of coarse, quadrangular, hexagonal or polygonal pits, about 0.228 mm. in radial diameter, 0.085 mm. in diameter at right angles to the radii. Over the condyle between the limbs are thinner-walled pits irregular in form and arrangement. Transverse striae diverge from the condyle over the locule. Length, 1.6 mm. (measured between the limbs). Thickness of wall at margin, 0.05 mm.

REMARKS. Part of one valve only of a seed. On the inner surface the condyle between the limbs is seen in section and shows the raphe canal. Owing to the imperfect condition and the limited amount of material no closer determination has been attempted.

V.34582 Figured Pl. 34, fig. 20. A broken valve of one seed. D. Curry Coll. Nursling, Southampton.

Family BORAGINACEAE

Genus EHRETIA Linnaeus

Ehretia clausentia n. sp.

Plate 34, figs. 21-28

DIAGNOSIS. Pyrenes mostly two-loculed (sometimes breaking longitudinally into one-loculed segments). Semi-ovoid, ornamented on the dorsal side by a network of ridges and hollows; those in the lower half few, long and narrow; those in the upper half shorter, smaller and more numerous. Locules opening by sub-marginal apical sutures on the ventral surface which may eventually extend almost to the base. Length of pyrenes, 1.5 to 2.5 mm.; breadth, 1.25 to 1.75 mm.

HOLOTYPE. V.34569.

DESCRIPTION. *Pyrenes*: Usually two-loculed, semi-ovoid originally, much compressed dorsiventrally in fossilization, bisymmetric about a median dorsiventral plane, roundly ovate in outline, convex on the dorsal surface, flat or slightly concave on the ventral surface. Dorsal surface with a conspicuous median groove, flanked on each side by a network of ridges enclosing hollows. These hollows are long, narrow and pointed at their extremities in the lower half of the pyrene; in the upper half they tend to be smaller, shorter, and more numerous. Ventral surface smooth, flat, or slightly concave. Germination by two large sub-marginal arcuate apertures on the ventral surface in the upper half of each pyrene, each aperture leading into one of its locules. The apertures may be continued as curved slits almost to the base. There is a marked

but not invariable tendency for each pyrene to split longitudinally down the middle (cf. Pl. 34, figs. 23, 28) so that two one-loculed pyrenes are produced. Wall, as seen in section, formed of rather spongy cells which are somewhat obscure but appear to be arranged in a columnar manner. Length of pyrenes, 1.5 to 2.5 mm.; breadth, 1.25 to 1.75 mm. Typical measurements are 2 by 1.5 mm.; 1.75 by 1.5 mm.; 1.5 by 1.5 mm.; 2 by 1.25 mm.; 2 by 1.75 mm.

REMARKS AND AFFINITIES. The pyrenes closely resemble those of the living *Ehretia acuminata* in the ornamentation of the dorsal surface, but they are somewhat smaller (*E. acuminata*, 2.5 to 3 by 2.25 to 2.5 mm.). They are slightly larger as well as longer relative to their breadth than the smoother pyrenes of a new species to be described from the Lower Bagshot of Lake, Dorset. For the distribution of the living representatives see p. 113.

It may be noted that the tendency of *E. clausentia* to break again into two one-loculed segments is probably assisted by fossilization with crushing.

- V.34569 Holotype, figured Pl. 34, fig. 21. A two-loculed pyrene. *D. Curry Coll.*
 V.34570 Figured Pl. 34, fig. 22. A smaller specimen. *M. E. J. Chandler Coll.*
 V.34571 Figured Pl. 34, fig. 23. A one-loculed specimen formed by median splitting of a two-loculed pyrene. *M. E. J. Chandler Coll.*
 V.34606 Figured Pl. 34, fig. 24. Another two-loculed pyrene. *M. E. J. Chandler Coll.*
 V.34607 Figured Pl. 34, fig. 25. Another beginning to split for germination. *M. E. J. Chandler Coll.*
 V.34608 Figured Pl. 34, fig. 26. Another, the germination splits have continued to the base. *D. Curry Coll.*
 V.34609 Figured Pl. 34, fig. 27. A similar specimen. *D. Curry Coll.*
 V.34610 Figured Pl. 34, fig. 28. Another beginning to split medianly into two one-loculed pyrenes. *D. Curry Coll.*
 V.34572 About thirty pyrenes, some of which are one-loculed segments. *D. Curry & M. E. J. Chandler Coll.*
 All from Nursling, Southampton.

Family?

Genus?

Plate 34, figs. 29-31

Wedge-shaped but incomplete segments of an endocarp not yet determined occur fairly abundantly at Nursling. They represent carpels which have split septically and gaped along the inner margins (now imperfect) so that the seed or seeds have escaped. The carpels appear to have been attached basally to a placenta from which they have broken away, and to have met in a valvate manner dorsally. The width suggests that there were at least five in the fruit. Dorsal outline sub-oval, somewhat rounded at the apex, truncate, broken at the base where originally attached. The carpels are convex dorsally from base to apex, flattened laterally. Exocarp, preserved on the dorsal surface, smooth and finely pitted; it tends to break away from the endocarp. This is thin and liable to distortion and can be seen lining the dorsal wall and forming the septa. Surface of septa obliquely striate, the fine striae diverging from a point near the apex (indicating perhaps the position of the placenta). Length of carpels, 2 to 4.2 mm.; dorsal width, 1.5 to 2.2 mm.; dorsiventral depth always incomplete.

- V.34600 Figured Pl. 34, fig. 29. A specimen showing the striate septal surfaces clearly preserved.
 V.34601 Figured Pl. 34, fig. 30. A larger valve or carpel.
 V.34602 Figured Pl. 34, fig. 31. Another valve or carpel.
 All the above *M. E. J. Chandler Coll.* Nursling, Southampton.
 V.34603 A number of specimens. *D. Curry & M. E. J. Chandler Coll.* Nursling, Southampton.

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