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THE LOWER TERTIARY FLORAS
OF SOUTHERN ENGLAND

II

FLORA OF THE PIPE-CLAY SERIES OF DORSET
(LOWER BAGSHOT)



BRITISH MUSEUM (NATURAL HISTORY)

THE
LOWER TERTIARY FLORAS
OF SOUTHERN ENGLAND

II

FLORA OF THE PIPE-CLAY SERIES OF DORSET
(LOWER BAGSHOT)

BY

MARJORIE ELIZABETH JANE CHANDLER

With twenty-nine plates
and twenty-five figures in the text

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PREFACE

THIS volume is the second of the series to be published under the title of *The Lower Tertiary Floras of Southern England* and deals, in particular, with the Lower Bagshot flora of Dorset.

Most of the material described in the present work is entirely new and was collected by Miss Chandler herself, often under trying conditions during and immediately after the period of the Second World War. The mechanical task alone undertaken by the author in preparing many hundredweight of matrix has been immense. All the photographs, as in her previous publications, are the work of the author.

The general results of her detailed descriptions are summarized in the Introduction, to which reference should be made for the author's conclusions regarding the topographical and climatic conditions indicated by the flora and its relationships with that of the London Clay.

ERROL I. WHITE
Keeper of Palaeontology

July 1960



AUTHOR'S PREFACE

IT is now over eighty years since Gardner in a short paper on the Lower Bagshot Beds of the Hampshire Basin (1877: 51) stated: 'I can give scarcely any *details* of the flora found in these beds, although it is, perhaps, one of the richest in the world, as but little is known with certainty respecting it.' Again, in 1923, in correspondence with a former Keeper of Geology, the late Sir Arthur Smith Woodward, Gardner wrote: 'though rich in Tertiary fossil plants we are behind every other country similarly rich, in describing and identifying them'.

When the first quotation given above was written a series of monographs on the British Eocene Flora had been planned for publication by the Palaeontographical Society. Unfortunately the work was never carried beyond the Ferns and Conifers but many drawings of the Angiosperms had been made by Gardner for the projected later volumes. When the second quotation was written Gardner was an old man who had given up any attempt to complete his records for publication and was negotiating with the British Museum (Natural History) for the sale of his drawings. These he eventually presented to the Museum, the specimens illustrated having been acquired some years before. In the present and succeeding monographs an attempt is at last made to remove the reproach voiced by Gardner so many years ago against British Palaeobotany.

Unfortunately the golden opportunities for collecting available to former generations of geologists have gone. The cliffs of the Bournemouth area are largely inaccessible to collectors, and although Gardner's drawings and many of his specimens are still in the Department of Palaeontology in only a few instances are the localities given. A number of drawings were lithographed, some showing locality. A few figures have original pencil localities which appear to be reliable. On some of the sheets of drawings, however, a later addition in ink, written by Gardner in a shaky hand, must be disregarded for there are instances where they can be proved to be erroneous e.g. in the case of a figure of a well-known Palm leaf (*Nipa*) from Hordle in the Sedgwick Museum, Cambridge; or again there is a sheet of drawings of characteristic London Clay fruits labelled Hordle, none of which occurs in that locality. The explanation of these erroneous ink entries has been provided by Mr. F. M. Wonnacott who remembers Gardner visiting the Museum as a very old man and adding localities when clearly his memory had ceased to be reliable.

Equally unfortunate is the fact that the specimens themselves were only adequately labelled in a few instances. Also for the majority the Register of specimens in the Museum is of little help, thousands of fruits and leaves being registered under one number V.1156 as 'Bournemouth and Alum Bay?' Whereas most of the fruit and flower-like impressions in a fine pipe-clay matrix may be presumed to come from the Dorset Pipe-clay (Gardner used the name Bournemouth to cover a wide area and collected both in the Lower and

Middle Bagshot) there is reason to suspect that some are from the Reading Beds of Reading but matrix cannot always be relied upon to indicate locality. In view of this state of affairs much of the Gardner collection has been put aside for the time being in the hope that by a study of his papers or the discovery of other old records further new light on the problem may be forthcoming.

In the early days of Tertiary palaeobotany interest was almost wholly centred in leaves and impressions generally. The recent research recorded in this volume is based largely on carbonaceous fruits and seeds which have been isolated from lignitic seams in the Lower Bagshot Pipe-clay Series. These were largely overlooked by the older observers. At the present day, when excavation of cliffs is frowned upon, carbonaceous fruits are more readily collected than good specimens of leaves. Inevitably therefore they form the backbone of the present series of investigations and it may be noted that on the whole they probably represent different genera from those preserved as Pipe-clay impressions.

Two of Gardner's fine figured palm leaves have been reproduced in Text-figs. 24, 25. The localities of these leaves appear to be satisfactorily established. Fan palms formed an important element of the flora in former days both at Studland and Corfe (Gardner & Ettingshausen, 1879: 16; Fisher, 1862: 83, footnote) but today they are not found in such abundance, hence the old record is of much importance.

It was expected that this Monograph would have appeared before a Bulletin on the Lower Headon flora. But although it went to press much earlier the publication has been greatly delayed. In consequence the Lower Headon Bulletin contains references to species diagnosed for the first time in the present work.

Especial thanks are due to Mr. E. St. John Burton who discovered the plant site at Lake and presented the first specimens from that locality. I must also thank most warmly the Keeper of Palaeontology Dr. E. I. White who has furthered the work in every possible way, as well as Dr. K. I. M. Chesters and Mr. F. M. Wonnacott of the same Department who have given invaluable help in the preparation of the manuscript and in seeing it through the press, and especially to Dr. Chesters for typing the manuscript and for preparing the index and bibliography.

MARJORIE E. J. CHANDLER

CONTENTS

	<i>Page</i>
PREFACE	v
AUTHOR'S PREFACE	vii
INTRODUCTION	I
1. General Introductory Remarks and Geological Background	I
2. The Lower Bagshot Beds of Dorset	2
3. The Plant-bearing Localities	4
(i) Studland	4
(ii) The Pipe-Clay Series	5
Lake	5
Arne	6
4. General Characteristics of the Lower Bagshot Flora	7
5. Differences of Habitat and Preservation in the Lower Bagshot and London Clay leading to certain differences in the two Floras	9
6. The Lower Bagshot Flora of Alum Bay, Isle of Wight	10
7. Other Sources of Information outside the Lower Bagshot	11
8. List of Lower Bagshot Plants	14
SYSTEMATIC DESCRIPTIONS	19
A. LOWEST PLANT BEARING BEDS AT STUDLAND	19
PTERIDOPHYTA	19
Polypodiaceae	19
Schizaeaceae	20
GYMNOSPERMAE	20
Taxodineae	20
ANGIOSPERMAE	36
Dicotyledones	36
Moraceae	36
Capparidaceae	36
Rosaceae	38
Incertae Sedis	38
B. CARBONACEOUS PLANT REMAINS OF THE PIPE-CLAY SERIES	39
PTERIDOPHYTA	39
Polypodiaceae	39
Schizaeaceae	40

	<i>Page</i>
GYMNOSPERMAE	42
Taxodineae	42
ANGIOSPERMAE	50
Monocotyledones	50
Cyperaceae	50
Palmae	55
Araceae	56
Dicotyledones	58
Moraceae	58
Nymphaeaceae	60
Menispermaceae	61
Lauraceae	65
Capparidaceae	66
Hamamelidaceae	69
Leguminosae	72
Rutaceae	73
Burseraceae	77
Euphorbiaceae	80
Anacardiaceae	90
Icacinaceae	95
Sabiaceae	100
Vitaceae	100
Dilleniaceae	111
Theaceae	111
Flacourtiaceae	114
Thymelaeaceae	115
Lythraceae	118
Nyssaceae	120
Cornaceae	122
Sapotaceae	132
Ebenaceae	133
Symplocaceae	134
Styracaceae	137
Apocynaceae	138
Boraginaceae	140
Solanaceae	141
Caprifoliaceae	144
Cucurbitaceae	144
Incertae Sedis	145
C. PIPE-CLAY IMPRESSIONS	158
ANGIOSPERMAE	158
Monocotyledones	158
Palmae	158

CONTENTS

xi

	<i>Page</i>
Dicotyledones	163
Hamamelidaceae	163
Sapindaceae	163
Incertae Sedis	164
BIBLIOGRAPHY	167
INDEX	170



INTRODUCTION

I. GENERAL INTRODUCTORY REMARKS AND GEOLOGICAL BACKGROUND

In two earlier monographs (Reid & Chandler, 1933 and Chandler, 1961) the floras of the Palaeocene and London Clay were described. The Post-Ypresian floras remain for consideration in a series of monographs.

Whereas in the Palaeocene evidence is derived from the London Basin, and in the Ypresian from both London and Hampshire Basins, after the London Clay palaeobotanical data are preserved exclusively in the Hampshire Basin. They occur in the important, oft-quoted, but in fact little-known sequence of plant-deposits ranging from the Lower Bagshot of Gardner (Pipe-clay Series of Arkell) to the Oligocene. The deposits are well displayed in the magnificent coast sections of Dorset, Hampshire and the Isle of Wight.

There are also scantier records of plants in the well-dated marine beds to the east at Selsey in Sussex which range in age from Cuisian to Auversian. A single plant only is known from marine Cuisian beds at Whitecliff Bay at the eastern end of the Isle of Wight. These plants of the eastern marine area have been described in a separate bulletin (Chandler, 1961*a*).

The transgression of the London Clay sea was responsible for the formation of marine beds as far west as Dorchester in which plants have not yet been found beyond Holtwood near Ringwood. After the London Clay the sea withdrew from Dorset and Hampshire which became a land surface for a long period upon which the Lower Bagshot Beds of the Studland-Corfe-Poole area, and the Middle Bagshot Bournemouth Freshwater Beds were laid down. For references to Gardner's use of the terms Lower and Middle Bagshot for these continental beds see Chandler, 1961 (Table on p. 8). The river which formed these deposits shifted its course to some extent from time to time but flowed entirely within the Hampshire Basin throughout the Eocene and Oligocene. Broadly speaking, the sea lay to the east, and the land to the west, but the boundary between sea and land was constantly moving. Sometimes depression of the land to the south and east caused marine transgression as in the episode covered by the Bournemouth Marine Series and Boscombe Sands up to and including the Barton Beds. At such times the estuary mouth lay further west. Later, again, in the Lower Headon, the sea withdrew and the estuary extended further east. From Studland eastwards to a short distance beyond Bournemouth the freshwater deposits form an almost continuous indivisible series, the 'Bagshot Beds' of Sheet 329, new series, Geological Survey maps. The series is broken only by the relatively recent gap of Poole Harbour where the cliffs give place to flats and stream channels. East of Bournemouth they are partially overlain by, and partially pass laterally into the marine and brackish delta mud of the Bournemouth Marine Series (part of the 'Bracklesham Beds' of the above-mentioned map). All the Bournemouth Beds will be discussed in a

subsequent volume. The plants from the Hengistbury and Barton Beds have already been described (Chandler, 1960).

Gardner (1882) subdivided the freshwater sequence into two series chiefly on the grounds that their floras were dissimilar. Although the supposed difference of vegetation cannot now be maintained, the plants of the two series have been described separately. The present volume deals with his Lower Bagshot flora.

The Lower Bagshot plants come from the sand, pipe-clays and grits west of Poole, the Bournemouth Freshwater plants from the sands, carbonaceous loams, small impure pipe-clay patches and brick-earths exposed in the cliff section between Poole Head and the East Cliff lift at Bournemouth.

2. THE LOWER BAGSHOT BEDS OF DORSET

Three main divisions are described by Arkell (1947) in Purbeck. They are:

3. (top) Agglestone Grit (50 ft. or more).
2. Pipe-clay Series (135 to 250 ft).
1. Redend Sandstone (140 ft. ?).

Almost all the plants come from the Pipe-clay Series, typical current-bedded sands, virtually devoid of animal fossils, with seams of pipe-clay (or plastic clay) often of commercial value from which abundant plant impressions were formerly collected. Both clays and sands are regarded as delta deposits formed by a river which flowed from granitic areas to the west or south-west. Arkell (1947: 216) states that they were probably laid down by currents in a shallow subsiding lake and that the river which fed it must have been large. White (1917: 20) considered that there are indications of rapid accumulation of sand-banks alternating with slow deposition of mud in intervening hollows. Gardner, who was intimately acquainted with these beds from which he collected, records that the pipe-clays occur as lenticular masses and intercalated bands in the Series, and that it was the decomposition of granite in the gathering ground of the river which produced both the coarse sand (with carbonaceous seams and debris) and the fine clay with impressions of leaves, fruits and insects.

The pipe-clay patches are of limited extent, each, according to Gardner, representing a small lake or hollow, first scooped by running water out of beds previously deposited, and then filled by fine sediments, a slightly different interpretation from that of White. Gardner estimated the depth of these basins as ranging from about 30 to 50 ft., and their circumference as from about one-quarter to three-quarters of a mile. Passing from west to east the clay patches become smaller and fewer, eventually equivalent in the Bournemouth Freshwater Series to the infillings of mere ponds or puddles. The diminution of the clay patches he considered to mark a change from a narrow valley to a broad low-lying tract near the sea (Gardner, 1877: 55).

The complexity of the stratification suggests that the river was swift, sedimentation keeping pace with the subsidence of the land so that enormous thicknesses of sandy beds were able to accumulate. In this connexion it is of interest to recall that Richards (1952: 207) comments on the great intensity of erosion in the tropics as shown by the muddiness of tropical rivers and the large amount of suspended matter they deposit when in flood. Beds to the west, i.e. nearer the source of the river, are naturally coarser and more purely fluvial than those to the east

including gravels and pebble-beds with angular pebbles. In parts of Dorset the gravels appear to occupy a valley eroded in secondary strata (Reid, 1896: 492), but further east there seems to be a gradual passage upwards from the loams of the London Clay.

Perhaps the best picture of comparable recent conditions is given by Ridley incidentally while discussing the dispersal of fruits and seeds (1930: 167). 'Periodically', he wrote, 'the rush of water from the mountains especially in tropical regions, is enormous, resulting in great floods and a large deposit of silt which gradually pushes the land out into the sea. In the floods of 1926, in the Malay Peninsula, some of the rivers rose from 60 to 85 ft. above the normal height, and silt brought down from the mountains lay from 5 to 6 ft. deep on the ground in the low country. In such rushes of water vast numbers of seeds must be brought down from the mountains. . . .' Later (p. 174), he added 'at intervals these rivers overflow and spread over the flat lands for many miles, often from 50 to 60 miles, sweeping with them seeds and floating aquatic plants as well as other vegetable débris. . . . These floods form lakes, streams and pools.' And once again (p. 186) 'rivers frequently change their course and seeds and fruits, bushes and small trees, clumps of bamboo and bananas travel unharmed long distances'.

Under conditions such as these, with repeated flooding, silting, change of stream course and formation of lakes and pools it is easy to conceive how the Lower Bagshot coarse sands with their thick seams of carbonaceous plant remains, and their pipe-clay deposits with fine impressions of pods, winged fruits and leaves were accumulated.

The paucity of the Lower Bagshot fauna is remarkable. Only a few insects and freshwater shells are known (Gardner, 1879: 16). A *Unio*-like shell and a beetle are preserved in the Dorchester Museum. The only recorded marine shells (Fisher, 1862: 83), are abundant *Cardita planicosta* and *Turritellae* in a mass of ferruginous sand from Lytchett near Poole (Dorchester Museum), a record said by White (1917: 20) to be 'doubtful'. *Ostrea*, denoting salt or brackish water, was found in Furzeybrook Clay Pit near Corfe (Fisher, 1862: 83, footnote). The occurrence of such shells was regarded as pointing to the neighbourhood of the sea. The presence of the mangrove-swamp fern *Acrostichum lanzaeanum* at Studland and Arne supports this view and there is much teredo-bored wood at Arne but this can be carried up tidal rivers for great distances, although whether it ever passes completely beyond the influence of saline water is not known (Gardner, 1886: 161).

The relationship of these British beds to the continental stages can only be guessed in the absence of interstratified marine fossiliferous beds. Freshwater strata overlying the London Clay may not unreasonably be supposed to be contemporary with the Cuisian as suggested by Wrigley & Davis (1937, pl. 18) but the upper limit of the stage cannot be precisely defined. Arkell (1947: 217) includes in this stage the whole of the continuous freshwater sequence to the top of the Bournemouth Freshwater Series. Wrigley & Davis, on the other hand, relate the 'Bournemouth Plant Beds' to the Lutetian (1937: 220, pl. 18), thus presumably placing the junction of Cuisian and Lutetian in the neighbourhood of Poole Harbour and below the finely laminated silts at Poole Head. It can only be stated with certainty that the clearly defined marine beds with *Nummulites prestwichianus* in the upper part of the cliff at Cliff End, near Mudeford give the upper limit of a series of strata, viz. Cuisian, Lutetian, and Auversian, between the London Clay and the Bartonian. No hard and fast lines of demarcation between these stages can be expected in a continuous series of freshwater deposits such as here occur. Nor is it probable that the plants can give any definite help in dating these deposits more

precisely. Floras change slowly, and while conditions of climate are relatively constant no sudden variation in the plant succession is likely to be found although there may be indications of different habitats. The position of the Lower Bagshots in relation to other British Eocene deposits is shown in a Table (Chandler, 1961: 8) where suggested correlations with the continental stages are also given.

3. THE PLANT-BEARING LOCALITIES

(i) STUDLAND

The oldest plant beds of the Lower Bagshot are found at Studland within the lowest 100 ft. of the Series. Monckton (1910, pl. 38, fig. 4) gives a photograph of the cliff section showing barren Sandrock (Redend Sandstone of Arkell) in the lower two-thirds of the cliff, and the plant beds above. These plant beds consist of interlaminated grey sandy clay resting on an irregular surface of the Sandrock. They appear to be intercalated between the Redend Sandstone and the Pipe-clay Series for they are absent in adjacent sections to the north where the Pipe-clay Series immediately overlies the Sandrock. Unfortunately little evidence is available from these plant beds. The horizon which formerly yielded leaf-impressions lies near the top of the cliff and is difficult to reach. Good productive fallen blocks are not now common (probably because a rich lenticle or pocket formerly existent has been eroded). Early literature refers to leaf-impressions including broken ferns, fan palms and a minority of dicotyledons with their leaves bent and broken. The palms are said to have been very abundant in the lowermost beds of Corfe and Studland (Gardner, 1877: 60). Gardner (Gardner & Ettingshausen, 1879: 16, 26; Gardner, 1886: 402, pl. 3, fig. 5) also mentions the following: *Acrostichum lanzaeanum*, *Ficus*, Leguminosae, *Aralia* and *Liquidambar*, but no figures or descriptions are given except of *Acrostichum* so that the determinations cannot be confirmed. A few poorly preserved seeds were found recently not more than 4 ft. above the Sandrock. Barren pinnule-impressions and well preserved carbonaceous fertile pinnules of *Lygodium* with spores are not uncommon in the clays (Chandler, 1955).

All plants lately collected are carbonaceous. The leaves, represented by actual desiccated leaf-substance quickly crack and crumble on exposure to air, revealing poor impressions of form and nervation beneath; such impressions do not show very clearly in the coarse dark matrix.

Another difficulty for the collector is that the plant bed matrix does not readily disintegrate even when boiled, while the carbonaceous remains are somewhat sparse and frequently imperfect. There can be little doubt, however, that at this horizon laborious collecting, boiling, and sifting would add to the scanty plant list. Up to the present only six species have been reliably determined: *Acrostichum lanzaeanum* Visiani and *Lygodium kaulfussi* Heer, both tropical ferns; the ubiquitous older Tertiary conifer *Sequoia couttsiae* Heer, *Rubus acutiformis* Chandler originally described from the Lower Headon of Hordle, *Burtonella emarginata*, *Burtonella* being a new genus of Capparidaceae, and a species of *Ficus*, the two last also suggesting tropical affinity.

It is unfortunate that a four-winged fruit compared by Maw with *Kydia* (1868: 74, fig. 1) is no longer in existence for the figure is inconclusive and the description inadequate.

(ii) THE PIPE-CLAY SERIES

The pipe-clay impressions which so attracted the early collectors have now largely disappeared although a few are preserved in old collections e.g. in Dorchester Museum and possibly in the Gardner Collection in the British Museum (Natural History). Reliable determinations of these plants are almost nil. The matrix is very fine so that it gives clear and beautiful impressions, but owing to its softness they are not very durable and are liable to be damaged. The majority of impressions which have survived are leaves which do not show great variety. There are also the few flowers and winged fruits of the Gardner Collection already mentioned most of which are probably from this horizon. Such impressions are difficult to determine as they lack distinctive characters and are seen in one plane only. The matrix is a whitish-grey pipe-clay tinged with iron-staining. One fruit is probably *Cupanooides* (p. 163, Pl. 28, figs. 9, 10). Others are referred to *Protoaltingia hantonensis* (p. 163, Pl. 28, figs. 6-8). At Furzeybrook Clay Pit near Corfe large palm leaves were at one time 'not uncommon' (Fisher, 1862: 83, footnote). A 'date palm' and 'species of willow' were reported in the neighbourhood of Corfe by Brodie (1853) and leaf impressions belonging to 'Salicineae' by Ruegg (quoted by Gardner & Ettingshausen, 1879: 13, 14). P. B. Brodie stated that many specimens collected by W. R. Brodie had been placed in the Dorchester Museum. A few specimens (presumed to come from Corfe) were there exhibited in 1944 including leaves of willow type and a broader leaf like a *Ficus*. No leaf substance was preserved. There were also two large palm leaf fragments one illustrated in Pl. 28, figs. 1-3 from Creech Barrow. Two winged seeds (Pl. 28, figs. 4, 5; Pl. 29, fig. 24) from Corfe are in the British Museum (V. 40281, V. 40280).

As long ago as 1882 (p. 470) Gardner wrote that only a few pieces of palm and a few dicotyledonous leaves have been preserved from the once rich deposits at Corfe Castle. At that time Studland still yielded macerated palms and ferns, and a few dicotyledons. Later (1889: 106) he referred to the large leguminous pods which give to the Lower Bagshot flora its tropical appearance, and, in a footnote on the same page he stated there are still parts of huge pods of *Cassia* and *Acacia* preserved in the Dorchester and Jermyn Street Museums [the latter now the Geological Survey and Museum] but these and many additional Gardner specimens of doubtful origin in the British Museum (Natural History) Collection which may well be Lower Bagshot are not dealt with in this volume. Three well localized fan-palms (Fisher Coll., Corfe Castle) are in the Sedgwick Museum, also a much decayed pinnate fragment with broad rachis (Corfe Castle). The fan-palms have a long rachis and one has marked asymmetry at the centre of the leaf. The Geological Survey also has fan-palms with long rachis (two Fisher Coll., Corfe; one Lower Bagshot, Isle of Purbeck), one also with large ligule from Furzeybrook, Creechbarrow.

Today, interest has shifted from the pipe-clays themselves to the sands with carbonaceous seams within the Pipe-clay Series. Two fine exposures have yielded abundant fruits and seeds, one at Lake, near Hamworthy, in the cliffs and foreshore on the north side of the Wareham channel of Poole Harbour, the other in the low cliffs and foreshore at Arne about a mile away on the opposite shore of the Wareham channel. Both are now threatened, that at Lake by the development of a caravan site, that at Arne by cliff fall and silting up of the section by the tide. *Lake*. (National Grid Reference 20/979907)

The plant beds were discovered in 1938 by E. St. John Burton during a painstaking

investigation of the Bagshot Beds. The exposure occurs west of the Hamworthy shipyard near Poole and east of the embankment which carries the Southern Railway line across the inlet called Lytchett Bay. The beds are seen in places to rest upon a mottled red and white pipe-clay which outcrops in the shore and is brought to the surface at intervals by a series of small folds into which the succession here has been thrown. In other places they rest upon a coarse gritty band. The greater part of the cliff section consists of typical Bagshot sands. There are a few unproductive seams of fine pebbles or coarse grit but part of the cliff is black with seams or lenticles of matted carbonaceous remains, largely wood and twigs with an abundance also of fruits and seeds. The black seams are impersistent and vary in composition although the same flora is found throughout. The coarseness of the deposit suggests transport by a turbulent stream, successive seams perhaps being formed in times of heavy spate. When the section was first visited samples were washed on the spot through graded sieves and about 60 lbs. of concentrated carbonaceous residue were taken home for examination. Other visits have since been paid to Lake from time to time. Numerous specimens were found of a conspicuous smooth endocarp now named *Icacinicarya inornata* (p. 98, Pl. 13, figs. 20-24; Pl. 14, figs. 1, 2). It could be picked out readily without sifting from some of the seams in the cliff and foreshore. Its abundance suggested that it belonged to a liana climbing upon trees which overhung the river. Many Euphorbiaceae, Mastixioideae and Menispermaceae were also found and the deposit is unusually rich in vines of which sixteen species are described. A different set of plants was collected during the most recent visits when *Icacinicarya* and Mastixioideae were still abundant, but Menispermaceae rather rare. Most of the seams lately examined show a high proportion of wood. During the winter collecting can be very profitable. On one such visit storms had scoured the beach and cut into the base of the cliff at the eastern end of the section exposing great tabular masses of indurated ferruginous sand hardened by contact with salt water into jagged ironstone slabs. In the exposures below these in the foreshore fine-grained deposits yielded less wood and better preserved seeds. In these beds there were many conifer twigs and detached cuticle fragments. Here was found the beautiful macerated fertile pinnule of *Lygodium poolensis* Chandler (1955: 312, pl. 38, figs. 88-96). *Anemia poolensis* (Chandler 1955: 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) represented by isolated or paired fertile pinnules, is most abundant in the woody seams above and frequently occurs in those which yield abundant *Icacinicarya*.

At the western extremity of the cliff immediately above a bed of pipe-clay about a square yard of finely laminated silt was exposed dipping steeply into the cliff and eastwards so that it quickly vanished below beach-level. Westwards this fine matrix was obscured by talus. Immediately above the silt were coarse sands with occasional woody seams. In the silts a few species only were found, mostly small. Shreds of cuticle also occurred. The appearance of the deposit suggested deposition in very still water, perhaps in a small lagoon with a limited flora. The most abundant fruits were *Scirpus lakensis* (p. 50, Pl. 6, figs. 7-14) a marsh plant, an extinct Capparidaceae genus *Palaeocleome* (p. 67, Pl. 9, figs. 1-15) and pyrenes of *Ehretia lakensis* (p. 140, Pl. 22, figs. 3-11). An occasional larger fruit or seed may have been blown into the pool or otherwise accidentally introduced.

Arne (National Grid Reference 20/970894)

This important section for plants had been overlooked until recently presumably on account of its inaccessibility, for it lies about a mile over the heath from Arne Church, in

private ground. The plant beds are found in a very low cliff formed of coarse sands which rest in the foreshore on mottled red and white pipe-clay. The upper part of the cliff is occupied by barren sands and grits below which are a few carbonaceous seams, fewer and thinner than those at Lake, perhaps deposited near the limits of a flood channel. Many characteristic Lake plants occur but there are also a few species not yet found elsewhere, at least in the Lower Bagshot Beds, e.g. *Wetherellia variabilis*, *Wardenia poolensis*. There are two beautiful specimens of *Tinospora*, a genus represented only by a few fragments at Lake. *Acaciniacarya inornata* is rare on the other hand; vines are common. *Anemia poolensis* is represented by a few three-fid terminal fertile pinnules as well as by the solitary and paired pinnules which also occur at Lake. An interesting feature of the Arne section, now unfortunately covered by silt and slipped material is a finely laminated compact black band formed of plant remains embedded in silt. The band lies near the base of the section below the coarse productive carbonaceous seams; it is much broken by minor folds and faults and by the action of the sea. Parts of it show matted masses of *Acrostichum lanzaeanum* pinnules. In other parts rootlets or numerous cuticle fragments of reed-like plants occur. One small fern fragment of *Anemia subcretacea* with repeatedly forking dichotomous nervation was seen. The band suggests a 'fossil' tropical swamp in which the fern *Acrostichum* grew rampantly where the influence of salt water was still felt. Patches rich in rootlets also yielded abundant seeds of the baffling *Rhamnospermum bilobatum* Chandler. Blocks of teredo-bored wood were present in places.

On the whole the Arne fruits and seeds are less well preserved than those from Lake. There were patches where every twig or other carbonaceous fragment was encrusted with coarse pyrites crystals completely concealing the structure. A few remains of larger fruits, represented by broken and indeterminable fragments, suggest that had the preservation been comparable with that of the London Clay many more of the larger elements in the flora would have been found.

4. GENERAL CHARACTERISTICS OF THE LOWER BAGSHOT FLORA

Of the forty families (or major Sections of families like Mastixioideae) recognized in the Lower Bagshot and here recorded, twenty-three are chiefly or exclusively tropical or subtropical, viz. Schizaeaceae, Palmae, Moraceae, Menispermaceae, Lauraceae, Capparidaceae, Rutaceae, Burseraceae, Euphorbiaceae, Spondieae (Anacardiaceae), Icacinaceae, Sabiaceae, Vitaceae, Dilleniaceae, Theaceae, Flacourtiaceae, Mastixioideae (Cornaceae), Sapotaceae, Ebenaceae, Symplocaceae, Styracaceae, Apocynaceae, Cucurbitaceae.

Some of these families have extensions into more temperate regions, e.g. Euphorbiaceae, largely owing to a few such widespread genera as *Euphorbia*. Others are represented by genera found chiefly, but not exclusively in the mountains of the tropics, e.g. *Symplocos*.

The Schizaeaceae, Icacinaceae, Spondieae, Flacourtiaceae, Sapotaceae and Mastixioideae are almost exclusively tropical. The Mastixioideae and Icacinaceae are each represented by three distinct genera. Both families are among the most abundant fossils in the deposit. The large tropical looking leguminous pods found by Gardner have already been mentioned (p. 5). Boraginaceae and Solanaceae are equally tropical and extra-tropical. Four families, Hamamelidaceae, Thymelaeaceae, Lythraceae and Caprifoliaceae are chiefly temperate today but with extensions into the tropics. With the exception of Taxodineae no exclusively temperate families

have been recognized, but there are a few which are truly cosmopolitan such as Cyperaceae and Nymphaeaceae, and these are water or marsh plants. The Lythraceae also are cosmopolitan and the species represented are from their mode of occurrence almost certainly marsh plants.

Existing genera are represented by *Acrostichum*, *Lygodium*, *Anemia*, *Taxodium*, *Sequoia*, *Scirpus*, *Trachycarpus*, *Calamus*, *Ficus*, *Tinospora*, *Rubus*, *Phellodendron*, ?*Lansea*, ?*Rhus*, *Natsiatum*, *Iodes*, *Meliosma*, *Vitis*, *Tetrastigma*, *Actinidia*, ?*Cleyera*, *Oncoba*, *Ammannia*, ?*Mastixia*, *Cornus*, *Diospyros*, *Symplocos*, *Styrax*, *Ehretia*, *Solanum*, *Sambucus*—a warm assemblage. *Vitis* is notably rich in individuals in the tropics at the present day as in the Lower Bagshot. If it were possible to relate more of the form-genera to living ones, tropical elements in certain families might appear rather than temperate ones, for example in the Euphorbiaceae where the huge size of the family and the practical difficulties of making a thorough examination of the fruits and seeds of all living representatives has necessitated referring most of the fossils to a form-genus *Euphorbiotheca*. There is also a number of genera which cannot be matched exactly although they belong to families small enough for a full study of the available living material to be made. To these apparently extinct forms new generic names have had to be given either here or in earlier publications e.g. *Palaeococculus*, *Wardenia* (Menispermaceae), *Rutaspermum* (Rutaceae), *Palaeobursera* (Burseraceae), *Dracontocarya* (Spondiaceae), *Palaeophytocrene* (Icacinaceae), *Alatospermum* (Lythraceae), *Hordwellia* (Theaceae?), *Eomastixia*, *Mastixicarpum* (Mastixioideae), *Dunstaniana* (Cornoideae) and *Nyssonidea* (Nyssaceae).

The presence of actual species which are found in the London Clay is an important discovery from the point of view of the climate indicated. Such are *Anemia poolensis*, a species very close to *Tinospora excavata*, ?*Palaeophytocrene foveolata*, ?*Meliosma sheppeyensis*, *Vitis pygmaea*, *Wetherellia variabilis* and ?*Mastixia cantiensis*. There are also *Natsiatum eocenicum*, *Rhamnospermum bilobatum* and *Sequoia couttsiae* only recently recognized in the London Clay and awaiting publication from that horizon.

The small numbers of named genera (*ca* sixty-four) and species (eighty-six) do not justify any attempt to base conclusions on mathematical calculations. The plants recorded do, however, suggest that conditions in the Lower Bagshot may have been at least as warm and humid as in the London Clay. Most of the Lower Bagshot families are represented in this older deposit but the following have not yet been recorded: Polypodiaceae, Cyperaceae, Cappariaceae, Rosaceae, Thymelaeaceae, Styracaceae, Caprifoliaceae. The London Clay has fifty-seven families of which twenty-nine are recorded in the Lower Bagshot Beds. The Lower Bagshot flora is essentially Eocene in character. Just as in the London Clay the proportion of trees and large shrubs is considerable, so in the Lower Bagshot out of about a hundred species, thirty-six can be stated with certainty to have been woody and erect, and twenty-seven others were probably large woody lianas. About a dozen only were herbaceous, most of these being marsh or water plants. The tropical family Cappariaceae appears to be represented by one aquatic or sub-aquatic species judging by the occurrence of the seeds of *Palaeocleome lakensis* in fine silts associated with abundant Cyperaceae. Among the herbs were the ferns *Anemia*, *Lygodium* and *Acrostichum*. The vegetation was largely that of a forest growing along river banks. No doubt the trees supported the lianas and the climbing fern *Lygodium*. Undergrowth was scanty but included *Anemia*. In pools and quiet stretches of water and marsh dense colonies of Cyperaceae grew. Coastal marshes only occasionally inundated at high tides were the home of *Acrostichum*.

5. DIFFERENCES OF HABITAT AND PRESERVATION IN THE LOWER BAGSHOT AND LONDON CLAY LEADING TO CERTAIN DIFFERENCES IN THE TWO FLORAS

In any comparison of the Lower Bagshot flora with that of the London Clay it is important to realize that some differences between them are due either to the very different conditions affecting these two floras during growth or to a different mode of preservation. The London Clay flora occurs in marine beds. Its fruits and seeds belong largely to river banks and coastal flats. They are presumed to have floated out to sea and to have sunk to the sea-bed when they became water-logged or when the water became deep and the river currents slackened (Reid & Chandler, 1933: 20). Hence *Nipa* is present in the London Clay for it belongs to the seaward margin of the mangrove swamps and the edges of tidal rivers, but it is absent from the continental Lower Bagshots where tidal waters rarely if ever penetrated. In support of this view is the fact that in the Bournemouth Marine Series *Nipa* reappeared.

In the Lower Bagshot *Acrostichum* occurred instead of *Nipa* as the representative of coastal vegetation since it belongs to the landward margin of the coastal swamps. The absence of *Nipa* is due therefore to geographical rather than to climatic conditions.

In the London Clay plant remains are sparsely distributed in the matrix. It is the action of the sea today which in eroding the cliffs and sifting the clay has concentrated the fossils in pyrites patches on the shore and made possible the large collections which have produced the long and varied lists of plants. It may be noted that very small seeds are not normally found by this mode of collecting unless they are preserved within a much larger fruit.

In the Lower Bagshot, on the other hand, plant remains are crowded in conspicuous seams, pockets and lenticles in the deposit *in situ* from which they can best be extracted by the somewhat slow and laborious process of sifting and hand-picking. Inevitably, therefore, the yield is poorer than in the London Clay and the variety of plants less but small fruits and seeds are more easily retrieved. Partly on this account, and partly because in the continental Bagshots the plants of inland lakes and quiet pools had a better chance of preservation, small-fruited gregarious Cyperaceae and other marsh and water plants occur in abundance. That an aquatic flora existed in the London Clay period is demonstrated by the rare fruits of Nymphaeaceae, but the distance they had to travel to the site of deposition and the small size of many must have greatly reduced their chance of preservation and discovery.

The mode of preservation in the London Clay is pyritization. Cell-structure is often beautifully preserved owing to infiltration of pyrites into each cell-cavity. Even soft pulpy tissues like mesocarp may still be present and show every detail, the pyrites cell-infillings keeping the tissues turgid as in life so that both shape and size are retained. The most delicate thin integuments are often preserved as impressions on thin films of pyrites. Carpels of fruits which would naturally dehisce tend to cohere through infiltration of pyrites to form a cement so that fruits still enclosing small seeds are frequent.

In the Lower Bagshot all fossils are carbonaceous with a minimum of pyritization and never with the complete replacement of cell contents by pyrites as in the London Clay. These carbonaceous fruits are easily crushed, distorted and sand-pitted. They have usually suffered much contraction on drying and the original size of these specimens must always have been greater than their dry measurements. Shrinkage sometimes amounts to half the linear

dimensions. This point can be well illustrated by reference to fruiting heads of *Protoaltingia hantonensis* from the Bournemouth Freshwater Beds where the difference between the external mould in sandy clay and the actual carbonaceous head is now considerable.

In carbonaceous fossils like those of the Lower Bagshot soft tissues such as mesocarp have usually been destroyed or are so contracted that details of structure cannot be seen. Dehiscence has often occurred in the absence of pyrites cement and small seeds have been shed. But they are recovered in quantity by sifting and picking out.

From the above remarks it follows that in the pyritized London Clay fruits many details of structure are available which are lost in the Lower Bagshot specimens. In the family Lauraceae, for example, the characters of exocarp, endocarp and seed are preserved in the London Clay fruits, whereas in the Lower Bagshot Lauraceae there is little evidence available but that of the form and external surface of the crushed berries. It has been possible therefore to describe six genera and a large number of species from among the London Clay Lauraceae, but in the Lower Bagshot specimens can only be referred to the form-genus *Laurocarpum*.

It is of interest to note the presence of *Anemia subcretacea*, *Vitis pygmaea?* and *Natsiatum eocenicum* in the Pre-Ypresian Woolwich and Reading Beds as well as in the Lower Bagshot.

6. THE LOWER BAGSHOT OF ALUM BAY, ISLE OF WIGHT

Continental deposits are again found at the western end of the Isle of Wight but unfortunately almost nothing is known of their flora. The famous leaf beds of the Pipe-clay at Alum Bay are in need of reinvestigation. Despite published statements that these beds are now worked out and that plants can no longer be obtained, they are still found from time to time, sometimes abundantly. No doubt their occurrence in patches and lenticles accounts for the lack of continuous productive exposures. The leaves are usually flat, smooth and detached from twigs. They are impressions with little but form and nervation. On account of their beautiful appearance they formerly attracted much attention, but in spite of this the Pipe-clay flora is one of the least known fossil floras in this country. La Harpe in 1856 named some specimens. Again in 1862 he figured and listed about twenty-one species with very brief descriptions (pp. 109-120, pls. 5, 6, 7). Conifers, *Quercus*, *Ficus*, Lauraceae, Proteaceae, *Aralia*, Sapindaceae, Leguminosae (leaves and fruits) were among the plants named; but his work is in need of revision. Mitchell (1865: 515, 516, figs. 1, 2) published an outline drawing of a five-lobed calyx-like organ (winged fruit?) which he referred to *Porana*. The evidence given is insufficient for determination. A distorted five-lobed calyx labelled *Porana oeningensis* A.Br. No. 1868 still exists in the Sedgwick Museum, Cambridge and bears a resemblance to the impression shown in Pl. 29, figs. 12, 13. There are also several leguminous pods there. In the British Museum (Natural History) 38759 is an unlabelled palm described in the Register as Bagshot?, I.O.W. while V.10465 and V.10879 are labelled Lower Bagshot, Alum Bay, I.O.W. An Alum Bay palm frond is illustrated in Text-fig. 25 on p. 161. Mitchell also stated that he had a collection made by Keeping including some 350 leaf-forms and fifty fruit remains but Gardner considered the flora very restricted as to species and throws doubt on these large numbers. Among the genera he accepted were *Ficus*, *Aralia*, *Juglans*, *Laurus*, *Acer* and a number of Leguminosae (Gardner & Etingshausen, 1879: 3, 16; 1889 in Reid & Strahan: 104). Gardner added little to the knowledge of this flora but regarded it as of Australian type. He figured and described

Marattia hookeri (1880: 55; 1882, pl. 12, figs. 1-6) and two species of *Podocarpus* (1883: 48, 50, pl. 2, fig. 15; pl. 8, figs. 1-16), one of which, *P. elegans*, is La Harpe's species. He observed that species were few in comparison with the number of specimens and stated that the Alum Bay leaves, including *Aralia* and *Liquidambar*, had been found at Studland but published no supporting evidence. He correlated the Alum Bay Pipe-clays with the Pipe-clays of Dorset placing them within the Lower Bagshot sands (Gardner, 1882: 424, 479). Wrigley & Davis (1937: 218, pl. 18) agreed with this conclusion on stratigraphical grounds, while pointing out the great need for further study of the plant remains. Earlier attempts to correlate the Alum Bay flora with that of the Barton Clay or Bournemouth Beds, or Sheppey (quoted by Gardner & Ettingshausen, 1879: 14) are now discredited. Plants listed by Ettingshausen (1880) are *nomina nuda*, and judging by the similar list which he published for the London Clay, rest on no scientific evidence, and may well be incorrect (cf. Reid & Chandler, 1933: 11-17).

Edwards (1936: 25, 27) calculated the percentage of leaf species from Alum Bay in the British Museum (Natural History) Collection with entire margins and found it to be 86% as compared with 76% for the London Clay. He quoted Endo's work on percentages of entire leaf margins in North and South Japan respectively and the well-known fact that in tropical Rain forests leaves with entire margins greatly predominate, decreasing progressively in passing to cooler regions. The high percentage of entire margins in the Alum Bay Pipe-clay therefore indicates conditions perhaps more tropical than when the London Clay was deposited.

A solitary spore of *Anemia* has recently been figured (Chandler, 1955, pl. 33, fig. 31). It came from a fine-textured bed with minute carbonaceous fragments and an abundance of pollen and cuticle fragments a short distance above the Pipe-clay. This bed also yielded a much macerated fruit of *Scirpus lakensis* and would repay further examination, but unfortunately all collecting at Alum Bay is seriously hampered nowadays by huge scree, which obscure fresh surfaces in the cliff section, due to the activities of collectors of coloured sands.

7. OTHER SOURCES OF INFORMATION OUTSIDE THE LOWER BAGSHOT

In the following species from the Lower Bagshot, Dorset, information has been drawn from other horizons and these specimens have also been illustrated:

Sequoia couttsiae Heer: Lower Bagshot, Dorset; Bournemouth Marine Beds and Cliff End Beds, Mudeford (Auversian?), Hampshire; basal beds, Hengistbury, Hampshire; Lower Headon, Hordle, Hampshire; Upper Headon, Colwell Bay and Hamstead Beds, Isle of Wight; Bovey Tracey Lake Basin, Devon (type locality).

Rubus acutiformis Chandler: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Branksome Dene, Dorset; Lower Headon, Hordle, Hampshire (type locality).

Caricoidea obscura Chandler: Lower Bagshot, Dorset; Cliff End Beds, Mudeford (Auversian?), Hampshire (type locality).

Palaeonymphaea eocenica n. sp.: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Sandbanks, Dorset (type locality).

Protoaltingia hantonensis n.sp.: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Bournemouth, Dorset and Hampshire (type locality).

Rutaspermum excavatum n. sp.: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Branksome Dene and Sandbanks, Dorset (type locality).

Natsiatum eocenicum Chandler: Lower Bagshot, Dorset; Lower Headon, Hordle, Hampshire (type locality).

Vitis pygmaea Chandler: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Branksome Dene and Sandbanks, Dorset.

Oncoba rugosa n. sp.: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Sandbanks (type locality) and Branksome Dene, Dorset; Cliff End Beds, Mudeford (Auversian?), Hampshire.

Hordwellia crassisperma (Chandler): Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Sandbanks and Branksome Dene, Dorset; Bournemouth Marine Beds (Auversian?), Southbourne, Hampshire; Cliff End Beds, Mudeford (Auversian?), Hampshire; Lower Headon, Hordle, Hampshire (original type locality).

Eomastixia rugosa (Zenker): Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Sandbanks, Dorset; localities between Canford and base of East Cliff, Bournemouth, Dorset and Hampshire; Bournemouth Marine Beds (Auversian?), Bournemouth, Boscombe and Southbourne, Hampshire; Cliff End Beds, Mudeford (Auversian?), Hampshire; Bartonian, Barton Cliff, Hampshire; Lower Headon, Hordle, Hampshire.

Mastixicarpum crassum Chandler: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, base of East Cliff, Bournemouth, Hampshire; Lower Headon, Hordle, Hampshire (type locality); Lignite above Boscombe Sands, Southbourne (Auversian?), Hampshire; Upper Hengistbury Beds, Hampshire; Cliff End Beds, Mudeford (Auversian?), Hampshire.

Nyssoidea eocenica n. gen. & sp.: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Bournemouth west of pier, Hampshire (type locality), and Sandbanks, Dorset; Cliff End Beds, Mudeford (Auversian?), Hampshire.

Diospyros headonensis Chandler: Lower Bagshot, Dorset; Lower Headon, Hordle, Hampshire (type locality).

Styrax elegans Chandler: Lower Bagshot, Dorset; Lower Headon, Hordle, Hampshire (type locality).

Solanispermum reniforme Chandler: Lower Bagshot, Dorset (var.); Bournemouth Freshwater Beds, Sandbanks and Branksome Dene, Dorset; Lignite above Boscombe Sands, Southbourne (Auversian?), Hampshire; Cliff End Beds, Mudeford (Auversian?), Hampshire.

Sambucus parvula Chandler: Lower Bagshot, Dorset; Lower Headon, Hordle, Hampshire (type locality).

Rhamnospermum bilobatum Chandler: Lower Bagshot, Dorset; Bournemouth Freshwater Beds, Sandbanks and Branksome Dene, Dorset, between Alum and Middle Chines, Middle and Durley Chines, Bournemouth, Hampshire; Bournemouth Marine Beds, Boscombe and Southbourne (Auversian?), Hampshire; Cliff End Beds, Mudeford (Auversian?), Hampshire; Lower Headon, Hordle, Hampshire (type locality); Upper Headon, Colwell Bay, Isle of Wight; Hamstead Beds, Hamstead and Bouldnor Cliffs, Isle of Wight.

Unknown Organisms (p. 156): Lower Bagshot, Dorset; Bournemouth Marine Beds Southbourne, (Auversian?), Hampshire; Lignite above Boscombe Sands Southbourne, (Auversian?), Hampshire; basal beds, Hengistbury, Hampshire; Bovey Tracey Lake Basin, Devon; Cromer Forest Bed, Pakefield, Suffolk; Reuver, Limburg, Netherlands.

8. LIST OF LOWER BAGSHOT PLANTS

Plant localities in the Lower Bagshot Beds are indicated in column 4. L=Lake, A=Arne, ST=Studland, s=Lower Swanwick, c=Corfe, P=Pipe-clay, locality not recorded, probably Lower Bagshot of Dorset.

Family	Genus and species	Known from older beds.	Locality in Lower Bagshot	Known from younger beds	Remarks
Pteridophyta Polypodiaceae	<i>Acrostichum lansaezanum</i> (Visiani)		ST.A.	x	Characteristic swamp plant in drier yet saline ground behind Mangroves. Essentially tropical. <i>Lygodium</i> a climbing fern, neo- and palaeotropical lands. <i>L. poolensis</i> resembles <i>L. scandens</i> Sw. and <i>L. reticulatum</i> Schk. in spores, species from West Africa and Further India to Chitral, South China, Malaya to Australia, Polynesia, Melanesia. <i>Anemia</i> relict genus in tropics of Old World (in Madagascar, tropical Africa, South India and Natal). Well represented in tropics and subtropics of the NewWorld.
Schizaeaceae	<i>Lygodium kaulfussii</i> Heer		ST.	x	
	<i>Lygodium poolensis</i> Chandler		L.		
	<i>Anemia poolensis</i> Chandler	x	L.A.	x	
	<i>Anemia subcretacea</i> (Saporta)	x	A.	x	
Gymnospermae Taxodineae	<i>Taxodium lakense</i> n. sp.		L.A.		Genus eastern and southern States of North America. Tree.
Monocotyledones Cyperaceae	<i>Sequoia couttsiae</i> Heer	x	ST.	x	Sierra Nevada. Tree.
	<i>Scirpus lakensis</i> Chandler		L.A.S.	x	Genus world-wide. Herbaceous, stagnant pools indicated.
	? <i>Scirpus</i> sp.		L.		
	<i>Caricoidea arnei</i> n. sp.		A.		
	<i>Caricoidea minima</i> (Chandler)		A.	x	Family cosmopolitan. Marsh or water plant.
	<i>Caricoidea obscura</i> Chandler		L.	x	
	Genus?		L.		
Palmae	<i>Trachycarpus raphifolia</i> (Sternberg)		C.	x	Family cosmopolitan tropical. Genus East Asia.

Family	Genus and species	Known from older beds.	Locality in Lower Bagshot	Known from younger beds	Remarks
Calameae	? <i>Sabal</i> sp.		A.	x	<i>Sabal</i> warmer America.
Araceae	<i>Calamus daemnorops</i> (Unger)		L.	x	Mostly climbers. Tropical jungle.
Dicotyledones	<i>Aracispermum arnense</i> n. sp.		A.		
Moraceae	<i>Ficus lucidus</i> n. sp.		L.	x	Cosmopolitan tropics and subtropics. Trees and shrubs.
Moraceae?	<i>Ficus</i> sp.		ST.		
Nymphaeaceae	<i>Ovicarpium reticulatum</i> n. gen. & sp.		A.	x	Cosmopolitan aquatic family.
Menispermaceae	<i>Palaeonymphaea eocenica</i> n. sp.		L.		Tropical and warm temperate family. Largely climbers.
	<i>Tinospora arnensis</i> n. sp.		L.A.		Genus <i>Tinospora</i> palaeotropical.
Lauraceae	<i>Wardenia poolensis</i> n. sp.	genus	A.	x	
Capparidaceae	<i>Palaeococcus lakensis</i> Chandler	x	L.A.	x	
	<i>Laurocarpum</i> spp.	x	L.	x	Tropical and subtropical family.
	<i>Burtonella emarginata</i> n. gen. & sp.		ST.L.A.		Family tropical and warm temperate.
	<i>Palaeooleome lakensis</i> n. gen. & sp.		L.		Occurrence of seeds suggest marsh or water plant.
	<i>Cappariadispermum eocenicum</i> n. sp.		L.		
Hamamelidaceae	<i>Protoaltingia hantonensis</i> n. sp.	genus	P.L.	x	Family wide north temperate range with some extension into tropics. Tree.
Rosaceae	Genus?	x	A.		Genus cosmopolitan.
Leguminosae	<i>Rubus acutiformis</i> Chandler		ST.	x	
Rutaceae	Genus?		L.		Family wide distribution. <i>Phellodendron</i> east temperate Asia.
	<i>Phellodendron costatum</i> Chandler	x	A.	x	
	<i>Rutaspermum excavatum</i> n. sp.		A.	x	
	<i>Rutaspermum glabrum</i> n. sp.		L.		
	<i>Rutaspermum magnificum</i> n. sp.		A.		
	<i>Rutaspermum striatum</i> n. sp.		L.		
Bursaceae	<i>Palaeobursera lakensis</i> n. sp.		L.	x	Cosmopolitan tropical mountain trees and shrubs, few coast level, few extratropical.

Family	Genus and species	Known from older beds.	Locality in Lower Bagshot	Known from younger beds	Remarks
Euphorbiaceae Phyllanthoideae	<i>Euphorbiotheca</i> (? <i>Andrachne</i>) <i>lakensis</i> n. sp. <i>Euphorbiotheca platysperma</i> n. sp. <i>Euphorbiotheca tuberculata</i> n. sp. <i>Euphorbiotheca digitata</i> n. sp. <i>Euphorbiotheca</i> spp. <i>Euphorbiospermum punctatum</i> n. sp. <i>Euphorbiospermum</i> sp. <i>Wetherellia variabilis</i> Bowerbank	x	L. L. L. L. L.A. L. L. A.		The family would be wholly tropical were it not for one or two widespread genera like <i>Euphorbia</i> . <i>Andrachne</i> tropics to warm temperate regions ascending to 9,000 and 10,000 ft. in Yunnan and western China.
Section? Euphorbiaceae? Anacardiaceae	<i>Dracontocarya glandulosa</i> n. gen. & sp. ? <i>Lamnea</i> sp. <i>Rhus lakensis</i> n. sp. <i>Rhus</i> spp. <i>Iodes acutiformis</i> n. sp.	genus x	L. L. L. L. L.A.	x	Cosmopolitan family, chiefly tropical. Section Spondieae tropical. Trees and shrubs. Genus tropical Africa and Asia. Genus subtropical and warm temperate.
Icacinaceae	<i>Natsiatum eocenicum</i> Chandler ? <i>Palaeophytocrene foveolata</i> Reid & Chandler <i>Icacinicarya inornata</i> n. sp.	x x	L. L.	x	Cosmopolitan tropical family. Largely climbers. Genus tropical Asia, Africa, Madagascar. Genus East Asia. <i>Phytocrene</i> aquatic lianas of tropical Asia and West Africa.
Sapindaceae? Sabiaceae	? <i>Cupanooides</i> sp. <i>Meliosma</i> sp. (? <i>M. sheppeyensis</i> Reid & Chandler)	genus ? x?	L.A. P. L.		Tropical and subtropical Asia and America. Shrubs and small trees. Mostly tropical and subtropical climbers.
Vitaceae	<i>Vitis ambigua</i> n. sp. <i>Vitis arnensis</i> n. sp. <i>Vitis cuneata</i> n. sp. <i>Vitis excavata</i> n. sp.	L. A. L. L.	L. A. L. L.		

Family	Genus and species	Known from older beds.	Locality in Lower Bagshot	Known from younger beds	Remarks
Vitaceae	<p><i>Vitis glabra</i> n. sp. <i>Vitis lakensis</i> n. sp. <i>Vitis platysperma</i> n. sp. <i>Vitis poolensis</i> n. sp. <i>Vitis pygmaea</i> Chandler <i>Vitis goodharti</i> n. sp. <i>Vitis symmetrica</i> n. sp. <i>Vitis triangularis</i> n. sp. <i>Vitis</i> spp. <i>Tetrastigma acuminata</i> n. sp. ? <i>Tetrastigma lobata</i> Chandler</p>	x	L.A. L. L.A. L. L.A. L.A. L. A. A. A. L.	x x	
Dilleniaceae	<i>Actinidia</i> sp.		L.	genus x	Cosmopolitan tropical family. <i>Actinidia</i> a climber, Southeast Asia to Malaya.
Theaceae	<i>Cleyera</i> ? <i>obliqua</i> n. sp.		L.	x	Cosmopolitan tropical and subtropical family.
Taonabeae	<i>Hordaealia crassisperma</i> (Chandler)		L.	x	
Theaceae	Genus? (cf. <i>Gordonia</i>)	genus x	L.		
Flacourtiaceae	<i>Oncoba rugosa</i> n. sp.	x	A.	x	Tropical and subtropical family. Genus tropical.
Thymelaeaceae	<i>Thymelaeaspermum lakense</i> n. gen. & sp. <i>Thymelaeaspermum</i> (?) <i>sulcatum</i> n. sp.		L.A.?		Markedly temperate but with few forms in tropics.
Lythraceae	<i>Ammannia lakensis</i> n. sp.		L.		Cosmopolitan but with few forms in tropics. Family herbs, shrubs and trees.
Nyssaceae	<i>Alatospermum lakense</i> n. gen. & sp.		L.	x	
Cornaceae	<i>Nyssonidea eocenica</i> n. gen. & sp.		L.A.		
Mastixioideae	? <i>Mastixia cantiensis</i> Reid & Chandler <i>Eomastixia rugosa</i> (Zenker) <i>Eomastixia urceolata</i> n. sp. <i>Mastixicarpum crassum</i> Chandler	x	A. L.A. L. L.	x x x	Mastixioideae tropical trees.

Family	Genus and species	Known from older beds.	Locality in Lower Bagshot	Known from younger beds	Remarks
Cornoideae	<i>Dunstania lakensis</i> n. sp.	genus x	L.	genus x	
Cornaceae?	<i>Cornus quadrilocularis</i> n. sp. Genus?	family x	L. L. L.	x x	
Sapotaceae	? <i>Sapotocarpum</i> sp.		A.		Cosmopolitan tropical family.
Ebenaceae	<i>Diospyros headonensis</i> Chandler		L.	x	Family largely tropical trees.
Symplocaceae	<i>Symplocos headonensis</i> Chandler		A.	x	Family tropical and subtropical, chiefly mountain plants, shrubs and small trees.
	<i>Symplocos lakensis</i> n. sp.		L.A.		
Symplocaceae?	<i>Symplocos</i> sp.		L.		
or Cornaceae?	Genus?		L.		
Styracaceae	<i>Styrax elegans</i> Chandler		L.	x	North and South America and West Indies, East and Southeast Asia, i Mediterranean.
Apocynaceae					Family largely tropical. Climbers, trees or shrubs.
Plumierioideae?	<i>Apocynospermum lakense</i> Chandler	x	L.	family x	
Section?	<i>Apocynospermum acutiforme</i> n. sp.		L.		
Boraginaceae	<i>Ehretia lakensis</i> n. sp.	genus x	L.		Genus chiefly palaeotropics. Small trees.
Solanaceae	<i>Solanum arnense</i> n. sp.		A.		Cosmopolitan family and genus.
Caprifoliaceae	<i>Solanispermum reniforme</i> Chandler		A.	x	
	<i>Sambucus parvula</i> Chandler		L.	x	Genus chiefly temperate Northern Hemisphere. Also in East Indies and Southern Hemisphere.
Cucurbitaceae	<i>Cucurbitospermum lakense</i> n. sp.		L.		Family subtropical and tropical climbers. Rare in temperate regions.
	<i>Cucurbitospermum obliquum</i> n. sp.		L.	x	
Incertae Sedis	<i>Rhamnospermum bilobatum</i> Chandler	x	L.		
	<i>Carpolithus arnensis</i> n. sp.		A.	x	
	<i>Carpolithus</i> spp.				

SYSTEMATIC DESCRIPTIONS

(All specimens are from Dorset (Chandler Collection) unless otherwise stated)

A. THE LOWEST PLANT-BEARING BEDS OF THE LOWER BAGSHOT AT STUDLAND

Note: Unless otherwise stated all specimens were found in dark laminated clays within 4 or 5 feet of the top of the Sandrock (Redend Sandstone) at Redend Point, Studland and within the lowest 100 ft. of the Lower Bagshot Series.

Pteridophyta

Order *FILICALES*

Family POLYPODIACEAE

Genus ACROSTICHUM Linnaeus

Acrostichum lanzaeanum (Visiani)

- 1858 *Fortisia lanzaeana* Visiani, p. 431, pl. 1, fig. 8; pl. 2, figs. 1, 5.
1879 *Chrysodium lanzaeanum* (Vis.) Gardner & Ettingshausen, p. 26, pl. 2, figs. 3, 4.
1886 *Chrysodium lanzaeanum* (Vis.): Gardner, p. 402, pl. 3, fig. 5.
1925 *Acrostichum* (*Chrysodium*) *lanzaeanum* (Vis.): Chandler, p. 10.
1926 *Acrostichum lanzaeanum* (Vis.): Reid & Chandler, p. 33, pl. 1, figs. 1-5; text-fig. 1
1961b *Acrostichum lanzaeanum* (Vis.): Chandler, p. 101, pl. 24, fig. 2.

Pinnules in white pipe-clay from plant beds near the cliff top at Studland have been recorded and figured by Gardner as indicated above. There can be no doubt as to their identity proved by the highly characteristic nervation. Gardner & Ettingshausen (1879: 28, 71), state that although they are abundant, usually only torn, twisted, and detached fragments are met with, and that they are massed together. The species has not recently been collected at Studland but it occurs in the Lower Bagshot of Arne (see p. 39) and at several other horizons in the Hampshire Basin, viz.: in the Bournemouth Freshwater and Marine Beds, the Lower Headon of Hordle and the Bembridge Beds of the Isle of Wight. It thus has a wide range in British deposits above the London Clay.

V.14926 Figured Gardner & Ettingshausen 1879, pl. 2, fig. 3. Pinnule tip and counterpart.

V.14927 Figured Gardner & Ettingshausen 1879, pl. 2, fig. 4. Distorted pinnule.

V.14989-90 Pinnule fragments. Probably also V.14982-88 (pink matrix).

All the above *f. S. Gardner Coll.*

Family SCHIZAEACEAE

Sub-family LYGODIEAE

Genus LYGODIUM Swartz

Lygodium kaulfussi Heer

1955 *Lygodium kaulfussi* Heer: Chandler, p. 308, pl. 37, figs. 70-83; pl. 38, figs. 84-87. See also for other references.

The species has been fully described and figured from Studland in the above work by the author and the relationship to living forms discussed.

Since then attention has been drawn to a paper by Kräusel & Weyland (1950, pl. 1, figs. 5, 6) in which some spores of *L. kaulfussi* are shown with sparse verrucosities. The Studland material appears to show these when entirely unmacerated but they disappear on the slightest maceration. Dr. R. A. Couper after examining preparations with an oil immersion lens states (ex. lit. 6. 11. 1955) that the projections are really tears and wrinkles in a very thin close-fitting perine (or perisphere?) and it is probably best to consider these spores as fundamentally unsculptured. It remains to catalogue the additional material.

V.40313 About twenty-five fertile pinnules or fragments of pinnules usually crowded with spores.

V.40314-15 Four slides showing spores extracted by maceration from fertile pinnules.

V.40316 Characteristic fragment of cuticle from a fertile pinnule.

All the above *E. St. John Burton Coll.*

Gymnospermae

Order CONIFERALES

Family TAXODINEAE

Genus SEQUOIA Endlicher

Sequoia couttsiae Heer

Plates 1-3; Pl. 4, figs. 1-32; Text-figs. 1-6

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

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

1922 *Sequoia couttsiae* Heer: Chandler, p. 385.

1957 *Sequoia couttsiae* Heer: Chandler, p. 82.

1960 *Sequoia couttsiae* Heer: Chandler, pp. 204, 221, pl. 33, figs. 80, 81.

1961 *Sequoia couttsiae* Heer: Chandler, p. 60, pl. 4, figs. 8, 9.

1961b *Sequoia couttsiae* Heer: Chandler, p. 103.

General Note. The first published account of *Sequoia couttsiae* was based on material from Hamstead. The more detailed description of better preserved and abundant specimens from Bovey followed later in the same year. Consequently the Hamstead material should rank as the type although for practical purposes the Bovey material has become the standard of comparison. It is clear from Heer's own statement (1862: 370) that his Bovey specimens were actually studied and described first, while the Hamstead material was only discovered and recognized after this had been done. Partly on this account, but mainly no doubt because of the quantity and good preservation of the Bovey *Sequoia*, Heer gives a much fuller description of this than of the more perishable and fragmentary Hamstead specimens. To the descriptions of external morphology of *Sequoia couttsiae* already published (Chandler, 1922, 1957) it is now possible to add much additional detailed information concerning cuticle structure which not only confirms the species as a true *Sequoia* (i.e. not *Metasequoia*), but also establishes as a single species plants from localities as widely separated in time as Studland, Southbourne, the Highcliff Sands, Cliff End near Mudeford, Hordle, Colwell, Hamstead and Bovey.

Thus the examination of the cuticle supports the determination of *S. couttsiae* at Studland although so far only three small twig fragments have been seen. This is the earliest record of the species in England, except for a single seed derived from the Reading Beds (Chandler, 1961: 60, pl. 4, figs. 8, 9).

There are but few earlier descriptions of the cuticle. C. & E. M. Reid published a short description and two figures of Bovey material (1910: 171, pl. 15, figs. 36, 37). Chandler published inadequate figures and descriptions of the fossil and its cuticle from Hordle (1922: 385, figs. 1*b*, 2*b*). Bandulska (1923: 257, pl. 21, figs. 31, 32) gave more details and better figures of cuticles from Bovey showing a tiny fragment of the lower surface. Her slide shows a large part of the lower surface, and the decurrent basilateral region of the upper (ventral) surface. Chandler (1957: 82) described more of the cuticle from Bovey.

The following pages are a record of *Sequoia couttsiae* cuticles from successive beds from the Lower Bagshot to Hamstead in the Middle Oligocene. In the first instance cuticles from the different horizons were described in detail individually as discovered at long intervals of time. On comparing the descriptions, figures, and specimens they were found to conform to the same distinctive pattern. A general description was therefore substituted for the series of descriptions and individual variations were noted. The chief differences were due to the age of the twigs, young tender cuticles having very thin cell walls and simpler stomata with rarely more than a single ring of auxiliary cells. The general description of both upper and lower cuticles of the species is followed by a catalogue of preparations from different localities used in the elucidation of the species. For convenience of comparison figures of preparations from different localities are given side by side. Many of the slides were difficult to prepare owing to the pyritized, rotted or abraded state of the material. Consequently some slides show mere scraps, the result of many attempts after many failures but in every case enough evidence has been accumulated to place the relationship beyond doubt. The frequent presence of fungal hyphae added to the difficulty of procuring good slides. Incidentally certain similarities between the cuticles of *Sequoia couttsiae* and *Araucarites* may be noted for when only very small scraps of cuticle are examined it is not always very easy at first sight to distinguish between them. In both large stomata occur with large thin guard cells and conspicuous pore. In both a ring, or a double ring of auxiliary cells placed end to end surround the stomata and show no clear

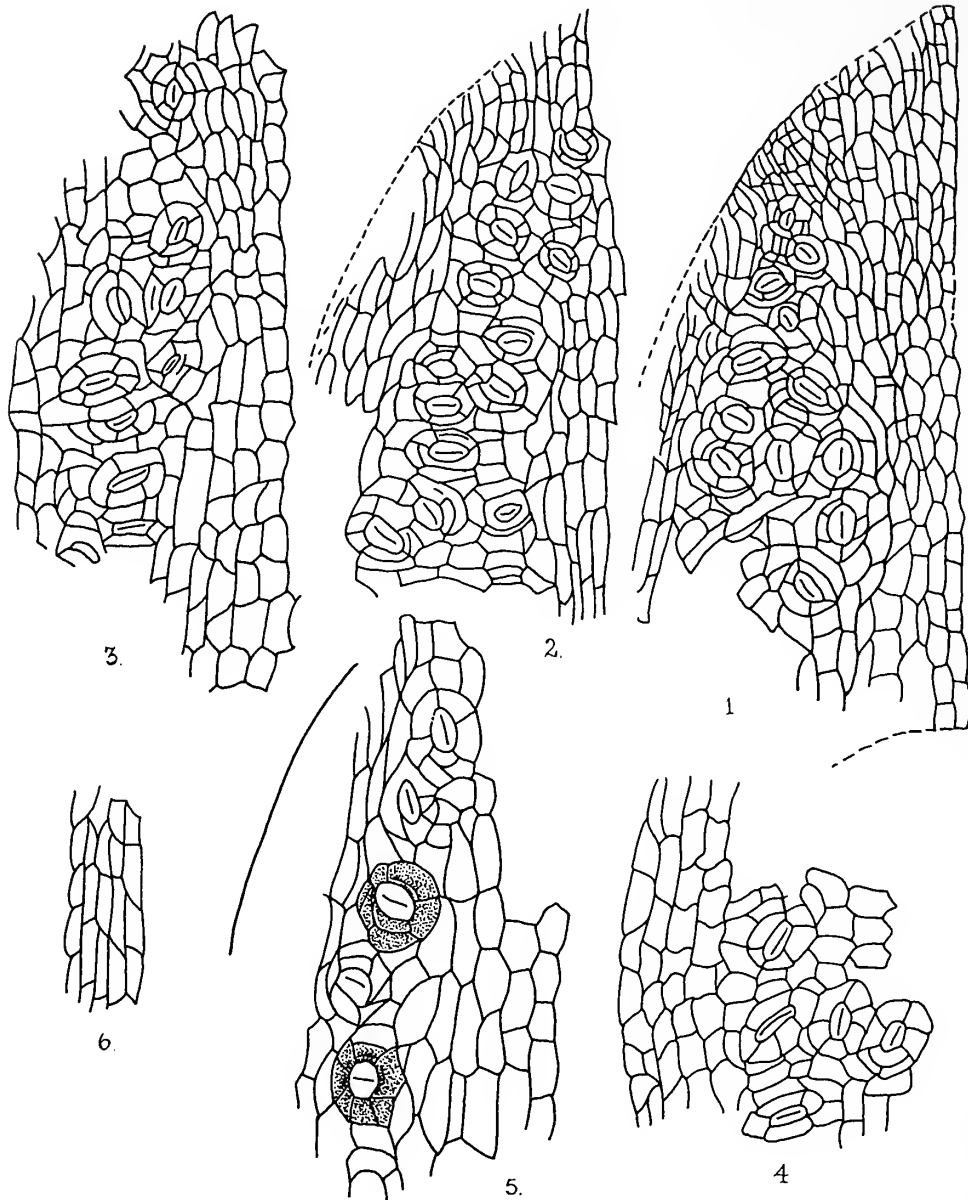


Fig. 1. *Sequoia couttsiae* Heer

1-3 Ventral cuticle, left half of leaf.

1. Based on V.40319 as in Pl. 2, fig. 3. Bovey.

2. Diagrammatic, based on V.40318a. Studland.

3. Specimen destroyed in remounting. Southbourne, above Boscombe Sands.

4, 5 Ventral cuticle, part of left side.

4. Specimen destroyed. Southbourne, above Boscombe Sands.

5. Near leaf tip, V.40324. Leafy lenticle, cliff base, Southbourne.

6. Ordinary epidermal cells of upper surface. Specimen destroyed. Bovey.

separation into polar and lateral cells. *Araucarites* cuticle is usually coarser and thicker-walled than that of *Sequoia couttsiae* and its stomata are larger. The outer pore of *Araucarites* is frequently broader relative to the length than that of *S. couttsiae*.

The terms hereafter used in describing the cuticles are borrowed from Professor Florin's great monograph on Conifer cuticles (1931).

The cuticles were first mounted for examination in glycerine for it was doubtful whether they would stand manipulation and dehydration. They were thus photographed. Later, when the glycerine began to evaporate, it was necessary to make an attempt at more permanent mounting. The medium used was usually Euparal, occasionally xylol. The treatment inevitably deteriorated some of the more tender specimens which have consequently altered a little in size and appearance since they were photographed. In a few cases only there was complete disintegration. Several fragments turned over during dehydration and therefore show the opposite surface to that figured, as can be confirmed by examining them from the back of the slide, but on the whole much evidence remains of what was originally portrayed.

DESCRIPTION. *Cuticle*: Stomata borne on both surfaces of the leaf. In general the structure is as follows:

(a) *Cuticle of the upper surface*. Plate 2, figs. 3-9; Pl. 3; Text-figs. 1; 2 (1-4, 7); 4 (1, 6-9); 5 (1-3, 6); 6 (2, 5).

(i) *Stomatal bands*. Two well marked stomatal bands occur one on each side of the midrib, they end below the apex and do not unite at the tip of the leaf in some specimens (Studland, Southbourne cliff base, Cliff End, Colwell, Bovey) while in others they may unite just below the apex (Cliff End, Hordle). They narrow above, and are continued below onto the decurrent lateral flanges of the leaf. The stomata are thickly scattered, variously oriented, many obliquely, but there are also many transverse and some longitudinal ones. There is a tendency for them to be arranged in short longitudinal rows which vary in number with the age and position of the twig. Towards the tip of the stomatal bands there may be only one stoma. A leaf from Studland (Pl. 2, fig. 9; Text-fig. 5 (2)) shows four stomata abreast at the broadest part of the band and two only abreast on the decurrent flange. In a fragment from Hamstead there appear to have been at least five stomata abreast at the broadest part of the leaf-base preserved (Pl. 3, figs. 11, 12). In Hordle material on the lateral decurrent flanges a single line of stomata occur, while in Colwell material there are two lines in the decurrent part of the leaf. A rather narrow leaf from the cliff base at Southbourne (Pl. 3, figs. 1-3; Text-figs. 5 (3); 6 (2)) shows two or three stomata abreast near the base of the free part of the leaf. A leaf from Lignite above the Boscombe Sands (Text-fig. 1 (3, 4)) shows one line of stomata near the tip, further down two or more, and at the base of the free part of the leaf (not shown in figure) four stomata abreast. Three or four abreast are also seen in some preparations from Hordle. On very young leaves from Hordle (Pl. 3, figs. 5, 6, 8) and Colwell (Pl. 3, figs. 9, 10) there appear to be only two or three stomata abreast in the broadest part of the leaves preserved but all are not complete at their bases.

(ii) *Ordinary epidermal cells*. Three bands of ordinary epidermal cells occur around the stomatal bands. A median band is usually broad and has many parallel rows of cells side by side towards the base of the leaf but narrows considerably above. It may almost vanish just below the apex, or in leaves where the two stomatal bands meet it vanishes altogether. In the narrow leaf from Southbourne cliff base already mentioned the median band is only about

twelve cells broad. In the leaf from the Lignite above the Boscombe Sands it is thirteen or fourteen cells broad at the extreme base narrowing to about ten cells at the middle of the free part of the leaf and to one or two only at the apex. In material from Cliff End the median band is from eighteen to about forty cells wide, and in a Colwell cuticle about seven cells broad at the leaf tip. A Hamstead fragment shows twenty-one rows of cells at the lowest part preserved. The marginal bands of ordinary epidermal cells are narrower and unite at the leaf apex, frequently they also unite there with the median band (seen in examples from cliff base, Southbourne, Cliff End). They are about seven or eight cells broad in a leaf from Studland and one in a leaf from Southbourne (cliff base), about four or five cells broad in one from the Lignite above the Boscombe Sands and about ten cells broad in a leaf from Cliff End. At the leaf tip the marginal cells tend to diverge, also along the margin of the leaf the cells of the outermost layer diverge at an acute angle (Lignite above Boscombe Sands, Southbourne). On the whole the cells of the marginal bands tend to be broader than those of the median band. The epidermal cells within these three bands are, except at the margin as stated, longitudinally elongate and aligned, frequently parallel-sided, often with rectangular ends but sometimes rounded or angled at the extremities. Near the leaf tip they may be narrowed and rounded at the extremities. Normally the walls are straight but occasionally very slightly sinuous especially at the angles (Lignite, Southbourne) or at the base of the leaf (Cliff End, Hordle) particularly in young leaves. Among the long narrow cells some shorter and more or less equiaxial ones may occur (Studland, Cliff End). Epidermal cells of the median band at Studland measure about 0.01 mm. in breadth. In a Hamstead cuticle they are 0.01 mm. broad and 0.01 to 0.03 mm. long. Some of the leaves examined (from Studland, cliff base Southbourne, Lignite Southbourne, Cliff End) show a fine granulation or reticulation all over the surface. Younger less dense cuticles appear to have no trace of reticulation and in these the cell walls are very thin (Hordle, Hamstead). In some of the older leaves from Southbourne cliff base the cuticles have become very thick and the cells have swollen convex outlines. Over the midrib in young leaves from Hordle they appear to be ornamented with a few scattered irregular papillae variable both in size and shape.

Ordinary epidermal cells are also interspersed among the stomata within the stomatal bands, a few of these are longitudinally elongate and aligned especially between adjacent longitudinal lines of stomata but the majority are irregular in shape and size, often equiaxial, frequently transversely elongate and aligned especially between neighbouring stomata of the same row.

(iii) *Stomata*. Stomata occasionally share auxiliary cells (Cliff End, Studland, Hordle) (cf. Text-fig. 2 (7)) but more frequently contiguous stomata have a complete set of independent auxiliary cells each, but without intervening ordinary epidermal cells. The stomatal pore is a broad or narrow oval, or may be sub-quadrangular, or somewhat curved. It is usually broad and rather larger on the decurrent flanges. It occupies about one-third of the length of the whole stomatal apparatus, is normally about 0.02 or 0.03 mm. long and about 0.01 mm. broad. A Hamstead cuticle shows stomata 0.02 to 0.04 mm. and in older leaves at Hordle they may be 0.04 mm. long. Guard cells are thin and clear with a conspicuous slit between them. There are four to six auxiliary cells arranged end to end in a ring around the outer pore. The ring may be double, or partly double (by longitudinal subdivision of the cells?) owing to the presence of two concentric cells (Pl. 2, fig. 9; Pl. 3, figs. 2, 3; Text-figs. 1 (1, 2); 4 (1, 6, 8, 9). Sometimes they are thickened along their inner edges, and occasionally also along their outer

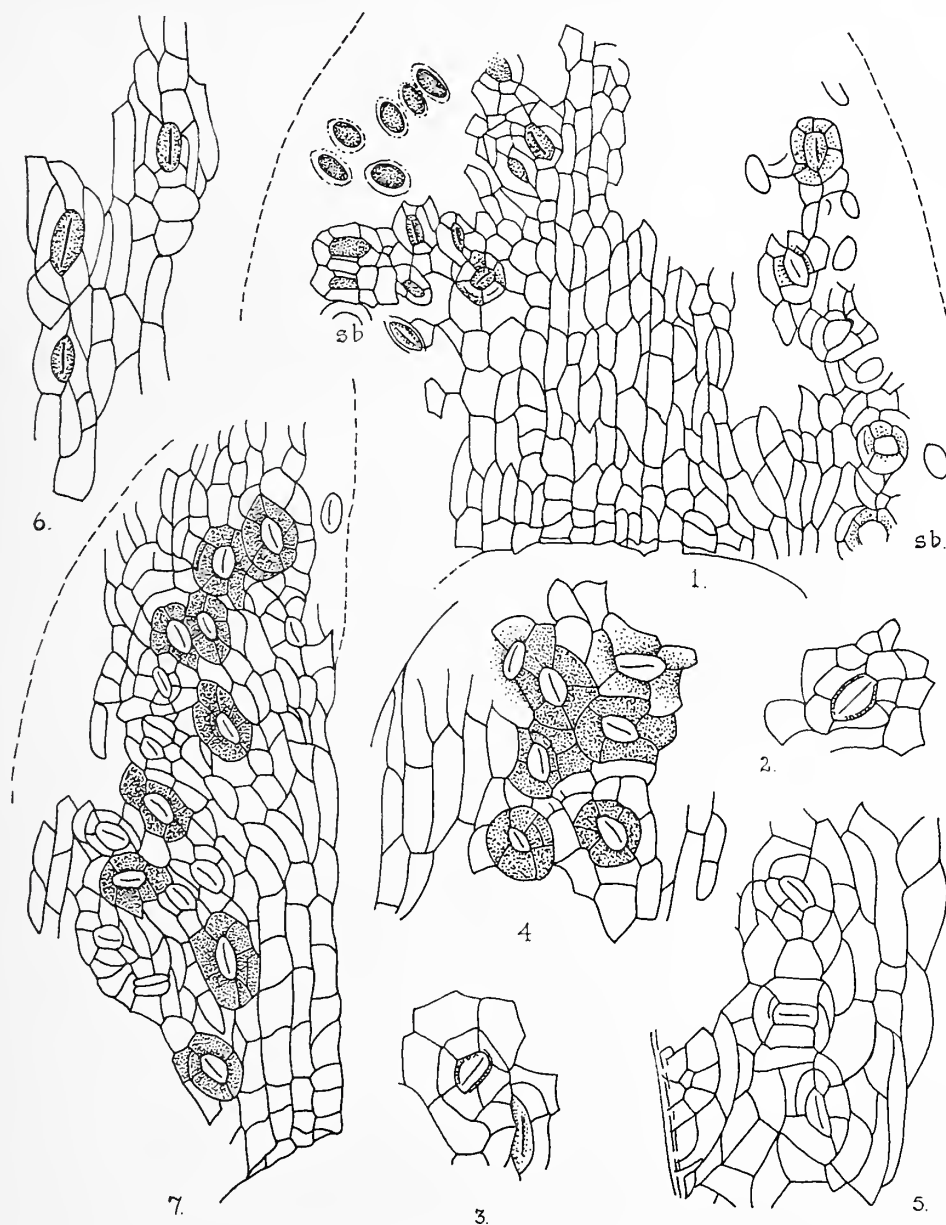


Fig. 2. *Sequoia couttsiae* Heer

1. Diagram of part of the ventral cuticle of a leaf (tip and decurrent base missing) showing distribution of stomata in the two bands (*sb*) and between the bands the ordinary epidermal cell band over the midrib. V.40349. Hamstead.
- 2, 3. Details of two stomata from a ventral cuticle. V.40349. Hamstead.
4. Part of a ventral cuticle of a young leaf, left stomatal band, leaf margin on left. From the leaf shown in Pl. 2, figs. 5, 6. Cliff End, Mudeford.
5. Fragment of the decurrent part of a dorsal cuticle, leaf margin to left, midrib to right. Based on V.40333. Cliff End, Mudeford.
6. Details of three stomata in a dorsal cuticle. Cliff End, Mudeford.
7. Diagrammatic drawing of ventral cuticle of young leaf, to left of midrib. Margin to left, decurrent flange broken away. Left stomatal band occupying most of the surface. Hordle.

edges. In young leaves (Cliff End, Hordle, Colwell) there is more rarely a second ring of concentric cells (Pl. 2, figs. 6, 8; Pl. 3, figs. 5, 6). In older leaves the cells vary in form and size so that the rings of cells may appear rather irregular. Auxiliary cells are scarcely more cuticularized than the surrounding epidermal cells except along their edges as described.

In the coarseness of the cells and thickness of the cuticle the Studland fragments are comparable with many Bovey specimens. They are more mature than the Colwell and than the Hordle preparations figured. Length of a leaf from Studland (ventral surface) including decurrent flanges about 1.9 mm.; maximum breadth about 0.6 mm.

(b) *Cuticle of the lower surface.* Plate 1, figs. 27-29; Pl. 2, figs. 1, 2; Text-figs. 2 (5, 6); 3 (1-10); 4 (2-5, 10-12); 5 (1, 3-5); 6 (1-4, 6).

This surface tends on the whole to be denser than that of the upper.

(i) *Stomatal bands.* The lower surface also has two stomatal bands which are broader and usually less sharply defined than those of the upper surface; also they do not extend so far towards the leaf tip as those on the upper surface, and they are very narrow at the upper end but broaden considerably lower down. At the extreme decurrent base of the leaf they may be reduced to a marginal line or lines, usually of oblique stomata, flanking a broad triangular area of epidermal cells (Text-figs. 5 (1, 4); 6 (2, 4)). In a specimen from the Lignite above the Boscombe Sands, Southbourne, there are two or three lines of oblique stomata in this area, but in a specimen from the cliff base at Southbourne there is a single line only. The stomata are sparsely scattered as compared with the upper surface. Near the base of the free part of the leaf there are nine or ten sub-parallel lines in each band in a cuticle from Cliff End, the bands extending only for about half the length of the free tip. The stomata frequently tend to be aligned in short longitudinal, often interrupted, rows (Pl. 1, figs. 28, 29; Pl. 2, fig. 2; Text-fig. 3 (3)). The alignment of individual stomata is commonly longitudinal, frequently also oblique, and sometimes transverse. In material from Cliff End longitudinal stomata predominate in the lower half of the free leaf tip where they are long and narrow. Higher up the leaf transverse stomata with broader pores are not uncommon.

(ii) *Ordinary epidermal cells.* The ordinary epidermal cells in the stomatal bands are frequently elongate sub-parallel sided and aligned longitudinally. Several rows may separate the longitudinal lines of stomata. The ends of these cells may be rectangular, angular (cells above and below alternating) or oblique ended. On the whole the epidermal cells of the stomatal bands are very similar to those outside them. Sometimes, however, they may be shorter or equiaxial and sometimes transversely elongate especially between stomata in the same row. But they also may be quite irregular in shape. The marginal epidermal cell bands unite with the median to form a long, triangular, stomata-free area occupying the whole breadth of the leaf tip (Pl. 3, fig. 1; Text-figs. 5 (1, 3-5); 6 (2)). In a leaf from Hordle about 2.2 mm. long and 0.9 mm. broad this stomata-free tip is 0.6 mm. long. The cell-walls are for the most part smooth but at the lower extremity of the decurrent base they tend to become irregular in outline with somewhat sinuous walls. Occasionally slight sinuosity occurs higher up the leaf. Coarse sinuosities are seen in the cell walls towards the base of the leaf in the median area in cuticle from the cliff base, Southbourne and are especially conspicuous in some of the transverse cell walls. Some cells in cuticle from the Lignite above the Boscombe Sands, Southbourne show fine reticulations or granulations, or small papillae about 0.016 mm. in diameter or less. Cuticle from the cliff base, Southbourne shows irregular shaped papillae about 0.03 mm. in diameter.

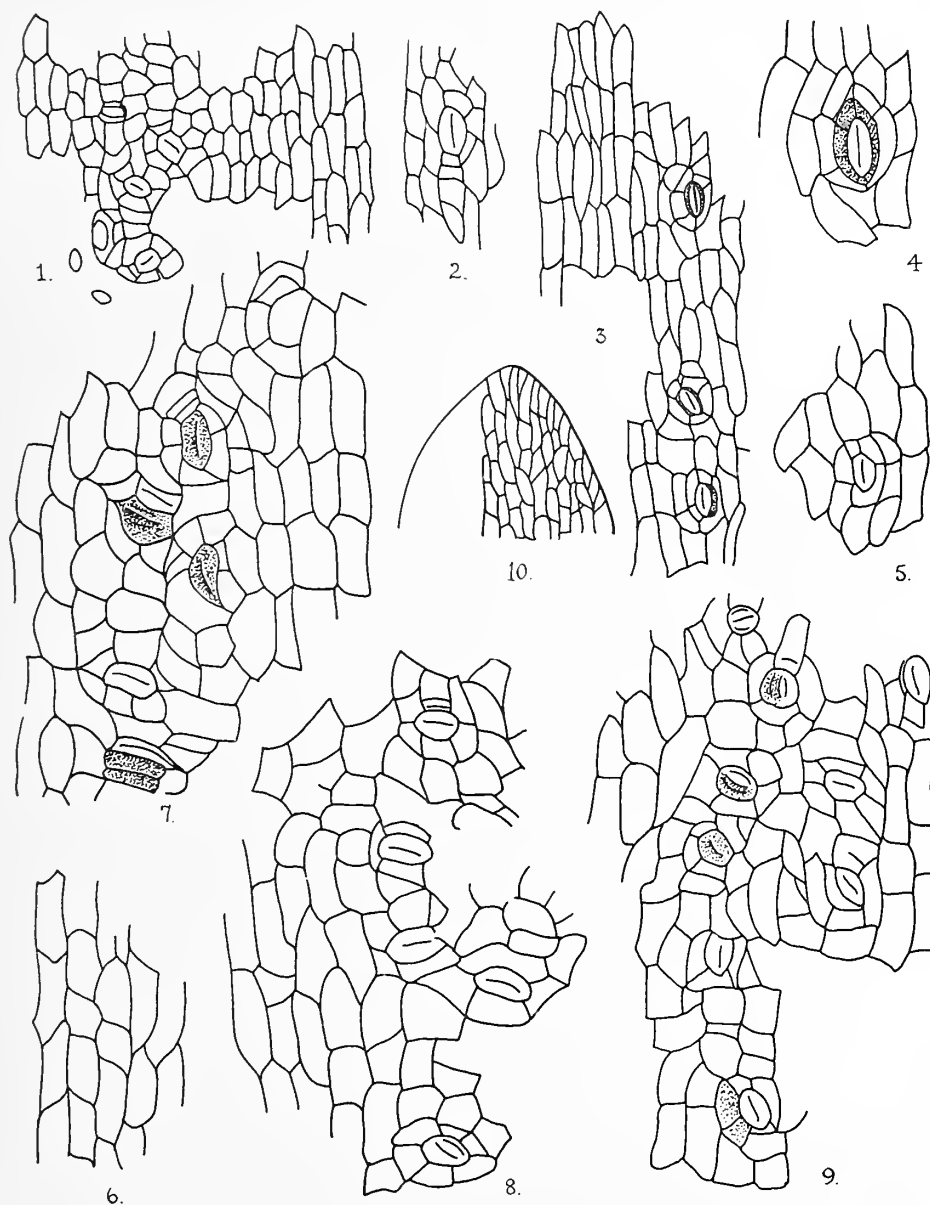


Fig. 3. *Sequoia couttsiae* Heer

1. Fragment of dorsal cuticle showing part of a stomatal band, margin to right, midrib to left. Bovey.
2. Dorsal stoma. Bovey.
3. Part of a stomatal band, dorsal, midrib on left. Studland.
- 4, 5. Details of two stomata of dorsal cuticle. Studland.
6. Epidermal cells, dorsal cuticle. Studland.
7. Part of dorsal cuticle, near the upper end of one stomatal band, margin on left, midrib on right. Based on V.40319 the specimen of which the ventral cuticle is shown in Pl. 2, fig. 3. Bovey.
8. Part of dorsal cuticle, stomatal band, midrib on left. V.40234.
9. The same, near leaf base.
10. Dorsal cuticle, epidermal cells of leaf tip. Figs. 8-10. Leafy lenticle, cliff base, Southbourne.
The originals of figs. 1-6, 8-10 cannot now be recognized.

In cuticle from Studland the reticulation producing a granular appearance is particularly well seen in partially decayed fragments infested with fungal hyphae. Cliff End cuticle shows a few scattered circular papillae chiefly on the decurrent basal part of the leaf and near the margin, otherwise it appears unthickened and unornamented. In somewhat older leaves rows of small obscure pits are seen on some of the cells. The median band of epidermal cells in leaves from the cliff base, Southbourne is at least thirty cells wide where broadest near the base of the free

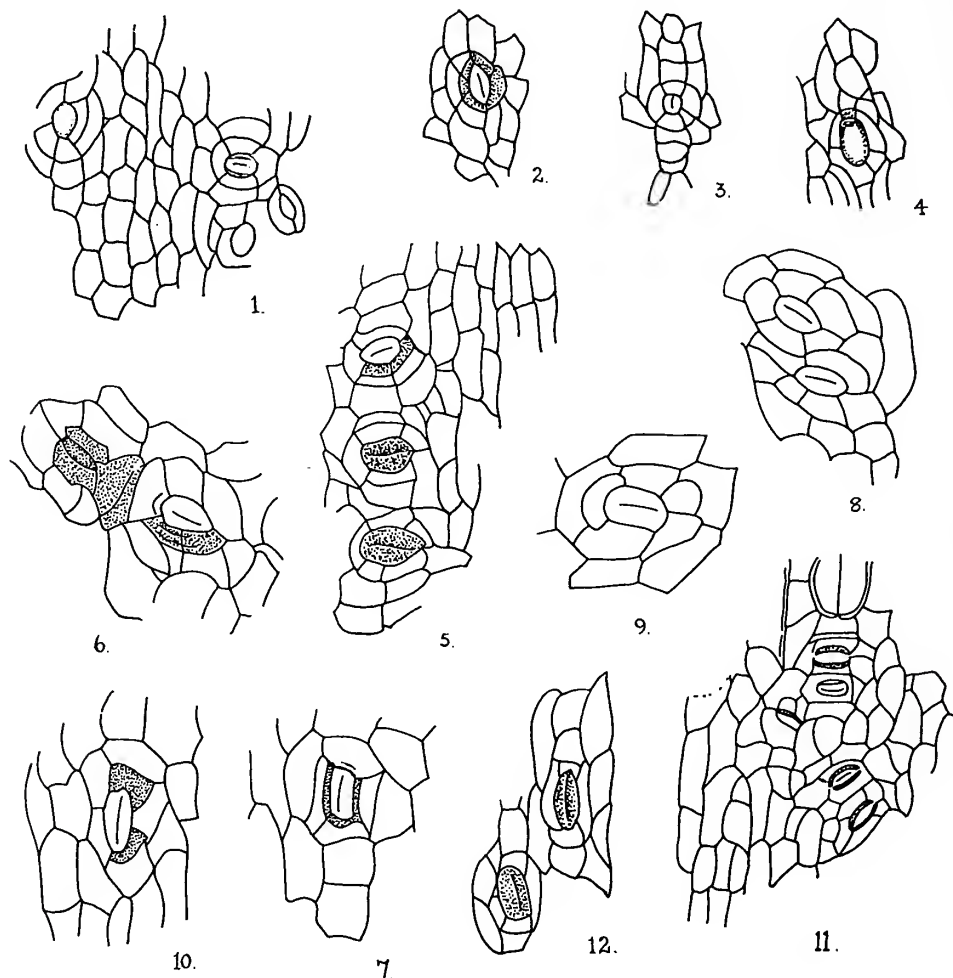


Fig. 4. *Sequoia couttsiae* Heer

1. A few stomata of ventral cuticle near the tip of a fairly mature leaf. Hordle. V.40343.
- 2-4. Typical stomata of lower cuticle. Hordle.
5. Less typical transversely oriented stomata of lower cuticle. Hordle.
6. Details of two stomata on the ventral surface of a broad leaf. V.40326.
7. Detail of a stoma on the ventral surface of a broad leaf. V.40326.
8. Detail of stomata of a ventral cuticle near the decurrent flanges. V.40327.
9. Stoma on a decurrent ventral flange. V. 40327.
10. A dorsal stoma from the decurrent basal part of the leaf. V.40327.
11. Detail of stomata on the dorsal cuticle. V.40327.
12. Detail of dorsal stomata. Cliff End, Mudford.

Figs. 6-11 from Lignite above Boscombe Sands, Southbourne.

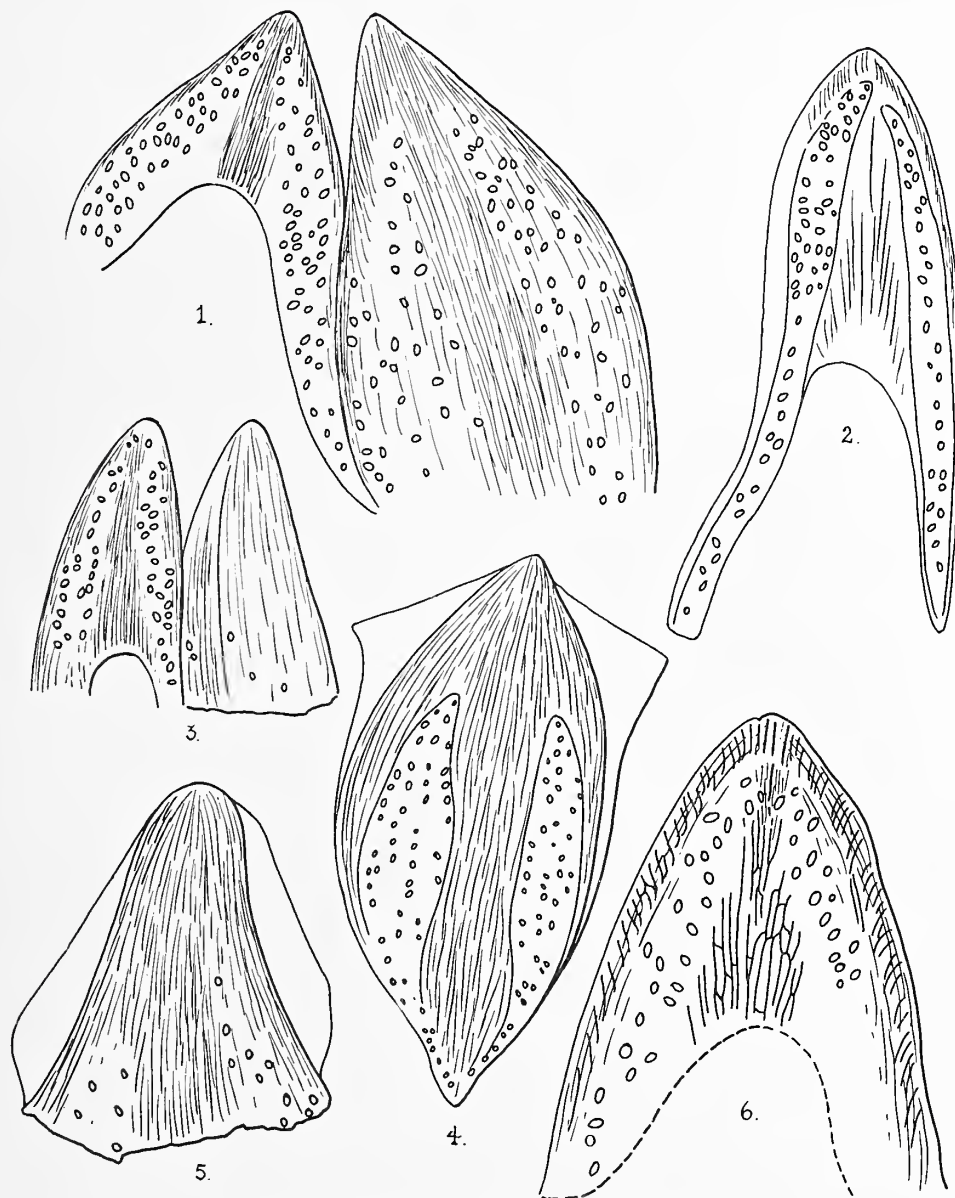


Fig. 5. *Sequoia couttsiae* Heer (Diagrams)

1. Distribution of stomata on ventral and dorsal surfaces of a falcate leaf. Breadth of leaf about 1 mm.; length of upper surface, 0.7 mm. at middle. Maximum breadth of lower surface about 1.4 mm.; length about 2 mm. as preserved. Bovey.
2. Ventral cuticle of a long narrow leaf showing long decurrent flanges. Reconstruction based on V.40318a as if the cuticle were straightened out. Studland.
3. Leaf tip, both surfaces. Based on V.40324. Leafy lenticle, cliff base, Southbourne.
4. Cuticle with ventral side split medianly the whole then opened out. To show distribution of stomata on dorsal surface including decurrent base. Based on various fragments. Hordle.
5. Cuticle similarly opened to show tip of dorsal surface and beginning of the two stomatal bands. Studland.
6. Ventral cuticle with incomplete decurrent flanges. Cliff End, Mudeford.

part of the leaf. It is twenty-four rows wide at about the middle of the leaf in a cuticle from the cliff top, Southbourne. The median band in leaves from Cliff End is formed of from eighteen to forty cells whereas the marginal bands of epidermal cells are only about ten cells wide. Cell measurements near the leaf tip in cuticle from Studland and from the cliff base, Southbourne are as follows: length about 0.02 to 0.05 mm.; breadth, 0.01 to 0.02 mm. Some leaves from the cliff base, Southbourne show occasional irregular dark inclusions usually not more than one per cell. Their outlines are not easy to distinguish, but they may be crystalline bodies.

(iii) *The stomata.* The stomatal pore is broad or narrow oval or oblong, or it may be narrowly quadrangular; the pore may be about 0.02 to 0.03 mm. long, the slit between the guard cell is distinct and the cells themselves clear and colourless. The auxiliary cells vary from four to six arranged in a ring end to end; sometimes there is a double ring of concentric cells, or there may be a double ring in part only (Pl. 1, figs. 27-29; Pl. 2, fig. 2; Text-figs. 2 (5, 6); 3 (1-5, 7, 9); 4 (2-5, 10-12)). Sometimes the cells of the two rings are so narrow and so exactly equal in size as to suggest their formation by subdivision of what was originally one cell. Occasionally (Cliff End, Pl. 2, fig. 2) there is rather obscure differentiation into polar and lateral auxiliary cells. Sometimes an auxiliary cell merges into an adjacent row of epidermal cells from which it can scarcely be distinguished (Cliff End, Studland, cliff base Southbourne). The auxiliary cells may, or may not, be distinctly more cuticularized than adjacent cells. In some specimens there is a ring of thickening (or a pair of longitudinal scales) where the auxiliaries abut on the guard cells. Sometimes a ring of thickening round the edge of the auxiliaries outlines the stomata (Cliff End). On the whole there is a tendency for stomata to be smaller with narrower auxiliary cells than on the upper leaf surface. Occasionally adjacent stomata occur which have auxiliary cells in common; more often auxiliary cells of adjacent stomata are merely contiguous, but most often of all the stomata are separated by ordinary epidermal cells.

1. *From the laminated clay above the Sandrock, Studland, Dorset.*

V.40317 Figured Pl. 1, fig. 1. A twig with spirally arranged scale-like falcate and decurrent leaves angled along the middle of the dorsal surface, acutely pointed, sometimes rather spreading.

V.40318 Figured Pl. 1, fig. 27; Pl. 2, fig. 9; Text-figs. 1 (2), 5 (2). Three slides prepared from the twig shown in Pl. 1, fig. 2.

V.40318a shows a ventral cuticle (Pl. 2, fig. 9; Text-fig. 1 (2)) with decurrent flanges, one torn and lying athwart the other, and two or three fragments of the dorsal cuticle from the same leaf (Pl. 1, fig. 27). The figured fragment was slightly damaged in remounting.

V.40318b shows a longitudinal strip of dorsal cuticle near the leaf tip, the upper end of one stomatal band can be seen.

V.40318c shows part of a ventral cuticle and a strip of dorsal cuticle near the decurrent base. It extends up to and includes part of one stomatal band.

A third twig much fungus-infested was destroyed in an attempt to prepare cuticle which was thin and young. Text-figs. 3 (3-6) were based on fragments no longer distinguishable.

All the above in blocks of matrix. *E. St. John Burton Coll.*

2. *From Bovey Tracey, Devon.* Plate 1, fig. 28; Pl. 2, figs. 3, 4; Text-figs. 1 (1, 6); 3 (1, 2, 7); 5 (1).

General Remarks: Previously published figures were of such small fragments as to be insufficient to show the essential characters of different parts of the leaf. The characters of upper and lower cuticles were described by Chandler (1957). The features of the decurrent base are now distinguished for the first time. Bandulska stated (1923: 258) that the epidermal cells

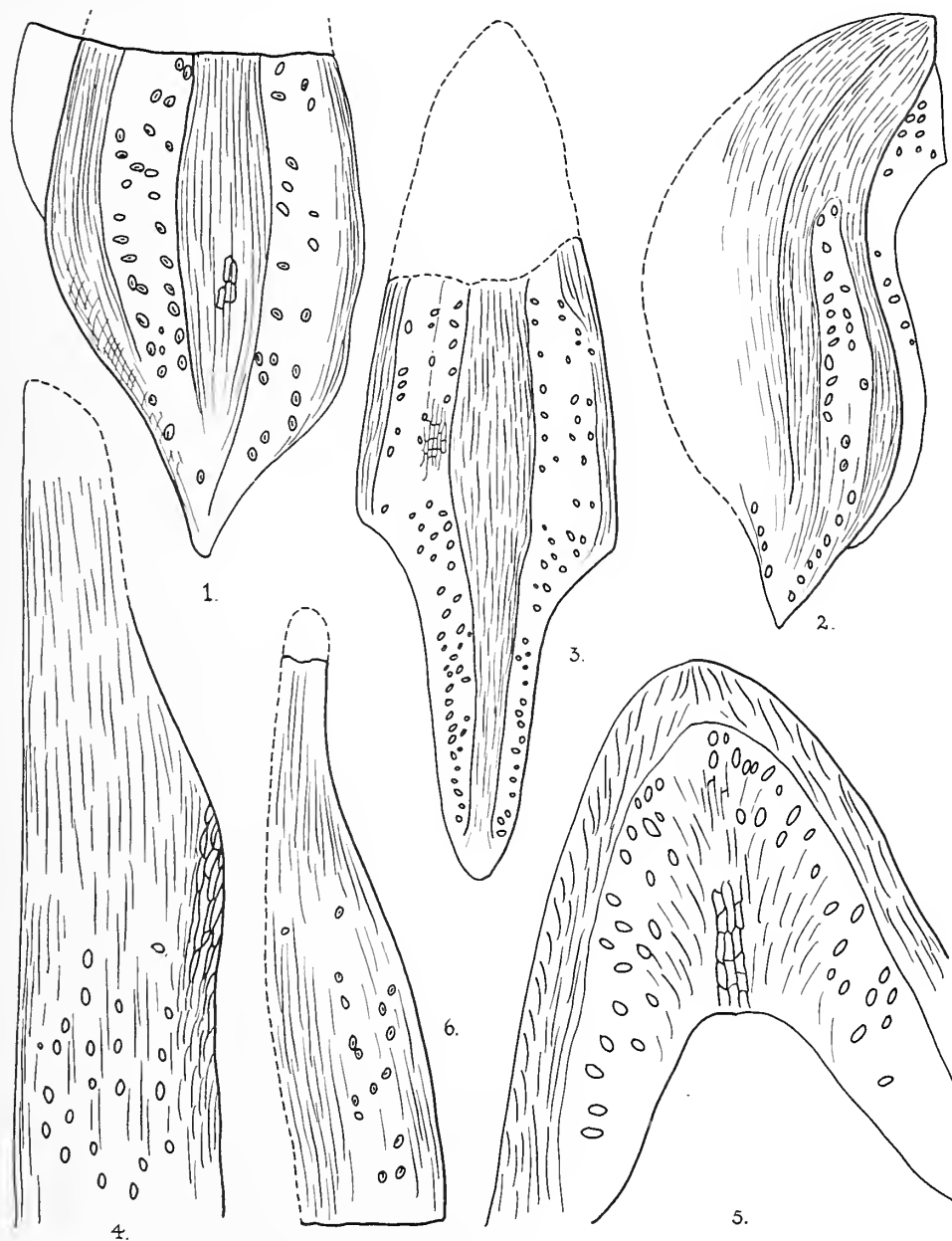


Fig. 6. *Sequoia couttsiae* Heer (Diagrams)

1. Decurrent basal part of a leaf showing distribution of stomata on the dorsal cuticle. Based on V.40324. Leafy lenticle, cliff base, Southbourne.
2. The distribution of stomata, dorsal cuticle on the right of the midrib and on the ventral cuticle opened out from the midrib on right side of leaf. Based on a distorted leaf in V.40324. Leafy lenticle, cliff base, Southbourne.
3. Distribution of stomata, on a long decurrent leaf base, dorsal cuticle, and on the lower free part of the leaf. Cliff End, Mudeford.
4. The same on the upper free part of a leaf, dorsal cuticle shown to right of midrib. Cliff End, Mudeford.
5. The same on the ventral cuticle of a young leaf. Hordle.
6. The same, dorsal cuticle to right of midrib, upper free part of a leaf. Studland.

outside the stomatal bands were irregular both in shape and direction and relatively wider in proportion to their length than those between the linear stomatal series, but further evidence indicates that the majority are elongate parallel to the midrib and are very long and narrow.

The cuticle in Pl. 2, fig. 3 was prepared from a somewhat stouter twig with broader leaves than that from Studland but its characters are essentially the same. Slides from other twigs with narrower leaves closely agree with the Studland preparations.

- V.40319 Figured Pl. 2, figs. 3, 4; Text-figs. 1 (1), 3 (7). Cuticles of several leaves. Fig. 3 shows the ventral cuticle of the free leaf tip and, lying athwart it, part of the ventral cuticle of the decurrent base of a second leaf. In remounting the specimens this latter separated and is now to be seen in a different place on the slide. Fig. 4 is the ventral free tip of another leaf, and has suffered slight damage in remounting. Text-fig. 1 (1) is based on this slide, also Text-fig. 3 (7), but this fragment of dorsal cuticle was also damaged in remounting. It came from the leaf which yielded the ventral cuticle in Pl. 2, fig. 3. There are also various other fragments of dorsal cuticle from lower down the leaves and some, both dorsal and ventral, are from the decurrent basal region. The original dorsal cuticle fragment seen in Pl. 1, fig. 28 disintegrated and is unrecognizable. *Reid Coll.*
- V.15864 Figured Bandulska, 1923, pl. 21, figs. 31-32. Bandulska's figures show only a small fragment of dorsal cuticle but the slide shows a piece of dorsal cuticle with a large part of one stomatal band, and the decurrent basal part of the ventral cuticle from one side of this leaf. V.42041-43 fragments of dorsal and ventral cuticle labelled 'from Mrs. Reid's material'.
- V.15456 Fragments of dorsal and ventral cuticle.
All the above *H. Bandulska Coll.*
- V.40320 Two fragments of dorsal cuticle and one of ventral. The latter shows the free part of the leaf and decurrent basal marginal part.
- V.40321 Dorsal and ventral cuticle of a narrow leaf like some of those from Studland. The ventral cuticle has lost the decurrent basal part on one side and on the other it is obscured by folding. The cuticle is infested by a microthyriaceous fungus of the *Asterinella* type identified by W. N. Edwards.

3. *From Bournemouth Marine and succeeding Beds (Auversian?)*.

The specimens are from three main horizons.

(a) From the cliff base at Southbourne in a much compressed leafy lenticle. (This horizon is well below the Boscombe Sands.) Also from another bed below the Boscombe Sands and from the base of the Sands themselves? in a carbonaceous lenticle.

(b) From Lignite immediately above the Boscombe Sands, at Southbourne, cliff top.

(c) From Cliff End, near Mudeford in the Highcliff Sands.

3(a). *From the cliff base, Southbourne, Hampshire.*

Cuticles were prepared from some of the numerous twig tips all of which are much compressed. The leaves are scale-like and spirally arranged, pointed at the apex, concave on the upper surface, angled on the dorsal surface, decurrent below, falcate in the free upper part, or sometimes adpressed. (Pl. 1, figs. 3, 4). No cones or seeds have yet been found. The twigs are rather stouter and older than those from Studland, Cliff End, Hordle, or Hamstead with stouter, denser cuticles, badly fungus-infested.

V.40322, V.42350 Figured Pl. 1, figs. 3, 4. Two twigs.

V.40323 Figured Pl. 3, figs. 2, 3. Several cuticle fragments. That in fig. 2 shows the free tip of a long narrow leaf, ventral and dorsal cuticles. The dorsal is preserved from the tip down to the upper end of a stomatal band on one side only of the midrib on the slide itself. Only the ventral cuticle is really shown in the figure. Also other dorsal cuticles, and part of a decurrent ventral base on the same slide from the same twig. Some fragments are probably from the same leaf.

- V.40324** Figured Pl. 3, fig. 1; Pl. 2, fig. 1; Text-fig. 1 (5) (based on this slide); Text-figs. 3 (8); 6 (1, 2) (based on distorted leaf). Several cuticle fragments. Dorsal and ventral cuticle without the decurrent basal part (Pl. 3, fig. 1; cf. also Text-fig. 1 (5)). Dorsal cuticle decurrent basal part which has split irregularly longitudinally since the photograph in Pl. 2, fig. 1; cf. also Text-fig. 6 (1). A distorted cuticle showing the whole length of the dorsal surface, and one of its stomatal bands (the other obscured by folding cf. Text-fig. 3 (8) and part of the ventral cuticle (cf. Text-fig. 6 (2)) also several other fragments chiefly of dorsal cuticle.
- V.42338** Numerous twigs.
All the above from a leafy lenticle, cliff base, Southbourne well below the Boscombe Sands, west of the ladder steps to the shore (now gone).
A few small fragments of twig from the Bournemouth Marine Sands, cliff base, Southbourne, east of the ladder steps. (Decayed),
A few twig fragments from a carbonaceous lenticle (base of the Boscombe Sands ?) about 8 ft. above the hard, dark Bournemouth Marine Sands at the cliff foot, Southbourne, east of the ladder steps. (Decayed.)

3(b). *From Lignite above the Boscombe Sands, Southbourne, Hampshire.*

Twigs of *Sequoia couttsiae* were among the most abundant plant remains at this horizon. Not only are they much pyritized but the cuticle is usually decayed or worn away. Nevertheless the form of the spirally arranged leaves and the general arrangement of the stomata are clear. The leaves are falcate, sometimes scale-like and adpressed, decurrent below, pointed above, angled dorsally, concave ventrally (Pl. 1, figs. 5-8). One young twig yielded very thin cuticle, another older twig yielded very dense opaque cuticle. Scraps were difficult to obtain and badly fungus-infested. Twigs are coarse on the whole. No cones or seeds have been found.

- V.40325** Figured Pl. 1, figs. 5-9. Four twigs. A detached leaf (fig. 9) probably this species, destroyed in an attempt to prepare cuticle.
- V.40326** See Text-fig. 4 (6, 7). Several small cuticle fragments on some of which drawings showing details of stomata were based. Although scraps only were obtained they are in better condition than most preparations from this horizon and less concealed by fungal hyphae in the cells.
One fragment (left-hand side of ventral cuticle of a young leaf) shows a stomatal band extending to the leaf tip (this cuticle has split longitudinally). Another is a similar but broader fragment.
The foliage was young so there are comparatively few stomata. There is also a good fragment of dorsal cuticle and several smaller pieces.
- V.40327** See Text-fig. 4 (8-11). Several small fragments of young cuticle. Some from the dorsal surface or possibly from the ventral surface near the junction of the free tip and decurrent flange (cf. Text-fig. 4 (8)). Some from the decurrent ventral flange showing large broad stomata (cf. Text-fig. 4 (9)), some from the decurrent basal part of the dorsal surface (cf. Text-fig. 4 (10) stoma to right of midrib at extreme base) and a large piece of cuticle covering most of the length of the dorsal surface and showing the right stomatal band on the free upper part of the leaf (cf. Text-fig. 4 (11)). There are also several other fragments from both surfaces showing good stomata.
- V.40328** Poorly preserved fungus-infested cuticle. It shows the dorsal cuticle of one short leaf (more or less perfect), and the dorsal cuticle of the free tip of another.
- V.40329** Made from an older twig shows a dense cuticle, dorsal surface, with stomatal bands, and a second large piece near the decurrent leaf base. There is also part of one decurrent ventral fragment. These cuticles show dense thickening or thick scales partly outlining the stomata at the circumference of the auxiliary cells.
- V.40330** A much fungus-infested leaf, ventral and dorsal cuticles. The ventral fragment includes the decurrent flange and shows the character and distribution of the stomata although it is in poor condition. The dorsal cuticle is from a long slender stomatal free leaf tip, the cells are heavily reticulated.
Note: Specimens on which Text-fig. 1 (3, 4) were based unfortunately disintegrated on attempting to mount them permanently.
- V.42339-40** Numerous more or less decayed twigs varying in size and age.

3(c). *From Cliff End, Mudeford, Hampshire (Highcliff Sands).*

Small compressed twigs, seeds and a cone-scale from this site agree with the corresponding organs from Bovey Tracey, Hordle, Colwell and Hamstead. The twigs are slender, with spirally arranged, falcate decurrent leaves (Pl. 1, figs. 10, 11) angled medianly on the dorsal surface. The seeds are flat, oval or oblong in outline, laterally winged, longitudinally striate, often with curved body, having a slight apical mucro. Wings variable in width, that on the concave margin of the curved seeds being wider than that on the convex margin (Pl. 4, figs. 9, 10). Hilar scar large, basiventral. Testa thin and hard, formed of equiaxial cells (or pits?) lying between the striae, so aligned over the body of the seed as to follow its curvature. Length of two seeds, 3 and 3.7 mm. respectively; breadth, 1.7 and 2.4 mm. The cone-scale appears to be the apical, terminal scale, as it is three-sided with conical escutcheon (Pl. 4, figs. 6, 7). This specimen has since decayed. Cuticle rather poorly preserved and fungus-infested.

V.40331, V.42351 Figured Pl. 1, figs. 10, 11. Two twigs.

V.40332, V.40338 Figured Pl. 4, figs. 9, 10. Two seeds.

V.42341-42 Eight seeds and numerous twigs.

V.40333 Figured Pl. 2, figs. 5, 6. Several fragments. Ventral cuticle of the free leaf tip with part of the decurrent basal region (figs. 5, 6). Ventral cuticle of another leaf, showing one stomatal band just above the decurrent leaf base. Fragments of dorsal cuticle, showing the decurrent basal region.

V.40334 Figured Pl. 2, figs. 2, 7, 8. Several small fragments of cuticle. The decurrent basal part of the ventral cuticle of a leaf is shown in Pl. 2, figs. 7, 8 and the main part of a stomatal band of the dorsal surface of the same leaf (the two still attached) in Pl. 2, fig. 2. Several small fragments of dorsal cuticle, one showing the free tip and the beginning of the stomatal bands below it.

V.40335 Several leaf cuticles still in the position of growth on a twig. The decurrent bases are clearly seen with thickening outlining the stomata of the dorsal surface.

V.40336 Very thin dorsal cuticle from a young twig, mainly from decurrent leaf base. Fungus-infested.

V.40337 Good fragment of cuticle from the decurrent leaf base.

4. *From Upper Hengistbury Beds, Hengistbury Head, Hampshire.*

V.40339 Figured Pl. 1, figs. 12, 13. Two twig fragments. Marine clays between 22 and 40 ft. above basal pebble bed, Upper Hengistbury Beds, south-east face, Hengistbury Head. *D. Curry Coll.*

The twig with somewhat incurved leaf tips represented in Pl. 1, fig. 14 was destroyed in an attempt to prepare cuticle.

Dark sands, cliff base, west end of Hengistbury Head.

5. *From the Lower Headon of Hordle, Hampshire.*

The species has been described already from twigs, cones, cone-scales and seeds (see p. 21). Additional figures are here given (Pl. 1, figs. 15-21, 29; Pl. 3, figs. 4-8; Pl. 4, figs. 5, 11-18; Text-figs. 2 (7); 4 (1-5); 5 (4); 6 (5)). The slides catalogued below confirm that the species is *Sequoia couttsiae*. Some of the cuticle was prepared from very young twigs and is thin. Most of the stomata in such preparations have a single row of auxiliary cells. Fragments of older denser cuticle have also been examined. Fungal hyphae and their fruiting organs are common in this species and often obscure the cells considerably. Specimens are much pyritized but not so heavily as in the Upper Headon Beds or the beds above the Boscombe Sands at Southbourne. On account of the condition all cuticle preparations are poor and mostly fragmentary. The best were obtained from very young leaves. Few twigs were as well developed and as well preserved as the Bovey material.

- V.20012 Figured Pl. 4, fig. 5. Carbonaceous cone.
 V.20014 Figured Pl. 4, figs. 11-18. Eight seeds.
 V.20015, V.40341 Figured Pl. 1, figs. 15-21. Seven twigs.
 V.40340 Figured Pl. 3, figs. 4-6. A young leaf tip, ventral cuticle. Also a second similar specimen.
 V.40342 Figured Pl. 3, fig. 7. The right-hand side of the ventral cuticle of a fungus-infested but more mature leaf.
 V.40343 Figured Pl. 1, fig. 29; Pl. 3, fig. 8. Several fragments of the dorsal cuticle of a leaf one of which is seen in fig. 29. Also a fragment of ventral cuticle on which Text-fig. 4 (1) is based, see also Pl. 3, fig. 8. The fragments on which Text-figs. 2 (7); 4 (2-5) are based cannot now be recognized.
 V.40344 A poor preparation of a dorsal cuticle showing the general distribution of the stomatal bands on the free and decurrent parts of the leaf. Ventral cuticle is seen opening out on each side of the free tip (cf. with Text-fig. 5 (4)).

6. *From the Upper Headon of Colwell Bay, Isle of Wight.*

With much difficulty a few fragments of cuticle were obtained from twigs found at this horizon where the presence of the species is confirmed by the occurrence also of cone-scales and seeds (Pl. 4, figs. 8, 19-27).

The young twigs with typical imbricate scale-like leaves are usually so completely impregnated with fine soft pyrites that cuticle preparation is out of the question. But one fragment yielded the readily recognizable cuticle of the ventral surface of a leaf (Pl. 3, figs. 9, 10), and from another twig, tiny scraps of extremely thin young cuticle of the dorsal surface were prepared. The poor condition is aggravated by the presence of a fungus which blocks the pores of the stomata and traverses some of the cell cavities.

- V.40345 Figured Pl. 4, fig. 8. Half a cone-scale. There is also a second unfigured specimen.
 V.40346 Figured Pl. 4, figs. 19-27. Six seeds, all much battered so that the lateral wings are damaged and sometimes shredded. One (figs. 20, 21) is beginning to split around the margin into its two valves. Two (figs. 23-26) are represented by one valve only which shows on its inner face the cavity of the seed body flanked on each side by remains of the wings. Region of seed body partially obscured by sand. The original of Pl. 1, fig. 22 (a twig) has now decayed.
 V.42023 A cone-scale from near the base of a cone.
 V.40347 Figured Pl. 3, figs. 9, 10. Part of the upper cuticle of a leaf tip. Most of the right side is missing except the upper end of the right stomatal band. The decurrent flanges are missing. The cuticle is very young and thin. Each stoma shows a single ring of auxiliary cells in almost every case.
 V.40348 A few poor fragments from the dorsal surface of a very young leaf show parts of a broad median band of epidermal cells, and a few stomata rather sparsely scattered. They are in the main longitudinally aligned with narrow inner pore and show a tendency to occur in longitudinal rows. Auxiliary cells form a ring round the pore.

7. *From the Hamstead Beds, Hamstead, Isle of Wight.*

Heer (1862) figured cones, twigs, and seeds. A few additional specimens from this type locality found in 1928 by G. W. Colenutt are figured here. On the evidence afforded by this material it has been possible to amplify Heer's description in certain minor respects. Evidence from cuticle is available for the first time and is given for comparison although only poor fragments have been obtained.

- V.40349 Figured Pl. 1, fig. 23; Pl. 3, figs. 11-13; Text-fig. 2 (1). A twig, now partly destroyed in preparing cuticle from its lower end. The slide shows the central part of the free tip of a leaf, ventral surface showing part of the two stomatal bands and the median band of epidermal cells (about twenty-one cells wide at the base). A second tiny fragment of cuticle appears to have come from one of the decurrent flanges near the base of the ventral surface.
 V.42348 A branching twig represented by an impression in a block of cement stone. It shows first and second year twigs. Also the crowding of the small falcate scale-like leaves at the base of the twigs.
 V.42349 Figured Pl. 4, fig. 1. A cone similarly preserved.

- V.40352 Figured Pl. 4, fig. 2. A detached cone-scale from the basal part of a cone (outer surface showing escutcheon).
Figured Pl. 4, fig. 3. Another, from the apical part of a cone.
Figured Pl. 4, fig. 4. Another, inner (or upper) surface.
- V.40351 Figured Pl. 4, figs. 28-32. Five seeds showing variation in shape and form and in curvature of the body of the seed.
- V.40349 Figured Pl. 1, figs. 24-26. Three twigs. Fig. 25 shows the crowding of the leaves near the twig base. One unfigured twig is mounted on the same slide.
All the above *G. W. Colenutt Coll.*
Note: The twigs, seeds and cone-scales were mounted with gum arabic on a cardboard slide in 1928. This proved to be a mistake for, on drying out thoroughly the specimens were unable to contract and in consequence they cracked.

Angiospermae

DICOTYLEDONES

Family MORACEAE

Genus FICUS Linnaeus

Ficus sp.

Plate 4, fig. 33

A small somewhat cracked and broken endocarp (now decayed), suboval in outline, slightly compressed from back to front, is probably referable to the family Moraceae, and perhaps to the genus *Ficus*. Its maximum diameter is 0.75 mm., and the diameter at right angles to this is 0.6 mm. Organs not clearly seen owing to the break in the surface, but judging from the uninterrupted rounding of the unbroken extremity and sides any organs must have lain at the opposite end at about the position of the break. Surface beset all over with large low rounded tubercles; wall between the tubercles fine-grained formed of minute equiaxial cells. The endocarp was extremely brittle and broke into angular fragments which show a columnar arrangement of the cells in section, about five columns occupying about 0.055 mm. The endocarp wall varies in thickness from 0.027 to 0.055 mm. Inner surface, as preserved, rather rough formed of interlocking cells with long digitations, but the outlines of the individual cells are not very clear. *E. St. John Burton Coll.*

Order RHOEDALES

Family CAPPARIDACEAE

Genus BURTONELLA nov.

Note: A single much crushed seed has been interpreted in the light of fairly abundant and much better preserved material from slightly younger beds at Lake. Without the help of these Lake seeds it would not have been possible to give a satisfactory account of the seed from Studland. Their description is therefore incorporated below.

DIAGNOSIS. Campylotropous seeds with unequal limbs, emarginate at the hilum due to the separation of the tips of the limbs. Testa of shiny, irregular, often rectangular cells with raised

walls. Tegmen of fine equiaxial or sinuous cells. Maximum transverse diameter of seed about 1 mm.

TYPE SPECIES. *Burtonella emarginata* n. sp.

Burtonella emarginata n. sp.

Plate 4, figs. 34, 35

DIAGNOSIS. That of the genus.

HOLOTYPE. V.40353.

DESCRIPTION. *Seed*: Campylotropous, transversely-subobovoid, emarginate near the pointed end between the limbs. Limbs unequal, micropyle terminal on the narrow limb, hilum within the emargination where the contiguous surfaces between the limbs are rough as if originally in contact or covered by an aril (now decayed?). Testa formed externally of black shining cells with raised walls forming a network, cells irregular in size and shape, rectangular, elongate or rounded, frequently about 0.03 mm. broad but varying greatly in length, diverging from the micropyle and converging to the opposite pole of the seed over which they become more or less equiaxial except near the margin where they are elongate and aligned parallel with the circumference of the seed. Thickness of testa about 0.025 to 0.03 mm.; tegmen translucent, thin, formed of fine sinuous cells, but there is also a layer inside the seed of equiaxial cells, 0.016 mm. in diameter. Diameter of seeds. 1) 1 by 0.75 mm. 2) 0.975 by 0.9 mm. 3) 0.95 by 0.75 mm.

REMARKS AND AFFINITIES. The curved form of the seed indicates relationship with Centrospermae or Rhodales. The separation of the unequal limbs at their extremities which produces the emarginate outline is characteristic of Rhodales, and occurs less frequently in the Centrospermae, e.g. in *Beta*. Seeds of identical form with unequal limbs and oblique axis of curvature occur in Capparidaceae and Resedaceae, e.g. in *Dactylaena*, and, after the soft aril between the limbs has been removed, in *Reseda lutea*. In *Dactylaena* the seeds tend to be larger. The maximum diameter of *D. glazioviane* is at least 2 mm. In *D. pohliana* much the same. After the thin outer integument has been removed similar ornamentation of the surface to that of the fossil is exposed. Some species of *Cleomella* also have a similar form of seed. In *C. angustifolia* the diameter of the seed is 1.5 by 0.75 mm. In *C. machrideana* the seeds are larger, 2.5 by 2 mm. It is not possible to discover to which of these genera, if to any living one at all, the fossil is most closely related. The small size and fineness of the ornamentation make exact comparison with Herbarium material very difficult. But the relationship to the family Capparidaceae appears to be clear. The tegmen in *Dactylaena* which could be examined microscopically agrees with the fossil in that it is formed of equiaxial cells about 0.016 mm. in diameter. In some respects e.g. in the oblique form and gap between the limbs *Cleomella* from North America strongly recalls the fossil, but its seeds are considerably larger. It seems advisable therefore to give this well characterized and readily recognizable form a new name. It has been called *Burtonella* after Mr. E. St. John Burton who first found it, while the specific name *B. emarginata* calls attention to the gap due to the separation of the limbs at their extremities.

- V.40353 Holotype, figured Pl. 4, fig. 34. A seed. Lake.
 Figured Pl. 4, fig. 35. A seed (now decayed), probably of this species. Maximum diameter, 0.9 mm.; diameter at right angles to this, 0.65 mm. Much crushed but showing typical surface ornamentation. *E. St. John Burton Coll.* Studland.

Family ROSACEAE

Genus RUBUS (Tourn.) L.

Rubus acutiformis Chandler

Plate 4, figs. 36-40

1925 *Rubus acutiformis* Chandler, p. 26, pl. 4, fig. 2.

1961b *Rubus acutiformis* Chandler: Chandler, p. 122.

DIAGNOSIS. Endocarp oboval or somewhat pyriform in outline, much compressed, sometimes sharply pointed near the subterminal attachment, ventral margin almost straight rimmed, surface sculpture of ridges not continued on to ventral rim. Length, 1.28 to 2.25 mm.; breadth, 0.67 to 1.3 mm. Holotype. V.20057 Hordle.

Two small endocarps (V.40355, V.42353) with narrowly rimmed straight ventral margins measure 1.47 and 1.3 mm. in length, and 0.67 and 0.8 mm. in breadth respectively. The specimens are rather poorly preserved and much pyritized, the rather coarse reticulations of the surface sculpture are much abraded. A comparison has been made with specimens of *Rubus acutiformis* from Hordle (cf. Pl. 4, figs. 39, 40) and other horizons where it has now been found (cf. Pl. 4, fig. 38 from Branksome Dene, Bournemouth Freshwater Beds). The specimens belong to a single species. *E. St. John Burton Coll.*

Incertae Sedis

Genus CARPOLITHUS Linnaeus

Carpolithus sp.

Plate 4, fig. 41

A much compressed seed (V.40357), transversely-suboval in outline having one long margin almost straight, the other convex. No organs can be detected but they are probably hidden in folds of the surface which occur along the convex margin. Surface formed of polygonal cells 0.025 mm. in diameter. Transverse diameter, 3 mm.; longitudinal diameter, 1.5 mm. *E. St. John Burton Coll.*

Unknown Organ

Plate 4, fig. 42

An elongate-obovoid body (V.40358) rounded and mucronate at the apex, narrowed gradually for about three-quarters of its length to the truncate base. Somewhat flattened, longitudinally four-angled, concave between the angles in which lie clusters of yellow shining,

translucent, subglobular bodies of resin-like consistency which, on removal, leave depressions about 0.3 mm. in diameter. Surface structure obscure. Ribs or angles longitudinally striate. Cavity small as seen in transverse section, almost obliterated by compression. Walls very thick. Length, 3.75 mm.; greatest diameter, 1.4 mm. Similar but smaller, shorter organs have been found in newer beds, e.g. at Bournemouth in the Freshwater Beds. The nature of these specimens is obscure. They have not the appearance of fruits or seeds. *E. St. John Burton Coll.*

B. CARBONACEOUS PLANT REMAINS FROM LIGNITIC SEAMS IN COARSE SANDS OF THE PIPE-CLAY SERIES

Pteridophyta

Order *FILICALES*

Family POLYPODIACEAE

Genus ACROSTICHUM Linnaeus

Acrostichum lanzaeanum (Visiani)

Plate 5, figs. 4, 5

See p. 19

Pinnae identical in form and nervation with *A. lanzaeanum* from the Lower Headon of Hordle, and from the Bembridge Beds have now been found at Arne in the Lower Bagshot Beds. For a record from Studland see p. 19. At Arne they occur in a fine laminated compact silty carbonaceous band near the base of the cliff section where they are represented by innumerable fragments large and small. The mode of occurrence suggests that they were fossilized near the position of growth, layer upon layer falling into the fine silt of an estuary, some fronds rotting, others becoming fossilized. The pinnae so far seen have always been very fragmentary. They lie in irregularly arranged masses one upon the other just as they are said to have occurred at Studland. The entire margin is preserved in some specimens. The midrib is prominent on the lower surface, flat or channelled on the upper. The anastomosing of the secondary nerves to form meshes of varying shape is a conspicuous feature. Polygonal depressions on the upper surface of the leaf within the meshes are clearly visible. Although the actual coriaceous substance of the leaf is preserved it cracks and curls immediately on exposure to air and the whole

finely laminated mass of silt is fissile and tends to split up into innumerable layers and fragments. It is doubtful whether specimens in such a matrix can be kept whole for any length of time. It is therefore important to make a full record of these specimens so two figures have been given illustrating good pinnae on the largest and finest block yet seen. Maximum width of pinnae about 50 mm. (24 mm. actually from margin of leaf to edge of midrib). Length always incomplete so far as seen.

V.40277 Figured Pl. 5, fig. 5. A pinnule showing the thick midrib, convex on the lower surface. In the upper part of the specimen the substance is broken away displaying the impression of the upper surface of the midrib and frond.

Figured Pl. 5, fig. 4. Part of the broad pinnule, impression of upper surface. This is superimposed upon part of another and overlain at the top left hand side by a small fragmentary impression of a third pinnule which shows the lower surface and clearly preserved nerve meshes. The third fragment lies adjacent to a tiny piece of the impression of an upper surface with its polygonal areoles in the meshes between the nerves. From a single large block near the cliff base, Arne.

Family SCHIZAEACEAE

Sub-family LYGODIEAE

Genus LYGODIUM Swartz

Lygodium poolensis Chandler

1955 *Lygodium poolensis* Chandler, p. 312, pl. 38, figs. 88-96.

V.31511 A solitary spore about 60 by 48 μ in diameter mounted on a slide of *Anemia poolensis* where it had become entrapped in a group of hairs of that species. As the *Anemia* from which the slide was prepared came from an entirely different gathering of Lake material, made on a different occasion, it presumably represents a second specimen of *L. poolensis* not merely a spore from the first fertile pinnule found.

Sub-family ANEMIEAE

Genus ANEMIA Swartz

Anemia subcretacea (Saporta)

Plate 5, fig. 3

1868 *Asplenium subcretaceum* Saporta, p. 315, pl. 23, fig. 4.

1880 *Anemia subcretacea* (Saporta) Gardner & Ettingshausen, p. 45, pls. 8, 9.

1882 *Anemia subcretacea* (Saporta): Gardner & Ettingshausen, p. 67.

1886 *Anemia subcretacea* (Saporta): Gardner, pp. 400, 402, pl. 1.

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

A fragment (now decayed) about 15 mm. long of a deeply dissected fern pinnule was too cracked and broken for full description. Moreover it was flaking from the matrix as it dried. Although the outline was very imperfect, such finished edges as were preserved indicated long narrow segments. The pinnule was traversed by veins which arose from the median nerve at acute angles and which forked repeatedly in a dichotomous manner. An unsuccessful attempt

was made to prepare a slide by maceration of a small fragment of frond, but it showed that the frond carried a thick felt of pointed hairs. Although the specimen was so imperfect it apparently agreed with *Anemia subcretacea* (Saporta). It was compared with figures of this species from Sézanne (the type locality), Arras (Landéniens grits) and Angers (Eocene grits) published by Depape (1929, pl. 1, figs. 1-8). The resemblance was striking. The same species was described from the Bournemouth Freshwater and Marine Beds (Gardner & Ettingshausen, 1880: 45, pls. 8, 9; Gardner, 1882: 67) and from the Bagshot Beds of Branksea Island (Gardner, 1886: 403). Broken carbonaceous fragments recently found at Branksome Dene, Bournemouth appear to be identical in character with this Arne fragment. Fertile pinnules of *Anemia poolensis* Chandler have also been found in Lower Bagshot Beds at Arne and Lake as well as in the Bournemouth Freshwater Beds of Branksome Dene. It is highly probable that the fertile pinnules so named belong to the same species as the barren pinnules originally described, and that both should ultimately be referred to *Anemia subcretacea* but at present definite connecting evidence is not available. From Arne.

Anemia poolensis Chandler

Plate 4, figs. 43-46; Pl. 5, figs. 1, 2

- 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.
 1961 *Anemia poolensis* Chandler: Chandler, p. 327, pl. 34, figs. 32-35; text-fig. 54.

The species was described fully in the above works. It remains to catalogue material from Lake on which the description was based and to record the discovery of fertile pinnules at Arne.

- V.31539 Figured Pl. 4, fig. 43. Pair of pinnules arising from stipe, one larger than the other. Cell-structure on upper surface unusually well preserved.
 V.31490 Figured Pl. 4, fig. 44. Single reflexed pinnule.
 V.31544 Figured Pl. 4, figs. 45, 46. Tightly reflexed pinnule showing attachment to stipe and rigid toothed segments.
 All the above from Lake.
 V.40807 Figured Pl. 5, fig. 1. Three terminal fertile pinnules tightly enrolled.
 V.40869 Figured Pl. 5, fig. 2. Pair of fertile pinnules showing jagged tips of segments. Two slides prepared from one of these pinnules show broken sporangia and apical annulus.
 Both the above from Arne.
 V.31484-92; V.31494-31511; V.31518. All pinnules or slides figured and described by Chandler (1955). V.31518 a solitary spore from Lower Bagshot of Alum Bay, Isle of Wight.
 V.31538 A series of sections at 10 μ and detached pinnule fragments showing felt of hairs (unfigured) from specimen sacrificed to produce slides V.31509 and V.31510. Also serial section now disorganized.
 V.40800-02; V.40804-05; V.40808-09; V.40811-13; V.40816-18; V.40821; V.40865-66. All detached pinnules, V.40800 still covered with felt of hairs. Many pinnules show sporangia in place. V.40821 is unusual in being neither reflexed nor enrolled. V.40802 from basal beds by ironstone slabs at Lake.
 V.40803; V.40810; V.40815; V.40820; V.40824; V.40868. Were all attached pinnules mostly in pairs, a few in threes. Some have separated since discovery.
 V.40806; Terminal pinnules.
 V.40807; V.40814; V.40831; V.40853. Pinnules showing mode of attachment to stipe or frond.
 V.40819; V.40822-23. Detached segments. V.40819 shows clearly the two rows of sporangia, V.40823 the superficial hairs.

- V.40832-34; V.40837; V.40851 (best seen in reflected light); V.40859; V.40861-63; V.40867. Slides showing sporangia still attached to pinnule segments.
- V.40836; V.40838-48; V.40850; V.40852; V.40854-58; V.40860; V.40864; Slides with spores, sporangia and paraphyses. In some the paraphyses are unmacerated and hence uncollapsed. V.40848 is a sporangium after treatment with Schultze. V.40864 shows sporangium with apical disc in profile.
- V.40825-28 Pinnules with sporangia, pinnule segments and detached sporangia mounted on opaque slides for examination by reflected light. They show paraphyses *in situ* (usually detached in macerated material).
- V.40829 Sporangia, one showing stomium extending throughout the length.
- V.40830 Serial sections at 6 μ celloidin, presumably both from same pinnule.
- V.40835 Slide used for spore count (115 spores).
- V.40849 Pinnule segment showing structure of wall. One attached sporangium shows apical plate. The above from Lake except where otherwise stated.

Gymnospermae

Order CONIFERALES

Family TAXODINEAE

Genus TAXODIUM Rich.

Taxodium lakense n. sp.

Plate 5, figs. 6-16; Pl. 6, figs. 1-6; Text-figs. 7, 8

DIAGNOSIS. Leafy twigs with a slight tendency to be bifacial, having stomata on both surfaces of the spirally arranged leaves. Epidermal cells often transversely elongate and aligned, frequently thick-walled in the older twigs and much inflated with a reticulate pattern (thickening original or secondary?) and occasional small papillae; in younger twigs sometimes with pits. Stomata rounded in the older twigs, more irregular in outline in the very young twigs, predominantly transversely aligned, with small outer pore, radially arranged auxiliary cells varying from four to seven in number, with a pair of longitudinal scales flanking the pore where the guard cells abut on the auxiliaries.

HOLOTYPE. V.40359.

DESCRIPTION. *Fruiting organs*: Represented probably by a male cone with spirally arranged scales (Pl. 6, figs. 5, 6).

Foliage: Small terminal twigs with spirally arranged narrow lanceolate leaves having long free tips and long decurrent bases, or with short closely imbricate scale-like lozenge-shaped leaves closely investing the stem, the leaves having very short free tips. The twigs with the longer leaves often bear falcate leaves at the extreme tips while those on the face of the twigs may be flat with triangular apices and a slight convexity or median longitudinal angle on the lower surface; they may be hollow on the upper surface. This flattening of the facial leaves gives some of the twigs rather a bifacial appearance. The midrib is prominent on the lower surface especially on the decurrent part of the leaf. The epidermal cells are small and convex over the midrib, much inflated or markedly convex and coarser elsewhere especially over the

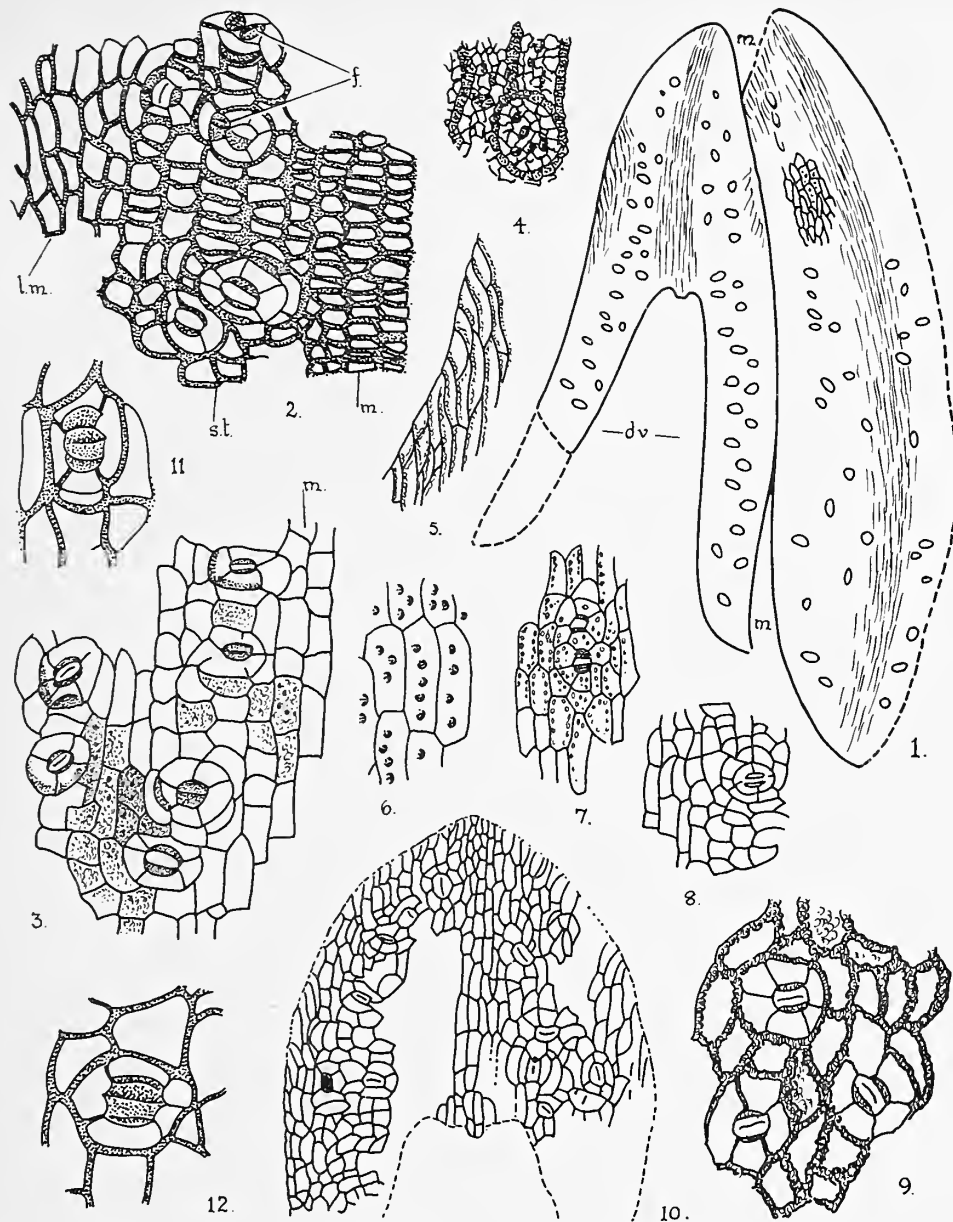


Fig. 7. *Taxodium lakense* n. sp.

1. Diagram showing distribution of stomata on the two surfaces both on the free tip and decurrent basal parts. (*dv*) the decurrent flanges of the ventral cuticle. Dorsal cuticle is to the right. (*m-m*) the leaf margin between the two surfaces. Numerous horizontal and oblique stomata are indicated.
2. Upper cuticle from base of free falcate part of a leaf. It shows the somewhat transversely elongate cells arranged in longitudinal rows over the midrib at *m* and the marginal epidermal cells of the left side at *lm*. Part of the left stomatal band at *st* between them. The thick walls of the inflated cells are shown and the radially arranged auxiliary cells around the stomata sometimes with thickened walls around the circumference. Pairs of scales are shown at the junction of the auxiliary and guard cells. Small oval dark brown inflated bodies at *f* appear to be fungi (cf. Pl. 5, fig. 14).
3. Part of lower cuticle of free part of same leaf showing scattered stomata with four to five radially arranged auxiliary cells and reticulate perhaps somewhat papillate ordinary epidermal cells. Midrib to right at *m*. The pairs of scales at the junction of guard cells and auxiliary cells are again shown. Cell walls thinner and cells less swollen than in the upper cuticle (cf. fig. 2 above).
4. Ordinary epidermal cells of lower cuticle from tip of lozenge-shaped imbricate scale-leaf (cf. Pl. 6, figs. 1, 2) showing reticulate thickening and scattered papillae.
5. Marginal epidermal cells, dorsal cuticle of leaf tip shown in figs. 2 and 3.
6. Ordinary epidermal cells with pits from a very young leaf.
7. A pair of contiguous transversely aligned stomata sharing a lateral cell, surrounded by ordinary epidermal cells which are somewhat reticulate and papillate. From the dorsal cuticle of a lozenge-shaped imbricate leaf near the midrib about half-way down. The midrib lay to the right. Pairs of scales at junction of guard and auxiliary cells are shown.
8. A solitary transversely aligned stoma from ventral cuticle near tip of falcate leaf shown in Pl. 5, fig. 14. It shows four auxiliary cells and the pair of scales. Midrib to left.
9. Part of a stomatal band of diamond-shaped scale-like leaf, dorsal cuticle near leaf tip to left of midrib. Four to six radial auxiliary cells can be seen and the pair of scales as described above. The unevenly thickened epidermal cells are indicated. Stomata are obliquely or transversely oriented.
10. Diagram of young leaf tip, ventral cuticle showing scattered variously oriented stomata; one transversely oriented stoma shows seven auxiliary cells.
- 11, 12. Two stomata with very broad guard cells (as measured at right angles to pore between them). Their breadth and the thickness and denseness of the pairs of scales parallel with the pore tend to obscure the transverse orientation of the stoma. Dorsal cuticle.

All the above are from Lake.

free apical part of the leaf. Length of the free part of three leaves, 1.7, 1.8 and 2.5 mm. respectively; breadth, 1.25, 1.1 and 0.6 mm. Length of the decurrent part of the third leaf, 2 mm. Stomata occur on both surfaces in all leaves. The basal beds of the cliff section and foreshore at Lake yield young twigs whose cuticles differ considerably in appearance from those of the older twigs. But the connexion is established by the occurrence of some comparable young cuticles derived from leaves born on the same twigs as the older ones described. Presumably these young cuticles come from the youngest leaves at the tip of these twigs. The following detailed descriptions are based on material from Lake, but similar cuticle structure is found in specimens from Arne.

(i) *Cuticle structure of older leaves with long free tips.*

A leaf with a free tip about 1.7 mm. long, 1.25 mm. broad was prepared and mounted on two slides. V.40361 shows the free tip of the lower cuticle and, still joined to it, the proximal part of the upper cuticle from its junction with the twig upwards. There is also a decurrent ventral flange on the same slide possibly from this leaf and certainly from the same twig. V.40361a shows the isolated free tip of the upper cuticle in V.40361, and the decurrent part of the lower cuticle of a leaf with one narrow ventral decurrent flange still adhering to it.

Lower cuticle. (a) Of the free tip (Pl. 5, fig. 15; Text-fig. 7 (1, 3, 5, 11, 12)).

Stomata in two bands, one each side of the midrib, somewhat sparsely scattered, the majority aligned transverse to the length of the leaf, a few oblique or longitudinal. There are three bands of ordinary epidermal cells outside the stomatal bands; a narrow band, about eight cells wide in the leaf now described, at each margin, the cells being narrow-elongate with oblique, pointed, or occasionally square ends, having also a row or rows of obliquely aligned cells at the extreme edge of the leaf which produce an irregular finely fringed margin. A broader median band about equal in width to the stomatal bands separates the two stomatal bands. Towards the leaf tip this band is only about thirteen cells wide. Lower down the leaf an occasional isolated stoma is seen within it. At the tip of the leaf the stomata are very few, widely scattered, irregularly distributed, and variously oriented. Further away from the leaf tip they become more numerous, and are frequently arranged in longitudinal rows, often but not invariably with their axes transverse to the length of the leaf, three or four rows of stomata occur at the lower end of the short fragment preserved on V.40361. Epidermal cells between the stomata square, rectangular, or irregular in shape; there may be as many as five rows of rectangular longitudinally aligned cells between adjacent longitudinal rows of stomata, but occasionally two stomata of adjacent rows are contiguous. Between the stomata in a single row there may be several (up to ten or more) epidermal cells, usually but not invariably transversely aligned, or adjacent stomata may be contiguous without intervening epidermal cells.

Stomata large more or less oval or subcircular in outline, often about 0.05 to 0.075 mm. in diameter. Stomatal pores oval, small relative to the size of the whole apparatus, about 0.025 mm. in length; guard cells clearly visible with a pair of thickly cuticularized scales extending their whole length where they abut on the auxiliary cells; auxiliary cells radially arranged around the pore, commonly five, sometimes four, occasionally six. The more or less equal development of the auxiliary cells gives to many of the stomata a smooth rounded outline (Text-fig. 7 (3, 11, 12)).

Epidermal cells thick-walled, commonly with small papillae, or with a fine reticulate thickening (original?) all over the walls. Over the middle region the cells are about 0.012 to 0.016 mm. broad. They have rectangular, oblique or pointed ends, the majority being rectangular, they are rather thinner-walled than the epidermal cells of the stomatal bands.

(b) Of the decurrent leaf base (Pl. 5, fig. 16).

Dense with thick-walled much inflated cells. Stomata sparse, arranged in widely spaced longitudinal lines having but few stomata in each. The lines of stomata are scattered over the whole surface, not concentrated in two well-defined bands. There may be from two to about eight or nine or even more epidermal cells between adjacent stomata in the same row, and about two to five rows of epidermal cells between adjacent rows. The epidermal cells are frequently rectangular. They tend to become smaller towards the sides of the leaf than they are in the middle. They are arranged in rectangular longitudinal rows and are thick-walled and convex. Near one margin they are very thick-walled and so dense as to be almost opaque. At the other margin they are very small, some being only 0.011 mm. broad. The walls are irregularly thickened in parts with a fine but clear conspicuous reticulate thickening. The majority of the stomata are oriented transversely; a few are oblique. Their outlines are well defined owing to the thickening of the outer walls of the auxiliary cells which is sometimes very conspicuous forming a dark brown opaque ring. They are oval or subcircular and about 0.1 to 0.125 mm. in diameter. Auxiliary cells four to six. Guard cells clear, thin, bearing thick brown scale-like semilunar appendages along their outer walls. Pores relatively small, quadrangular or oval, 0.025 to 0.05 mm. long.

Upper cuticle. (a) Of the free tip (Pl. 5, fig. 14; Text-fig. 7 (1, 2, 8)).

The description is pieced together from the complementary fragments of the single leaf in slides V.40361 and V.40361a.

The cuticle is much thicker-walled on the upper than on the lower surface of the leaf and is formed of smaller cells (cf. Pl. 5, figs. 14, 15). The stomata occur in two bands, one on each side of the midrib, they are fairly abundant except towards the extreme tip where they become fewer, usually isolated, until they finally die out altogether. They are mostly transversely or obliquely aligned (Pl. 5, fig. 14; Text-fig. 7 (1, 2)). There are three bands of epidermal cells outside the stomatal bands, a pair of narrow marginal bands about eight cells wide formed of square or rectangular cells in the inner part (about four rows of cells) and of obliquely aligned cells, narrower and more irregular in shape at the extreme margin, and a median band over the midrib. The median band in this leaf is about fourteen cells wide below, and about seven cells wide at the leaf tip. The cells may measure 0.025 mm. in breadth and only about 0.012 mm. along the axis parallel with the length of the leaf. The stomata are arranged in two or more longitudinal rows, they are 0.05 to 0.075 mm. in diameter with smooth subcircular or oval outlines and oval pores about 0.025 mm. long. The guard cells are clearly marked with a pair of thick scale-like appendages along their length at the junction with the auxiliary cells. The auxiliary cells have much thickened outer walls so that the outlines of the stomata are clearly defined. They are radially arranged around the pore, four to six (very rarely seven, V.40365) in number, the walls between them which radiate from the pore are very thin (Text-fig. 7 (2)).

The stomata of adjacent rows within the stomatal bands may be contiguous, or separated by one or more rows of epidermal cells. Each stoma usually has its own independent ring of

auxiliary cells but occasionally a cell may be shared by adjacent stomata. The epidermal cells within the stomatal bands are thick-walled (much thicker than those over the midrib), often equiaxial and irregular in outline, but frequently rectangular, and sometimes transversely elongate, aligned in one or more rows between the neighbouring stomata of a row. Five or more such cells may occur between two adjacent stomata (Text-fig. 7 (2)).

Epidermal cells outside the stomatal bands greatly thickened, their outlines somewhat confused owing to marked inflation of the cells, and the variable thickness of their walls due sometimes to reticulations and sometimes to tag-like prolongations of a wall. In parts of the surface there is clear evidence of an irregular fine network of thickening. On the surface of the cuticle there are occasional oval or subcircular brown semi-translucent bodies with smooth contours (0.025 to 0.05 mm. in diameter). They occur both inside and outside the stomatal bands (Text-fig. 7 (2)) and are probably fungal growths as hyphae can be traced in some of the leaves.

(b) Of the decurrent ventrilateral flange at the base of the leaf (V.40361, V.40361a, V.40362).

This part of the cuticle is contiguous with the decurrent basal part of the dorsal cuticle (Pl. 5, fig. 16). The narrow flange has numerous, close-set, crowded, transverse or obliquely oriented stomata, usually oval, but otherwise similar in character to those of the lower surface but frequently larger, 0.15 by 0.05 mm. in diameter. Length of pores, 0.05 to 0.075 mm. Stomata often contiguous, but sometimes a few epidermal cells irregular in shape and outline are scattered among them. The ventral edge of the flange (i.e. that towards and united with the twig) is formed of dense, much thickened brown cuticle.

(ii) *Cuticle of some young leaves.*

The cuticle of the dorsal (lower) side of a young leaf from the same twig as the leaf described above is seen on slide V.40361a. It shows the long decurrent base, and the basal end only of the upper surface with marginal decurrent flange and a small fragment only of the free tip. The whole cuticle is extremely thin-walled and delicate. There are other young cuticles in slides V.40367, V.40369-72.

Lower cuticle. (Pl. 6, figs. 3, 4; Text-figs. 7 (6); 8 (1, 3, 4)).

All cells on the free portion of the leaf preserved in V.40373 show pits on the radial walls, three to six appearing in each cell as round greenish dots. On the decurrent leaf base they are not apparent. Cells longitudinally aligned and elongate, rectangular ended, or with pointed or oblique ends, more or less parallel-sided, about 0.012 to 0.016 mm. broad. Stomata few, scattered irregularly, with rather irregular outlines owing to marked inequalities in the development of the auxiliary cells which vary in number from four to six, rarely seven. They are very slightly more cuticularized than the surrounding epidermal cells. A stoma at the extreme base of the decurrent part of a young leaf in slide V.40373 shows seven unequal auxiliary cells (Pl. 6, figs. 3, 4; Text-fig. 8 (3)). Maximum diameter of stomatal apparatus about 0.05 mm., and of the outer pores about 0.016 mm. Most of the stomata are longitudinally aligned. Guard cells clear, thin, scales on guard cells (if any) obscure, but in a few cases they appear to be present and to close the aperture completely as if by a dark brown thickened skin.

Upper cuticle. (Text-figs. 7 (10); 8 (2)).

The epidermal cells in this fragment (V.40361a) which shows the side of the upper surface only, are longitudinally aligned, shorter than on the dorsal surface, pitted in the upper free part of the leaf. The stomata are few, but more abundant than on the dorsal side, usually

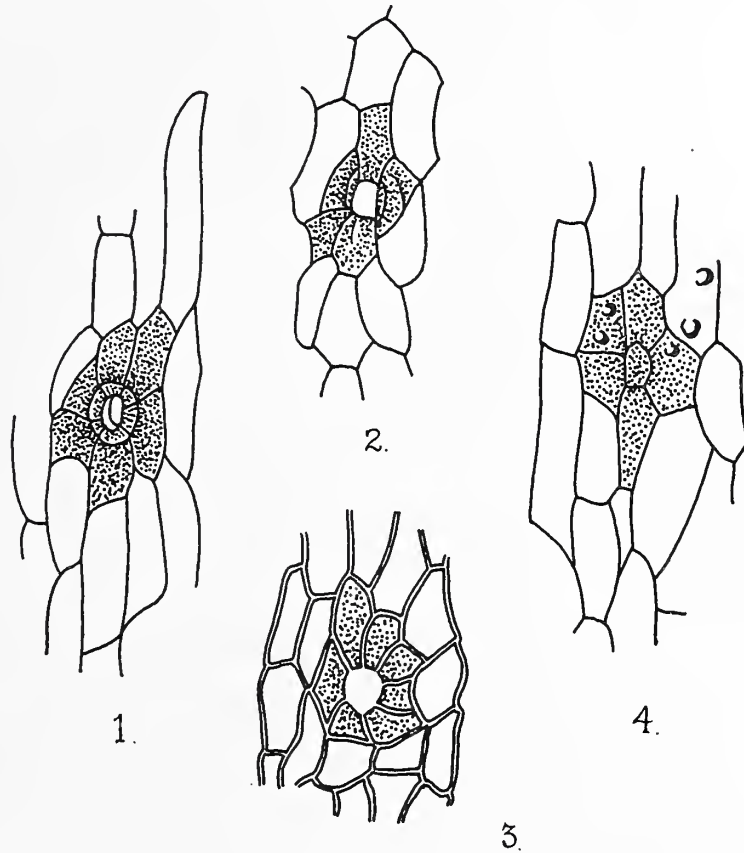


Fig. 8. *Taxodium lakense* n. sp.

1. Solitary stoma with six auxiliary cells on dorsal cuticle, situated near junction of free and decurrent parts of leaf. It is surrounded by thin-walled elongate epidermal cells.
2. Stoma with five auxiliary cells on ventral cuticle at extreme base of the free region.
3. Stoma with seven auxiliary cells, dorsal cuticle at extreme base of leaf.
4. Stoma with five auxiliary cells, dorsal cuticle near base of free part of leaf. Although the auxiliary cells are scarcely cuticularized the stomatal pore is closed by thick brown cuticle or scales.

All from a single young leaf with extremely thin cuticle near the tip of an imbricate twig. Lake.

longitudinally aligned, occasionally oblique, often irregular in outline owing to the unequal size and shape of the auxiliary cells which vary in number from four to six (rarely seven, V.40384), commonly five. The auxiliary cells are slightly more cuticularized than the surrounding epidermal cells. The guard cells in some cases show longitudinal scale-like appendages where they abut on the lateral auxiliary cells.

(iii) *Other slides.*

Show much inflated cells often transversely aligned over the median area of the ventral cuticle near the base of older leaves, sparsely scattered stomata on both surfaces which are not obvious at first sight owing to the confusing effect of the inflated cells around and near them. Pits occur in the cell walls of the dorsal surface in young leaves (Text-fig. 7 (7)). Long narrow cells are seen in the lower decurrent parts of these and there are sparse stomata of irregular shape (V.40370).

(iv) *Cuticle of an imbricate twig with small lozenge-shaped scale-like leaves.* (V.40363, V.40364).

Lower cuticle. (Pl. 6, figs. 1, 2; Text-fig. 7 (4, 7, 9)).

When perfect having an elongate lozenge-shape with rather rounded lateral angles. In slide V.40363 the extreme tip of the leaf is broken away but originally the lateral flanges of the upper cuticle adhered along the margins of the decurrent lower (dorsal) side. The cuticle is thickly beset with scattered stomata tending to be concentrated in broad stomatal bands, a few isolated stomata only occurring over the middle area. The bands almost die out above the extreme base of the leaf. The stomata are mostly oblique, but some are transverse and a few are longitudinal. There are no stomata at the margin where a band about twelve cells deep of epidermal cells occurs formed of oblique, long, narrow cells about 0.06 mm. broad, which dovetail into one another. The median longitudinal area is formed of longitudinally aligned and elongate cells about 0.04 mm. broad, more or less rectangular at their ends, but occasionally oblique, angled, or pointed. Cell walls thick, uniformly thickened by reticulate thickening or small close papillae (Text-fig. 7 (4, 7, 9)).

The stomata are circular to oval, the pore also subcircular or oval. There are from four to six auxiliary cells with thin radial walls and much thickened circumferential walls outlining the stomatal apparatus. The auxiliary cells sometimes have reticulate thickening like that of the epidermal cells. Very occasionally adjacent stomata share an auxiliary cell (Text-fig. 7 (7)). The guard cells are distinct and thin, with a pair of crescentic scale-like appendages or thickenings where they join the lateral auxiliaries (Text-fig. 7 (7, 9)). Diameter of stomata, 0.02 to 0.03 mm. Diameter of pore, 0.01 mm.

Upper cuticle.

Of similar cells and stomata but less strongly cuticularized. No sufficiently large fragments have been seen for detailed description.

(v) *Cuticle from young imbricate leaves near the tip of the same twig.*

This shows thin-walled cells, often longitudinally elongate with rectangular ends. Pits when present are obscure. Reticulation of the epidermal cells is scarcely apparent. The stomata are few and scattered with four or five auxiliary cells.

REMARKS AND AFFINITIES. Twigs with similar characteristics occur both at Lake and Arne. Their external form shows nothing of indubitably decisive diagnostic value. It was therefore necessary to examine the cuticle to discover their relationship. A detailed study was made of the Lake material which was the first to be discovered. Later when twigs were found at Arne cuticle preparations showed identical characters. In some older twigs from Lake if well

preserved the inflated convex cells are a conspicuous feature. When present they can be detected with a pocket lens. The Arne twigs are usually more battered hence the cuticles are less well preserved and cannot always be prepared, small fragments only being obtained. The occurrence of stomata on both surfaces excludes relationship with many genera and families of Coniferae. The presence of from four to seven radial auxiliary cells points to alliance with Cupressaceae or Taxodiaceae among amphistomatous forms. The inflated epidermal cells, often transversely elongate and aligned, especially on the ventral surface of the leaf, the rounded, often transversely orientated, stomatal apparatus with thin-walled auxiliary cells sparsely scattered as compared with Cupressaceae indicate relationship with the genus *Taxodium*.

Gardner's records of *Taxodium* at Bournemouth were not supported by cuticle structure while recent evidence from cuticles indicates that his specimens of *T. europaeum* belong to the Cupressaceae as will be shown in a later monograph. It therefore appears advisable to give a new specific name *Taxodium lakense* to the Lake and Arne specimens which yield the distinctive and recognizable cuticle described.

- V.40359 Holotype, figured Pl. 5, fig. 6. A twig.
 V.40360 Figured Pl. 5, fig. 7. Another twig.
 V.40361 Figured Pl. 5, figs. 14, 15; Text-fig. 7 (2, 3, 8). Cuticle from an imbricate twig with long free tips as described on p. 44.
 V.40361a Figured Text-fig. 8 (1-4). Cuticle fragment of the same leaf as in V.40361 showing the extreme tip of the ventral cuticle. Also the decurrent basal part of the dorsal cuticle and one still adherent decurrent flange of the ventral cuticle. The decurrent basal cuticle of a thin leaf near the tip of the same twig.
 V.40362 Figured Pl. 5, fig. 16. Decurrent cuticle of another leaf, both surfaces and part of the leaf tip.
 V.40363 Figured Pl. 6, figs. 1, 2; Text-fig. 7 (4, 5, 7, 9). Cuticle from short facial scale-like leaves of an imbricate twig.
 V.40373 Figured Pl. 6, figs. 3, 4. Dorsal cuticles thin, young twisted fragments. One shows a seven-celled stoma. Some sinuous-walled cells of a young dorsal cuticle near tip of twig. Also dorsal cuticle from the free tip of another leaf. Typical large stomata.
 V.40384 Figured Text-fig. 7 (10). Shows a young leaf tip, ventral cuticle with typical epidermal cells and scattered variously oriented stomata. The cuticle is extremely thin and delicate, one transversely oriented stomata appears to show seven auxiliary cells. Poorly preserved and obscured by fungus.
 V.40385 Figured Text-fig. 7 (11, 12). Cuticles from older leaves, both surfaces and decurrent base as described on pp. 44-46. Another tip of an older leaf, much fungus-infested (cf. Text-fig. 7 (1)), shows on the ventral surface many transversely oriented stomata.
 Basal decurrent part of a leaf (Text-fig. 7 (11)). The dorsal cuticle shows many transversely oriented stomata, the form of the stomatal apparatus is much obscured by fungus.
 Fragment of dorsal surface (Text-fig. 7 (12)). In the scattered stomata, owing to the breadth of the guard cells at right angles to the slit and to the thickness of the cuticle scales at their junction with the auxiliary cells, the orientation is not infrequently obscured and can only be detected as the result of close scrutiny.
 V.40386 Figured Pl. 6, figs. 5, 6. A male cone largely destroyed in an unsuccessful attempt to extract pollen.
 V.40364 An imbricate scale-like leaf, both surfaces, some parts showing inflated cells with thick walls.
 V.40365 An imbricate twig. Cuticle from both surfaces showing inflated cells. Dorsal cuticle of the long free tip, fragments of ventral showing transverse cells. One attached to the dorsal fragment shows a stoma with seven auxiliary cells.
 V.40366-67 Decurrent dorsal cuticle, some young with pits.
 V.40368 Imbricate foliage, both surfaces with typical stomata.
 V.40369-70, V.40372, V.40374-76. Imbricate foliage, young, including decurrent cuticle. Pits shown in places.
 V.40371 Imbricate foliage, very young, typical stomata on ventral flanges and decurrent dorsal parts.
 V.40377 Imbricate foliage, young, from a twig with a male cone. Fungus-infested. Shows typical stomata.
 V.40378-79 Imbricate foliage, some very young with very short falcate free tips and decurrent basal parts of leaves.
 V.40380, V.40383 Young and thin imbricate foliage, some showing inflated cell walls, and some reticulated cell walls as in the lozenge-shaped leaves.

- V.40387 Several small twig fragments.
 V.40388 A twig and (?) part of male cone.
 V.40381-82 About fifteen twigs and several small fragments. V.40382 *E. St. John Burton Coll.*
 All the above from Lake. V.40371, V.40373-74, V.40376, V.40378-79, V.40381 from base of section by ironstones.
 V.40389, V.42358-62 Figured Pl. 5, figs. 8-13. Six twig fragments.
 V.40390 Numerous twig fragments.
 V.40391-92 Two slides prepared from twigs with falcate leaves. They show typical ventral cuticles and fragments of dorsal cuticle.
 V.40393 From the long decurrent basal leaves of another twig. Shows several fragments of dorsal cuticle flanked on each side by the narrow fringe of ventral cuticle.
 V.40394 Cuticle from twig tip showing one or two scales of a male cone.
 All the above from Arne.

Angiospermae

MONOCOTYLEDONES

Family CYPERACEAE

Section SCIRPOIDEAE

Genus SCIRPUS (Linn.)

Scirpus lakensis Chandler

Plate 6, figs. 7-18

1960 *Scirpus lakensis* Chandler, p. 206, pl. 30, fig. 26.

1961a *Scirpus lakensis* Chandler: Chandler, p. 33.

DESCRIPTION. *Fruit*: (Rarely seen unabraded.) Attenuated urceolate in outline, somewhat bisymmetric as suggested by the invariably flattened form, attenuated at the apex into a long tapering persistent style which arises rather abruptly out of the body, contracted rather suddenly below into a conspicuous truncate neck with basal aperture. Surface longitudinally ridged. Wall thin, carbonaceous, formed of transversely elongate hexagonal cells, sometimes measuring as much as 0.1 by 0.3 mm., arranged in regular longitudinal rows. The dovetailed ends of adjacent rows form the conspicuous longitudinal ridges described. They are finely zigzagged and somewhat serrated along their crests. There are about six or seven of these zigzag ridges on each surface of the flattened fruit extending throughout its length. Almost invariably the carbonaceous coat is abraded and there remains only a shining semi-translucent tough lining layer, almost chitinous in appearance, representing the innermost layers of the carpel. In this condition the alternating lines of transversely elongate cells form a conspicuous feature. In many abraded specimens rows of stiff bristles are seen along the crests of the longitudinal ridges, they represent the broken down remains of the abraded cell walls. In others these remains are worn away leaving the ladder-like arrangement of cells very clearly exposed. Macerated specimens from Swanwick show a single oval seed. The most worn specimens of all are pale yellow, glistening like oil silk, with ghost-like impressions only of the rows of cells.

Length of perfect fruit with carbonaceous coat, 1.6 mm.; breadth, 0.725 mm. Length of its neck, 0.2 mm.; breadth, 0.3 mm. Length of its style, 0.3 mm. Other specimens vary in length from 1.8 to 2.5 mm. and in breadth from 0.65 to 0.8 mm. Maximum length of style seen, 0.7 mm.

REMARKS AND AFFINITIES. Numerous specimens. The relationship of this species for long eluded discovery. It was known only from abraded specimens showing either the inner integument, or that integument clothed with ragged bristles representing the remains of the decayed outer coat. But eventually an unabraded fruit was found in fine silt at Lake and it was then at once apparent that it belonged to the Cyperaceae. Fruits with narrow distinct necks and long persistent style bases occur both in Caricoideae and Scirpoideae. It was in the latter group however that the distinctive transversely aligned cells arranged in longitudinal rows were found in several genera e.g. *Eleocharis acicularis*, but this species lacks the conspicuous longitudinal ridges between the rows of cells as well as the contracted neck and long style base. *Fimbristylis dichotoma*, *F. diphylla*, and *F. vahlii* have broader smaller fruits with relatively coarser cells, the greatest breadth being near the apex not at the middle, and the style base being very short, with deciduous style. In *Scirpus setaceus* the cell-structure and longitudinal ridges are exactly comparable with those of the fossil although the fruit is relatively broader and again has its greatest breadth well above the middle while it lacks the sharply delimited basal neck. The fossil agrees in size and form with *Blysmus*, although in the few available species of this sub-genus of *Scirpus* the characteristic cell-structure has not so far been seen. There is little doubt however that the relationship is with *Scirpus* and it may be with the sub-section *Blysmus*. Provisionally the fossil is referred to *Scirpus*. The occurrence in similar fine laminated silt both at Lake and Sandbanks (Bournemouth Freshwater Beds) indicates a plant living in quiet stagnant water, and the abundance of the fruits suggests a gregarious habit. This accords well with the habit of the living *Blysmus*, found today in Europe, the Himalayas, and Chile, and with the habits of many species of the world-wide genus *Scirpus*.

Scirpus lakensis also occurs in the Lower Bagshot Beds at Arne and at several other stations in the Bournemouth Freshwater Beds, also at Alum Bay. Specimens from these localities will be described and catalogued in due course.

A seam full of more or less abraded fruits was recently found by Mr. D. Curry and the late A. G. Davis in a lignitic band above the London Clay in a Brick pit at Lower Swanwick, the horizon was thought to be Lower Bagshot.

V.40397 Holotype, figured Pl. 6, figs. 7-9. A fruit with outer carbonaceous coat preserved.

V.40398-V.40402 Figured Pl. 6, figs. 10-14. Five fruits with the coat worn away leaving the somewhat hyaline inner integument.

V.40403 Numerous specimens showing various degrees of abrasion.
All the above from fine silt, base of section, western end.

V.40404 A short broad much abraded specimen with translucent coat showing the transversely elongate cells with another more typical fruit. From coarser beds.
All the above from Lake.

V.40396 Figured Pl. 6, fig. 15. A fruit with long style preserved.

V.40395-V.40495 Eight fruits.
All the above from Arne.

V.41924 Figured Pl. 6, figs. 16, 17. Two somewhat abraded fruits. That in fig. 17 partially macerated and therefore semi-translucent.
Figured Pl. 6, fig. 18. Seed out of another macerated specimen. Decayed.

- V.41926-31 Six slides with mounted fruits. These have been dissected so that the seed has been released.
- V.41925 Small sample of lignitic matrix showing numerous seeds.
All the above *D. Curry & A. G. Davis Coll.* Lower Bagshot? Lignitic band near base of new pit above London Clay. Lower Swanwick, Hampshire.
- V.40405 Two much abraded specimens, probably this species. Lower Bagshot; fine carbonaceous band just above Pipe-clay, Alum Bay, Isle of Wight.

?Scirpus sp.

Plate 6, fig. 19

A somewhat laterally compressed fruit (V.40406) with carbonaceous outer coat preserved may belong to a distinct species of *Scirpus*. It resembles the last in size and form and length of style except that it lacks the definitely contracted basal neck. The base is truncate and carries a few blunt-ended spines or processes. The surface bears five longitudinal flange-like ridges, two on one surface, one on the other, and one at each margin. They extend from the base of the fruit to the tip of the style. Surface smooth formed of fine equiaxial cells about 0.08 mm. in diameter. Internal arrangements not seen. Length including style, 1.65 mm.; breadth, 0.8 mm. Length of style, 0.3 mm. From Lake.

Section CARICOIDEAE

Genus CARICOIDEA Chandler, 1957: 86

Caricoidea obscura Chandler

Plate 6, figs. 20-33; Text-fig. 9

- 1960 *Caricoidea obscura* Chandler, pp. 207, 223, pl. 30, figs. 27-33, pl. 33, figs. 98-105.
1961a *Caricoidea obscura* Chandler: Chandler, p. 33, pl. 7, fig. 34.
1961b *Caricoidea obscura* Chandler: Chandler, p. 106, pl. 24, figs. 22-44.

DESCRIPTION. *Fruit*: (Pl. 6, figs. 20-24, 29-32) Sub-obovoid, truncated below by a large foramen (the attachment), rounded or obscurely mucronate at the apex (the style), sometimes obscurely angled longitudinally, usually slightly compressed laterally, the compression probably original. The basal foramen opens into a short cylindrical canal 0.2 mm. long, giving access to an oburceolate endocarp. Epidermis black and shining formed of finely digitate cells, rectangular and longitudinally elongate in the lower part where they may be 0.016 by 0.05 mm. in diameter, equiaxial above and about 0.008 to 0.025 mm. in diameter. Beneath the epidermis are regular equiaxial cells 0.01 mm. in diameter, with a tendency to radial alignment. They form a thick spongy coat traversed by occasional longitudinal fibres. The coat varies in thickness, the maximum, 0.5 mm., being towards the base of the enclosed endocarp; at the apex and middle the thickness is 0.2 mm. in the specimen measured.

Dimensions of four fruits: 1) Length, 2 mm.; transverse diameters, 1.75 by 1.25 mm. 2) Length, 1.75 mm.; diameters, 1.5 by 1.25 mm. 3) Length, 1.75 mm.; diameters, 1.5 by 0.75 mm. 4) Length, 2 mm.; diameters, 1.5 by 0.5 mm.

Endocarp: (Pl. 6, figs. 25-28, 33) Oburceolate, sharply mucronate at the apex with narrow truncate basal neck having a basal aperture closed by a circular plug with a small central

mucro; plug 0.15 mm. in diameter. Surface smooth. Cells of endocarp, 0.012 to 0.016 mm. in diameter, equiaxial, rounded. Dimensions of three endocarps: 1) Length, 1.3 mm.; diameter, 1.2 mm. 2) Length, 0.95 mm.; diameter, 0.75 mm. 3) Length, 1.1 mm.; diameter, 0.85 mm.

Seed: Solitary, erect, testa thin, semi-translucent, formed of transversely elongate cells producing transverse striae 0.008 to 0.016 mm. apart. Lining of testa also showing conspicuous longitudinal folds and crumples giving a longitudinally rippled effect, the ridges being about 0.012 mm. apart at the broadest part of the seed.

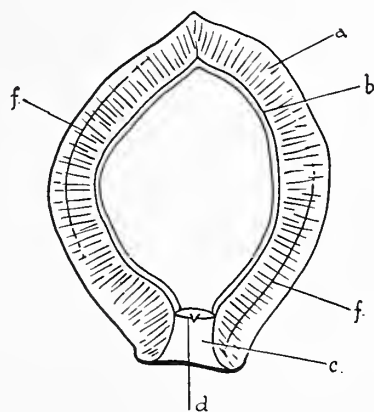


Fig. 9. *Caricoidea obscura* Chandler

Diagrammatic longitudinal section of fruit and endocarp. *a*, fruit; *b*, endocarp; *c*, gaping basal aperture; *d*, plug; *f*, fibres in fruit wall.

REMARKS AND AFFINITIES. Numerous fruits and endocarps. The irregularly rounded scarcely faceted form is original and not the result of abrasion of a formerly much faceted fruit. This is shown by the presence of the black epidermal cells which can be traced over all parts of the surface in a few specimens.

The holotype (V.40407) is from the Highcliff Sands, Cliff End, near Mudeford where the best material (V.40408-13) was obtained and where the species was first found (see Pl. 6, figs. 20-28). But the species also occurs at Lake.

V.40414, V.42356-57 Figured Pl. 6, figs. 29-31. Three fruits with remains of epidermis.

V.40415 Figured Pl. 6, figs. 32, 33. A fruit fractured longitudinally (after maceration with nitric acid) showing the endocarp, now detached as seen in fig. 33.

V.40416, V.40418-19, V.41940 Numerous fruits, some with epidermis preserved. V.40418 from fine silts, base of section, western end. V.41940 *E. St. John Burton Coll.*

V.40417 Thirteen detached endocarps.
All the above from Lake.

Caricoidea arnei n. sp.

Plate 6, figs. 34, 35

DIAGNOSIS. Fruit sub-obovoid or sub-pentagonal, much compressed, bisymmetric, excavated at the base, mucronate at the apex, maximum breadth at about one-third of the length from the apex. Length about 2 mm.; breadth, 1 to 1.25 mm.; thickness, 0.5 mm.

HOLOTYPE. V.40420.

DESCRIPTION. *Fruit*: Approximately bisymmetric, sub-obovoid or sub-pentagonal in outline, excavated at the narrow base by a large foramen marking the attachment, expanding gradually upwards for about two-thirds of the length after which the sides converge meeting at a wide angle in the conspicuous apical mucro which marks the style base. The margin in the plane of symmetry is angled and the fruit is considerably compressed at right angles to this plane. The broad faces sometimes show a few obscure longitudinal furrows or flutings. Surface with shining epidermis of longitudinally aligned cells with finely digitate walls. Carpel wall thick, spongy, compact, of equiaxial cells. Length of fruits about 2 mm.; breadth, 1 to 1.25 mm.; thickness, 0.5 mm.

Endocarp: Not seen isolated from the fruit but its rounded form is obscurely visible impressed through on to the outer surface. Its wall is compact as seen in section.

REMARKS. The species is frequent at Arne and always shows the same compressed form, excavated base and marked mucro. These characters distinguish it from *C. obscura* (above) a species abundant at Lake. Many of the specimens are worn but a few show the shining epidermis with characteristic cells.

V.40420 Holotype, figured Pl. 6, fig. 34. A fruit showing elliptical basal aperture.

V.40421 Figured Pl. 6, fig. 35. Another fruit with more of the style preserved.

V.40422 Numerous fruits.

All the above from Arne.

Caricoidea minima (Chandler)

Plate 7, fig. 1

1925 *Cladium minimum* Chandler, p. 14, pl. 1, fig. 5a, b.

1961b *Caricoidea minima* (Chandler) Chandler, p. 105, pl. 24, figs. 18-21.

DESCRIPTION. *Fruit*: Sub-obovoid, slightly flattened, truncate at the base by a large foramen leading into a short canal. This marks the attachment and placenta. Apex rounded without mucro (as preserved). Surface abraded so that the shining epidermis is not preserved, but in its present condition the structure is obscure a few rounded equiaxial cells only being visible. Thickness of wall not seen. Length of fruit, 2.5 mm.; diameter, 2.25 by 1.5 mm.

Endocarp: Not seen.

REMARKS AND AFFINITIES. A single abraded fruit (V.40423) the form of which indicates relationship with the section *Caricoideae* of the family Cyperaceae. It appears to be identical with *Cladium minimum* a species based originally on the endocarp (V.20033) only (Chandler, 1925: 14, pl. 1, fig. 5a, b) but lately the fruit also has been recorded from the Lower Headon of Hordle (Chandler, 1961b). This fruit measures 2.75 to 3 mm. in length and has a maximum diameter of 2 mm. From Arne.

Family CYPERACEAE?

Section CARICOIDEAE?

Genus?

Plate 7, figs. 2-5

A number of sub-cylindrical fruits, more or less truncate at the base, contracted to an obtusely-pointed apical style may belong to Cyperaceae, but have not been satisfactorily identified. Each has a large basal circular aperture, at least 0.38 to 0.4 mm. in diameter, with rounded incurved margin. The carpel wall externally has an appearance of being pitted with pits arranged in longitudinal rows about 0.01 to 0.015 mm. apart, but when seen by transmitted light, after maceration, some specimens reveal that the striae are produced by longitudinally elongate cells the walls of which are closely digitate with blunt-ended digitations. These macerated specimens also sometimes show what appears to be an inner more oval body (seed?) with a large subcircular basal scar (plug?) 0.01 to 0.015 mm. in diameter. Length of fruits, 1.3 to 1.4 mm.; breadth about 0.68 mm.

V.40424, V.42363-65 Figured Pl. 7, figs. 2-5. Four fruits, one slightly curved and distorted.

V.40425 A seed.

V.40426 Numerous fruits.

V.40427-29 Three slides with fruits permanently mounted after maceration with nitric acid, showing details of structure described above.

All the above from fine silt, base of section, western end, Lake.

Family PALMAE

Sub-section LEPIDOCARYINAE

Sub-family CALAMEAE

Genus CALAMUS Linnaeus

Calamus daemonorops (Unger)

Plate 7, fig. 6

1860 *Palaeospathes daemonorops* Unger, p. 9, pl. 2, figs. 9-12.

1862 *Palmacites daemonorops* (Unger) Heer, p. 1056, pl. 55, figs. 7-15; pl. 60, figs. 50-53; pl. 62.

1957 *Calamus daemonorops* (Unger) Chandler, p. 88, pl. 12, figs. 24-42.

A pair of spines or prickles (incomplete at the distal end and much crushed) attached to a flattened striate base with rough surface formed on one face of fine equiaxial cells. The surface of the spines themselves is finely striate. Close microscopic comparison with similar spines from Bovey has been made. The characters appear to be identical.

The specimen (V.40430) has been referred to *Calamus daemonorops* (Unger) which occurs at Bovey, but it must be borne in mind that more than one genus and species may have similar

spines, and it may prove that these organs alone do not afford sufficient evidence for specific or even for generic determination. Research in recent years has provided fresh evidence about the Bovey palm based on fruits in varying stages of development. The evidence from all organs points to relationship with the group Calameae of the sub-section Lepidocaryinae. The species was said to occur 120 yds. east of Honeycomb Chine, Boscombe (White, 1917: 31). From Lake.

Genus SABAL Adans.

? *Sabal* sp.

Plate 7, figs. 7, 8

1960 *Palmophyllum* sp., Chandler, p. 208, pl. 31, figs. 36, 37.

A fragment from the centre of a small fan-palm leaf (V.40431) shows part of a short rounded upstanding ligule on the upper surface with several pinnae bases of which the lower appear to overlap the upper. On the lower surface a fragment of rachis and about nine narrow pinnae bases are visible, the pinnae diverging at a narrow angle which becomes gradually wider towards the lower end of the fragment. The whole specimen is much corroded and sand pitted. It is 9.5 mm. long, 5 mm. broad and represents part of a very small leaf of *Sabal* type. Similar fragments occur in lignitic rafts above the Boscombe Sands and one such was found in the Hengistbury Beds. From Arne.

Family ARACEAE

Genus ARACISPERMUM Nikitin

Aracispermum arnense n. sp.

Plate 7, figs. 9-12; Text-fig. 10

DIAGNOSIS. Seeds orthotropous, varying in shape, hilum large, funnel-shaped, micropyle at opposite pole of seed. Testa thick of small equiaxial cells. Surface dimpled and rugose. Cavity cylindrical. Length, 1.5 to 3.5 mm.; breadth, 1.75 to 3 mm.; thickness, 0.5 to 1 mm.

HOLOTYPE. V.40432.

DESCRIPTION. *Seed*: Very variable in shape owing to crowding in the fruit; sometimes inflated and angular, sometimes, although less frequently, more or less compressed and elongate-oval. Some seeds have one surface slightly concave where the seed was closely adpressed against the convex surface of another. At one pole of the seed which may be at the end of the longer or the shorter axis of the circumference of a seed, or in the middle of a large flat facet, there is a conspicuous circular or elliptical funnel-shaped opening apparently the hilum, about 0.9 by 0.3 mm. in diameter in two specimens, 0.7 by 0.6 mm. in a third. Within the opening a small circular scar is sometimes seen where the nutrient fibres entered the testa. At the opposite pole there is another smaller opening sometimes sunk in an emargination on the surface or at the circumference (in flattened seeds) or in a depression when on a broad surface. The internal structure shows that this is the micropyle. Fractured or imperfect specimens reveal that the testa (or albumen?) is thick (as much as 0.57 mm. thick), spongy, formed of small

equiaxial thick-walled cells about 0.028 to 0.038 mm. in diameter. Its thickness and texture admirably adapted for floating suggest a marsh or water plant. Superficially the surface is dimpled and rugose with irregular rugosities longitudinally aligned and with remains of longitudinal striation, but where abraded the hollow spongy cells are exposed. The cavity of the seed is sub-cylindrical broadening towards the micropyle and narrowing towards the opposite end, longitudinally striate owing to the orientation of fine elongate cells. The tegmen is semi-translucent, yellowish, not fused with the testa, narrowing rather rapidly to the micropyle which is marked by a slightly thickened and conspicuous mucro, gradually narrowing to the hilar end where it has a circular or subcircular roughened chalaza scar. The tegmen is formed of slightly inflated equiaxial cells about 0.01 mm. in diameter. The appearance is that of an orthotropous seed. If anatropous, the raphe must have been superficial and is now worn away.

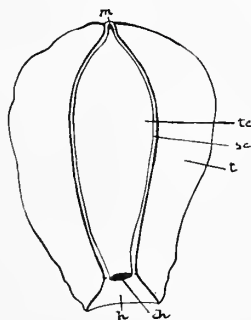


Fig. 10. *Aracispermum arnense* n. sp.

Diagrammatic longitudinal section through seed-cavity. *h*, hilum; *ch*, chalaza; *m*, micropyle; *t*, testa; *te*, tegmen; *sc*, seed-cavity.

The following are typical seed dimensions: 1) Length, 2.75 mm.; breadth, 3 mm.; thickness, 0.75 mm. 2) Length, 3.25 mm.; breadth, 2 mm.; thickness, 1 mm. 3) Length, 2.5 mm.; breadth, 1.75 mm.; thickness, 0.75 mm. 4) Length, 2.5 mm.; breadth, 3 mm.; thickness, 1 mm. 5) Length, 1.5 mm.; breadth, 2.25 mm.; thickness, 1 mm. 6) Length, 3.5 mm.; breadth, 2 mm.; thickness, 0.5 mm.

REMARKS. Although no living seeds identical in character have been seen there can be no doubt that the family Araceae is indicated. In it orthotropous seeds occur, the testa may be thick and spongy in section e.g. *Cyrtospermum*, part of *Acorus*, and dimpled externally e.g. *Acorus*, *Spathiphyllum*, a large micropylar aperture and smaller hilar opening are seen e.g. in *Cyrtospermum* and *Epipremnum* but these have curved seeds. Several seeds may occur in the locules with consequent mutual distortion during growth. The family is a large one and it has been impossible to examine the seeds of any but a small fraction among which no exactly comparable material has been seen. The seeds are therefore referred to the form-genus *Aracispermum* Nikitin. The specific name *Aracispermum arnense* indicates their origin at Arne.

V.40432 Holotype, figured Pl. 7, fig. 9. A somewhat flattened seed with emarginate micropylar end.

V.40433-35 Figured Pl. 7, figs. 10-12. Seeds. V.40433 with concave facet due to pressure of an adjacent seed.

V.40436 Six seeds and several fragments or imperfect specimens, one showing tegmen.

All the above from Arne.

DICOTYLEDONES

Family MORACEAE

Genus FICUS Linnaeus

Ficus lucidus n. sp.

Plate 7, figs. 13-18; Text-fig. 11

DIAGNOSIS. Carpels with an inconspicuous longitudinal angle down one side, funicle entering the locule near the apex close to a tiny recurved mucro. Surface shining, of equiaxial slightly convex cells 0.01 to 0.012 mm. in diameter. Carpel wall columnar in section, about 0.05 mm. thick, inner surface of finely sinuous cells about 0.05 mm. in diameter. Length of carpel, 1.3 to 1.85 mm.; breadth, 0.85 to 1.4 mm.

HOLOTYPE. V.40437.

DESCRIPTION. *Carpel*: Sub-ovoid or sub-obovoid but having an inconspicuous longitudinal somewhat rounded angle along one side terminating at the upper end in a small recurved mucro (Pl. 7, figs. 13, 14, 18) adjacent to the aperture through which the funicle enters the locule. Surface black or shining formed superficially of regular equiaxial slightly convex cells, 0.01 to 0.012 mm. in diameter. In section there is a thin layer of readily detachable epidermis within which is a coat approximately 0.05 mm. thick formed of one or more layers of radially aligned cells producing a columnar effect. The inner surface of this columnar coat shows finely sinuous cells, 0.05 mm. in diameter. Seed pendulous, chalaza close to funicle and placenta, testa hard opaque formed of longitudinally aligned cells, 0.01 mm. broad. Length of carpel, 1.3 to 1.85 mm.; breadth, 0.85 to 1.4 mm. (sometimes exaggerated by compression).

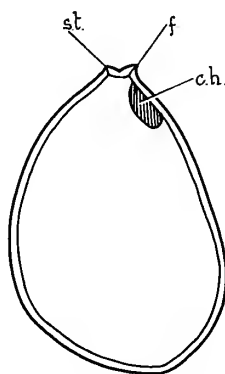


Fig. 11. *Ficus lucidus* n. sp.

Carpel in longitudinal section (diagram). *st.*, style; *f.*, funicle; *ch.*, position of chalaza on seed within.

REMARKS AND AFFINITIES. More than a dozen specimens, the majority relatively uncrushed. The form and cell structure indicate the family Moraceae while size and details of structure point to the genus *Ficus*. This large family of tropical plants contains at least 700

species and it does not seem practicable to trace relationship to individual species among the living. Nevertheless this species is distinctive and readily recognizable when found in other deposits. It is quite impossible to relate it to any of the many fossil species based on leaves.

V.40437 Holotype, figured Pl. 7, fig. 13. A carpel showing well the recurved mucro at the upper end.

V.40438-40, V.43523-24 Figured Pl. 7, figs. 14-18. Carpels. V.40438 is somewhat crushed and V.40440 so compressed as to show the longitudinal angle along which splitting has started.

V.40441-42 Eighteen seeds, some much crushed and somewhat broken.

All the above from Lake. V.40439-42 from fine silt, base of section, western end.

Family MORACEAE?

Genus OVICARPUM nov.

DIAGNOSIS. Subvoid, obscurely bisymmetric endocarp with brittle walls, columnar in section, pitted externally and internally the pits having finely toothed walls. Placenta at narrow upper end. Seed unknown. Dimensions about 2.5 to 3.75 mm. by 2.25 to 3.5 mm.; thickness at right angles to plane of symmetry, 1 to 1.25 mm. (reduced to some extent by compression in fossilization).

TYPE SPECIES. *Ovicarpum reticulatum* n. sp.

Ovicarpum reticulatum n. sp.

Plate 26, figs. 25-28

DIAGNOSIS. That of the genus.

HOLOTYPE. V.40443.

DESCRIPTION. *Endocarp*: Subvoid, often somewhat compressed (although this is increased by fossilization), slightly bisymmetric, an obscure marginal longitudinal angle lying in the plane of symmetry on one side along which there is a tendency to split. In some specimens one margin has a more convex outline than the other. There appears to be an organ (funicle and placenta?) indicated by a slight prominence at the narrow end. Walls extremely brittle, about 0.038 to 0.057 mm. thick, columnar in section, formed superficially of finely toothed equiaxial cells producing pits about 0.027 to 0.038 mm. in diameter. Internal surface also with finely toothed equiaxial concave cells having a tendency to longitudinal alignment. These cells diverge from the placenta. Remains of a compact thin light brown tissue adhere in patches in a few specimens, possibly representing exocarp. Dimensions of some perfect endocarps: 1) Length, 2.5 mm.; breadth, 2 mm.; thickness, 1.5 mm. 2) Length, 2.75 mm.; breadth, 2.25 mm.; thickness (reduced by compression), 1 mm. 3) Length, 2.5 mm.; breadth, 2 mm.; thickness, 1.25 mm. 4) Length, 3.25 mm.; breadth, 2.25 mm.; thickness (reduced by compression), 1.25 mm. 5) Length, 2.5 mm.; breadth, 2.4 mm. (completely flattened). Dimensions of separated valves: 1) Length, 3 mm.; breadth, 2.75 mm. 2) Length, 3 mm.; breadth, 2.5 mm. 3) Length, 3.75 mm.; breadth, 3.5 mm. 4) Length, 2.5 mm.; breadth, 2.4 mm.

REMARKS AND AFFINITIES. Specimens are fairly common but the wall is so brittle that perfect endocarps are rare and are usually only small. Even separated valves are commonly fragmentary. Moreover this species tends to be pyritized and very liable to decay. The form and ornamentation are together highly characteristic. The form suggests Moraceae in which

family cells with toothed or digitate margins occur. The absence of definite evidence as to the seed and its attachment leaves a slight element of doubt in regard to the relationship. Until fuller knowledge of the fossil and of comparable living forms indicates closer relationship the endocarps are referred to a new genus *Ovicarpum* under the name *Ovicarpum reticulatum*.

V.40443 Holotype, figured Pl. 26, fig. 25. A small endocarp.

V.43102 Figured Pl. 26, fig. 26. Another, somewhat larger.

V.40444, V.40446 Figured Pl. 26, figs. 27, 28. Two endocarps each represented by a single valve.

V.40445, V.40447-48 Endocarps, valves and many fragments.

All the above from Arne.

Family NYMPHAEACEAE

Genus PALAEONYMPHAEA Chandler, 1961: 64

Palaeonymphaea eocenica n. sp.

Plate 7, figs. 19, 20

DIAGNOSIS. Seeds with embryotega referable to Nymphaeaceae, testa cells shining, convex, finely digitate, somewhat irregular in size and arrangement with a tendency to be transversely aligned. Largest cells about 0.05 to 0.075 by 0.02 to 0.025 mm. in diameter. Hilum prominent. Length of seeds, 2 to 3 mm.; breadth, 1.25 to 2 mm.

HOLOTYPE. V.40449 from Bournemouth Freshwater Beds of Sandbanks.

DESCRIPTION. *Seed*: Anotropous, subglobular to ovoid (generally now more or less distorted and flattened) with terminal circular or subcircular aperture, 0.45 to 0.7 mm. in diameter, closed by a conical embryotega (germination plug). Micropyle at the middle of the embryotega indicated by a small rimmed depression from which transversely oblong convex cells radiate. Hilum a large conspicuously and irregularly rimmed aperture contiguous with the micropyle. Diameter across the two apertures from rim to rim about 0.2 by 0.05 mm. Raphe a conspicuous rounded longitudinal ridge terminating on the embryotega close to the hilar rim. Chalaza at the opposite end of the seed indicated externally by tubercles in some specimens. Testa with an outer very shining skin which appears to be readily detachable as it is often missing. It is formed of convex cells with digitate walls about 0.05 to 0.075 by 0.02 to 0.025 mm. in maximum diameter. Over the embryotega this skin appears to have straight-sided cells. Surface exposed by decay of this outer layer dull with obscure impressions of the cells of the outer layer having slightly sinuous margins. These impressions are somewhat concave (as in *Euryale* when the outer skin has been removed), they vary greatly in shape and arrangement. Around the embryotega they are transverse-elongate, oblong and concentrically arranged. Over the raphe they are longitudinally elongate and aligned. Elsewhere over the surface they are irregular in form and size, some being almost equiaxial but with a tendency to transverse alignment. They are largest towards the middle of the seed. They show no evidence of the very regular alignment in longitudinal rows seen in Recent *Nymphaea*. Length of seeds, 2 to 3 mm.; breadth, 1.25 to 2 mm.

REMARKS AND AFFINITIES. The type locality for this species is Sandbanks. One seed only, in a rather poor state of preservation, having been found up to the present at Lake. The condi-

tion was, however, sufficiently good to establish beyond any question the identity of the specimen. Form and character of these anatropous seeds relate them to Nymphaeaceae but no living genus exists in which the testa cells correspond exactly in shape and arrangement. In *Brasenia* and *Victoria* the digitations are much deeper and more complicated. In *Euryale* and *Nuphar* the testa cells are simpler and not digitate. The name *Palaeonymphaea* has been given on account of the resemblance to *Nymphaea* which is, however, distinguished by the very regular arrangement in longitudinal and transverse rows of the digitate testa cells. Circular or oval scars about 0.3 mm. in diameter may be the remains of pustules caused by a fungus.

V.40450 Figured Pl. 7, fig. 20. A somewhat abraded and battered seed.

V.40451 A much crushed seed. Fine silt, base of section, western end.
Both the above from Lake.

Family MENISPERMACEAE

Section TINOSPORA Diels

Genus TINOSPORA Miers

Tinospora arnensis n. sp.

Plate 8, figs. 4-10

DIAGNOSIS. Endocarp beset with conical tubercles coarser and much longer than those of *T. excavata*, longer also and more close-set than those of *T. wilkinsoni*. Dorsal ridge rather conspicuous, ventral ridge much more conspicuous than in the above mentioned species, ventral aperture smaller than in either, its maximum diameter about 1 mm. Length of endocarp, 6 mm.; breadth, 5 mm.

HOLOTYPE. V.40452.

DESCRIPTION. *Endocarp*: Bisymmetric, hemispherical with a fairly conspicuous median dorsal ridge in the plane of symmetry and a marked ventral one especially at the upper end. Ventral depression deep forming a large hemispherical hollow with small median oval aperture about 1 mm. long. Splitting in the plane of symmetry for germination of the seed. Surface ornamented with straight conical spines having a marked tendency to be aligned parallel with the circumference. On the ventral surface the spines are arranged both parallel with the aperture and in radial rows around it. Near the aperture they are smaller, shorter, and rather close-set giving a somewhat fluted appearance. On the locule wall a slight dimpling indicates the position of the spines. Wall woody, 0.05 to 0.1 mm. thick, formed both superficially and internally of criss-cross fibres. In section the wall appears close and compact but a broken endocarp from Lake shows small radially aligned rectangular cells. Both fibres and cells of the surface diverge from the bases of the spines, the spines themselves being longitudinally striate. Styler scar sub-apical on the median ridge of the ventral surface (best displayed in a crushed endocarp, Pl. 8, fig. 5, where it appears as a small rimmed aperture). Length of endocarp,

6 mm.; breadth, 5 mm. (including spines). Length of crushed endocarp (including spines), 8 mm.; breadth, 6.75 mm. Length of longest spine preserved about 0.35 mm.

Seed: Solitary, represented by parts of the testa. It conforms to the locule in shape. Testa cells rounded equiaxial.

REMARKS. Although there is some resemblance between the Lower Bagshot endocarps and those of *T. excavata* Reid & Chandler from the London Clay (cf. Pl. 8, fig. 11) the two appear to belong to distinct species. In *T. arnensis* the spines are coarser and longer than those of *T. excavata* and longer and more close-set than those of *T. wilkinsoni* Chandler. The ventral ridge is more marked than in *T. excavata* and the ventral aperture is somewhat smaller than in either of the London Clay species. In view of the difference of preservation in the London Clay and Lower Bagshot material, it is not easy to judge which characters are truly specific, but having regard to all the available evidence there seems to be little doubt that the Lower Bagshot endocarps represent a distinct species. The name *Tinospora arnensis* is given to indicate the type locality.

V.40452 Holotype, figured Pl. 8, fig. 4. Well-preserved endocarp.

V.40453 Figured Pl. 8, figs. 5, 6. Dorsiventrally crushed endocarp.

V.40454-5 Fragments of endocarps.

All the above from Arne.

V.40456 Figured Pl. 8, figs. 7-10. Fragment of an uncrushed endocarp showing the edge of the ventral hollow and typical spines, also remains of enclosed seed. Lake.

Section COCCULEAE Diels

Sub-section COCCULINAE Diels

Genus WARDENIA Chandler, 1961: 158

Wardenia poolensis n. sp.

Plate 7, figs. 21, 22

DIAGNOSIS. Endocarp much compressed laterally, marginal rim broad. Ventral margin concave, elongate foramen situated close to this margin. Nodular ridges arising from the outer side of the raised horse-shoe shaped ridge are continued onto the marginal rim for about two-thirds or a half of its width where they terminate abruptly and bluntly. Maximum diameter of endocarp about 5.5 mm.; maximum diameter at right angles to the above along a line between the curved limbs, 5.25 mm.

HOLOTYPE. V.40457.

DESCRIPTION. *Endocarp*: Bisymmetric, laterally flattened, formed of two equal valves which separate for dehiscence in the plane of symmetry. More or less gibbous in outline, slightly oblique, somewhat concave along the ventral margin having a broad marginal horse-shoe shaped flange. At its broadest the flange occupies about one-third of the greatest diameter of the endocarp; it narrows towards the ends of the limbs. It is delimited along its inner edge by an upstanding horse-shoe shaped ridge which is rounded and nodular. The ridge has a horse-shoe shaped groove along its crest. On the outer side of the ridge there are conspicuous nodular

prominences continued as ridges onto the flange; ridges, separated by deep furrows, terminate abruptly at about one-half to two-thirds the width of the flange from the margin of the endocarp. Beyond the ridges the flange is fairly smooth (surface somewhat obscured by sand-pitting) or obscurely fluted. The inner curve of the horse-shoe ridge has a few short rounded nodules which end abruptly against the smooth central area between the limbs of the horse-shoe. The central area is small, concave near its circumference becoming slightly convex towards the ventral margin. It is pierced by a narrow elongate foramen near the stylar limb, the foramen measuring 1 by 0.3 mm. and ending about 0.5 mm. from the concave ventral margin of the endocarp. Surface formed of fine radially aligned cells. Maximum diameter of endocarp (transverse to the limbs), 5.5 mm.; diameter at right angles to this between the limbs, 5.25 mm.; thickness (somewhat crushed) about 1 mm.

Seed: Seen only in fragments. Testa of equiaxial more or less equal sized cells with raised walls, about 0.018 mm. in diameter.

REMARKS. One much sand-pitted endocarp (V.40457). Another species of the genus was described from the London Clay (Chandler, 1961: 158) which is somewhat smaller (5 by 4 mm. in diameter) and the diameter between the limbs is considerably shorter than the maximum diameter at right angles to the limbs. The radial ridges on the marginal rim do not terminate abruptly at some distance from the edge of the endocarp, the micropylar limb appears to be relatively shorter so that the ventral margin is slightly less concave.

This endocarp differs from a *Wardenia* awaiting description from Southbourne in its much larger size (Southbourne species, 3.5 by 3 mm.), in its more concave ventral margin and in the greater proximity of the elongate foramen to the ventral margin and to the stylar limb. It resembles it in having radial ridges on the marginal rim which terminate abruptly at some distance from the edge of the endocarp. From Arne.

Genus PALAEOCOCCULUS Chandler, 1961: 330

Palaeococculus lakensis Chandler

Plate 7, figs. 23-29; Pl. 8, figs. 1-3; Text-fig. 12

1961 *Palaeococculus lakensis* Chandler, p. 330, pl. 33, figs. 8-10.

SYNTYPE. V.40458.

DESCRIPTION. *Endocarp*: One-loculed, one-seeded, oval, oboval, transversely oval, or subcircular in outline, the variation in shape being partly original, partly emphasized by distortion in fossilization. Much flattened, bisymmetric about a plane parallel with the flattened lateral faces, splitting into two valves in the plane of symmetry.

External surface having a more or less smooth marginal flange ornamented in some specimens with a few flutings or radial ridges (Pl. 7, figs. 27, 28; Pl. 8, fig. 1); more or less concentric with the flange is a broad sharply inflated and differentiated horse-shoe shaped or sub-spiral area ornamented with widely spaced marked radial ridges, fifteen or more in number (Pl. 7, figs. 23, 25, 28; Pl. 8, fig. 1). This region is rounded, short, slightly incurved, relatively broad at one end, and narrowed to a point which extends to the margin of the endocarp at the other (the stylar) end. A strand of fibres overlies the outer ridge of this region and gives off a

branch along each transverse rib. Within again is an elongate curved depression (the shape of a comma or of a reversed comma), rounded above, extending as a narrow deep furrow to the marginal attachment between the limbs of a horse-shoe shaped locule.

The inner face of each valve revealed by dehiscence of the endocarp shows the more or less horse-shoe shaped locule with its two extremities towards the base of the endocarp and at least one of its limbs slightly incurved (Pl. 7, fig. 24; Pl. 8, fig. 2; Text-fig. 12). The stylar limb is the longer and narrower and is sharply pointed with terminal style, the other incurved limb is shorter, sometimes broader, and rounded at its extremity. The locule corresponds with the ribbed inflated part of the external surface. The carpel wall between the limbs is fused so as to

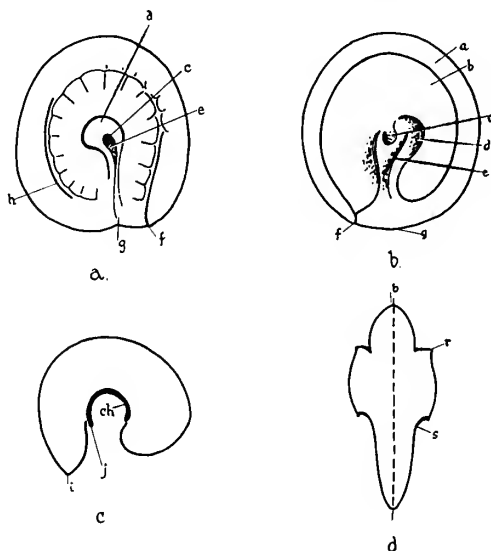


Fig. 12. *Palaeococculus lakensis* Chandler

(a) Exterior of valve of endocarp. (b) Interior of valve of endocarp. (c) Seed. (d) Section at right angles to plane of symmetry. *a*, suture plane; *b*, locule; *c*, foramen; *d*, condyle; *e*, split marking imperfect fusion of limbs; *f*, style; *g*, attachment; *h*, angle with fibre band delimiting inflated area; *i*, micropyle; *j*, hilum; *ch*, chalaza; *r*, radially ribbed region; *s*, sunk median area; dotted line, plane of dehiscence.

form a curved clavate partition or condyle, but the fusion is incomplete so as to leave an elongate curved foramen (Pl. 8, figs. 2, 3) continued as a secondary slit almost to the base of the endocarp where splitting along the line of fusion between the limbs has often taken place as the result of fossilization. The condyle corresponds with the curved depressed median area on the external surface (Pl. 7, figs. 23, 24; Text-fig. 12). The placenta lies near the inner end of the condyle where this is pierced by the foramen adjacent to the stylar limb (Text-fig. 12). The marginal sutures of the valves are smooth, as much as 0.1 mm. broad, and are coextensive with the external marginal flange. The carpel walls are formed of criss-cross fibres, coarser outside, finer on the shining locule lining. Dimensions of endocarps: 1) 3.5 by 2.25 mm. 2) 2 by 1.5 mm. 3) 1.8 by 1.5 mm. Dimensions of a typical specimen, 2.5 by 2.3 mm.

Seed: Approximately horse-shoe shaped, conforming to the locule, hence the limbs are somewhat unequal, the sharply pointed micropylar limb being the narrower and longer, the

rounded chalazal limb being shorter, broader and more curved. Hilum on the inner (ventral) margin of the micropylar limb (Text-fig. 12), raphe and chalaza ventral at the apex of the curve and continued along the broader limb for some distance. Testa formed of equiaxial cells, 0.012 to 0.016 mm. in diameter. Diameter of a seed across the two limbs, 1.5 mm.; space between the limbs, 0.5 mm. broad.

REMARKS AND AFFINITIES. Numerous specimens. The curved bisymmetric compressed endocarp with horse-shoe shaped locule is highly characteristic of the family Menispermaceae, section Cocculeae. The specimens show a distinctive *combination* of characters not seen in any living genus hitherto examined viz. 1) The flattened form with broad marginal flange corresponding with a thick wall and broad suture. 2) The broad inflated locule with transversely ribbed external surface forming a sub-spiral band of external ornamentation. 3) The elongate condyle between the limbs occupying almost half the longitudinal diameter of the endocarp.

The closest resemblance is apparently with *Cocculus*, certain species of which show a similar sub-spiral band of transverse ridges overlying the locule and an elongate condyle, but no species has been seen with the wide marginal flange and suture. Also on the outer surface of *Cocculus* fibres lie near the inner margin of the transversely ridged area over the locule, not near the *outer* margin of this region.

Hypserpa and *Tiliacora* also have long condyles, but no corresponding marginal rim externally.

Menispermum and *Sinomenium* have a marginal rim externally but it overlies the locule and does not correspond with a thick suture at the junction of the valves; also the limbs of the locule and seed are short, and the condyle correspondingly short and broad. The name *Palaeococculus* was given to indicate the probable relationship of this distinctive form. An endocarp was also found in the London Clay of Nursling (Chandler, 1961: 330).

V.40458 Syntype, figured Pl. 7, figs. 23, 24. An endocarp which has split in the plane of symmetry.

V.40460, V.42352 Figured Pl. 7, figs. 27, 28. Two endocarps showing variation of form.

V.40459, V.40461, V.42354-55 Figured Pl. 7, fig. 25; Pl. 8, figs. 1-3. Valves of four endocarps. V.40461 shows clearly the foramen between the limbs.

V.40462 Figured Pl. 7, fig. 26. Distorted valve of an endocarp and its detached seed.

V.40463 A valve of another with seed in position.

V.40464-65 Numerous endocarps. V.40465 from basal beds with ironstones.

All the above from Lake.

V.40466 Figured Pl. 7, fig. 29. A distorted endocarp. Arne.

Family LAURACEAE

Genus LAUROCARPUM Reid & Chandler, 1933: 225

Laurocarpum spp.

Plate 8, figs. 12-15

A number of berries belong to Lauraceae and almost certainly to more than one genus within that family. While it is probable that *Cinnamomum* is present, the data in most instances are too few to make generic determination possible. If more precise information were available about the cell structure of the epicarp in living forms considerable light might be

thrown on the closer relationship of such fossil fruits as these. Not all of the berries are complete, but several specimens show an attachment scar (flattened in fossilization) sufficiently large to indicate a swollen receptacle. The specimens are catalogued in detail below and serve to show that the family was well represented at Lake.

- V.40467** Figured Pl. 8, fig. 14. A subglobular berry, 6.5 mm. long, 5.75 mm. in diameter in its present flattened condition. There is a basal scar of attachment 2 mm. in diameter. The epicarp is formed of fine equiaxial cells about 0.016 to 0.02 mm. in diameter, concave superficially as preserved. Surface black somewhat shining but not highly polished at least in its present state.
- V.40468** A subovoid berry 8.5 mm. long, 6.5 mm. broad. Diameter of flattened attachment scar, 2 mm. The specimen is broken on one side at the apex and in the section thus displayed obscure traces of a columnar endocarp can be seen about 0.05 mm. thick. Surface black as in V.40467 above.
- V.40469** Figured Pl. 8, fig. 15. Subovoid berry, length, 7.75 mm.; breadth, 6.5 mm.; diameter of crushed chalazal scar, 2 mm. Surface black, somewhat shining, pitted, pits 0.013 to 0.016 mm. in diameter or rather more. The above appear to belong to a single species.
- V.40470** Figured Pl. 8, fig. 12. A subglobular berry, 6.25 mm. long, 5.5 mm. broad. Attachment not seen owing to a break in the surface. Epicarp extremely shiny, crumpled with rounded crumples due largely to contraction in drying. There is some evidence however of close-set sunk circular scars which may be an original pattern. The coat has a highly characteristic yellowish semi-translucent appearance, and a leathery consistency. It is formed of rather regular equiaxial cells about 0.018 mm. in diameter. Where shrunk it shows slight longitudinal striations. It is strongly suggestive of *Cinnamomum*.
- V.40471** Another specimen, too imperfect for measurement, may belong to the same species. Attachment not seen. It also has a wrinkled shining epicarp of equiaxial cells about 0.016 mm. in diameter, frequently concave superficially as preserved, on the broken edge the endocarp is clear in section. It is columnar and about 0.05 to 0.075 mm. thick.
- V.40472** Figured Pl. 8, fig. 13. A smaller subglobular berry shows a very different surface. The epicarp is formed of elongate cells arranged in groups variously oriented so as to produce a complex pattern. The cells are about 0.012 mm. broad. The basal scar (flattened) is 2 mm. in diameter. Length and breadth of berry, 5.75 mm.
- V.40473** A fragment, too incomplete for measurement, shows a much puckered and crumpled epicarp of leathery appearance. Its cell structure is characteristic and distinct from those described above consisting superficially of equiaxial conspicuously convex cells about 0.018 to 0.027 mm. in diameter. All the above from Lake. V.40469 from base of section near ironstones.

Order *RHOEDALES*

Family CAPPARIDACEAE

Genus *BURTONELLA* Chandler, see p. 36

Burtonella emarginata Chandler

Plate 8, figs. 16-26

The species has already been described; the description being based on material from Lake (p. 37). This was necessary for the elucidation of a poorly preserved seed from Studland. A few additional specimens are catalogued below.

- V.40354** Figured Pl. 8, figs. 16-25. Ten seeds showing variations of form and size.
- V.40475-76, V40478** Seeds. V.40476 is distorted. V.40478 from basal beds below ironstones in foreshore. All the above from Lake.
- V.40479** Figured Pl. 8, fig. 26. A seed, 1 by 1.2 mm. in diameter. Arne.

Genus PALAEOCLEOME nov.

DIAGNOSIS. Seed campylotropous, very variable in outline, bisymmetric, somewhat flattened at right angles to the plane of symmetry. Curved cavity with limbs unequal in length and breadth. Outer thin coat of testa ornamented with conspicuous tags or excrescences. Inner compact integument pitted externally, pits about 0.03 to 0.07 mm. in diameter arranged parallel with the margin of the seed. Seeds variable in size from about 1.25 by 0.9 mm. to 6 by 7 mm.

TYPE SPECIES. *Palaeocleome lakensis* n. sp.

Palaeocleome lakensis n. sp.

Plate 9, figs. 1-15

DIAGNOSIS. That of the genus.

HOLOTYPE. V.40480.

DESCRIPTION. *Seed*: Campylotropous, very variable in outline, sub-quadrangular or sub-circular, hooked or sub-obovoid, deeply emarginate between the limbs which may be slightly unequal in length, or very unequal as in the hooked seeds (Pl. 9, figs. 1, 2, 6, 7). Seeds bisymmetric, usually much flattened, the flattening increased by compression in fossilization, limbs also unequal in breadth, micropyle terminal on the narrower and usually longer limb, hilum in the emargination between the limbs, chalaza on the inner curve of the shorter limb (Pl. 9, fig. 15). Testa having an outer thin coat frequently ornamented with a series of tag-like prolongations or excrescences most apparent at the margin of the seed. They may be regularly or irregularly grouped but are usually arranged so as to diverge from the area between the limbs of the curved seed-cavity. In some seeds the excrescences are pointed and spine-like (Pl. 9, fig. 14), in others thick and blunt-ended as preserved (Pl. 9, figs. 1, 3, 6). The coat which carries the tags is finely striate, the striae being arranged in variously oriented groups, each group having a series of parallel striations due to elongate narrow cells. In parts of the testa the outer coat may be missing altogether, or it may have been partly abraded. When absent a thicker more compact integument within is exposed on which a series of deep pits can be seen arranged parallel with the margin of the seed (Pl. 9, figs. 5, 6, 10, 13, 14). The pits may be as much as 0.07 mm. in diameter. Frequently they measure 0.057 mm. in a radial direction, and 0.285 to 0.038 mm. at right angles to this (i.e. parallel with the circumference of the seed). Their outlines are rather irregular, somewhat crested or frilled. The pits are probably formed themselves by much smaller cells which can be seen in the section of this coat. The locule is both longitudinally and transversely striate, the longitudinal striae following the curvature of the limbs. In the locule lining the transverse striae are normally more conspicuous, but when the testa begins to crack, the cracks follow the longitudinal striae which thus become more conspicuous than the transverse ones (Pl. 9, fig. 8). Seeds vary considerably in size. Some typical measurements are 6 by 7 mm.; 1.25 by 0.9 mm.; 1.75 by 1.6 mm.; 2.8 by 2.5 mm.; 1.2 by 1.25 mm.; 1.75 by 1.25 mm.; 3 by 2 mm.; 1.5 by 1.4 mm. In each case the first measurement is parallel with the limbs of the seed, the second is across the breadth of the two limbs at right angles to the first.

REMARKS. Numerous seeds. The curved form with emargination between the limbs and the character of the integuments indicate the family Capparidaceae. Seeds with an outer coat having irregular tag-like excrescences are to be found in *Crataeva* (otherwise unlike the fossil) and in *Cleome* e.g. in *C. gigantea*. The species of *Cleome* seen have more inflated seeds with greater regularity of outline. *C. gigantea* appears to be less coarsely pitted whereas in *C. violacea* the pits are coarser than in the fossil. The resemblance is not sufficiently close to justify the ascription of the fossil to *Cleome*. It is here referred to a new genus *Palaeocleome* to indicate the general resemblance described above, not implying any direct derivation of *Cleome* from the fossil. All seeds so far obtained except one come from the fine silt at the base of the section to the west. Their abundance in this matrix associated with *Scirpus* suggests a water or marsh plant of gregarious habit. The family Capparidaceae occurs in the tropics and warm regions of both hemispheres. Some genera frequent stream banks, so that the habitat suggested is not an impossible one within this family.

- V.40480 Holotype, figured Pl. 9, fig. 1. A typical seed showing a relatively broad short outline.
 V.40481 Figured Pl. 9, fig. 2. An unusually exaggerated hooked form of seed with marked surface tags.
 V.40482-83 Figured Pl. 9, figs. 3, 4. Two broad seeds with basal emargination.
 V.40484 Figured Pl. 9, fig. 5. A seed with beautiful hooked form, few surface tags preserved and the pits of the inner hard layer of the testa finely displayed.
 V.40485 Figured Pl. 9, fig. 6. Another hooked seed showing both coats of the testa.
 V.40486 Figured Pl. 9, figs. 7, 8. One valve of a seed showing a somewhat worn external surface and the seed-cavity on the opposite side.
 V.40487 Figured Pl. 9, fig. 9. A seed with unusually developed excrescences especially at the base of the chalazal limb.
 V.40488-89 Figured Pl. 9, figs. 10, 11. Two hooked seeds with the coats displayed.
 V.40490 Figured Pl. 9, fig. 12. A broad emarginate seed with conspicuous excrescences.
 V.40491 Figured Pl. 9, fig. 13. An unusually small seed of compact sub-quadrangular form.
 V.40492 Figured Pl. 9, fig. 14. A hooked seed with spine-like excrescences.
 V.40493 Figured Pl. 9, fig. 15. A seed-cast showing the curved form of the cavity, the long micropylar limb, and the shorter broader chalazal limb. The hilum lies between the limbs. Part of the detached testa is also preserved.
 V.40494-96 Numerous seeds showing variation in form. V.40496 a typical seed from coarser beds above fine silt. All except V.40496 from fine silt, base of section, western end, Lake.

Genus CAPPARIDISPERMUM Chandler, 1957: 98

Capparidispermum eocenicum n. sp.

Plate 9, figs. 16, 17

DIAGNOSIS. Campylotropous seed rounded or transversely oval in outline, bisymmetric with curved limbs unequal in length and breadth. Flattened somewhat at right angles to the plane of symmetry. Testa with regularly arranged superficial pits parallel with the outline of the seed, about 0.027 to 0.055 mm. in diameter. Diameter of seeds, 0.7 to about 1 mm.

HOLOTYPE. V.40497.

DESCRIPTION. *Seed*: Campylotropous, rounded or transversely oval in outline with an emargination between the two limbs marking the hilum, bisymmetric, flattened at right angles to the plane of symmetry, but the flattening considerably exaggerated by compression in fossilization. Testa where best preserved ornamented with regularly arranged shallow pits or depressions concentric with the outline of the seed (Pl. 9, fig. 17). The rims of the pits show

small tags or sinuosities and it is possible that the large pits themselves are built up of very much smaller cells as in *Palaeocleome* (p. 67). Diameter of pits about 0.027 to 0.055 mm. Dimensions of two seeds: 1) 1 (breadth) by 0.7 mm. 2) 0.855 (breadth) by 0.7 mm.

REMARKS. The characters are those of Cappariaceae. The small seeds somewhat resemble *Tovaria* in size, but the seeds of *Tovaria* are ornamented with tubercles not pits. The closest resemblance appears to be with *Cleome*. In *C. violacea* the diameter is about 1 by 0.9 mm. and the pits which are similar to those of the fossil but even more regular are about 0.055 to 0.082 mm. in diameter. Hence the fossil is smaller and more finely pitted than this living species.

V.40497 Holotype, figured Pl. 9, fig. 16. A crushed seed. The pits are present but owing to the compressed condition do not show clearly in the photograph.

The original of Pl. 9, fig. 17 was unfortunately lost. It showed the pits particularly clearly as can be seen from the figure.

V.40498 A second specimen showing pits clearly.

All the above from fine silt, base of section, western end, Lake.

Family HAMAMELIDACEAE

Genus PROTOALTINGIA Reid & Chandler, 1933: 247

Protoaltingia hantonensis n. sp.

Plate 9, figs. 18-24

Note: Carbonaceous ovoid fruiting heads identical with some from the Bournemouth Freshwater and Marine Beds occur at Lake in a much battered and abraded condition. Impressions of similar heads are described on p. 163, Pl. 28, figs. 6-8 from the Dorset Pipe-clay. In order that the evidence may be fully given the present description is based on the better preserved specimens from the Bournemouth Freshwater Beds some of which are illustrated here for comparison with the poorer Lake material.

1961b *Protoaltingia hantonensis* Chandler, p. 121, pl. 26, fig. 60.

DIAGNOSIS. Fruiting heads agglomerated, ovoid with numerous close-set capsular fruits sunk in rounded areoles. Fruitlets two-loculed, four-partite distally, without awns, free segments of capsules curved. Length of largest head, 20 mm.; breadth, 15 mm.

HOLOTYPE. V.40499 from Bournemouth Freshwater Beds of Bournemouth.

DESCRIPTION. *Fruiting head:* Ovoid (much compressed in fossilization), agglomerate, having a longitudinally striate peduncle and a short axis (as evidenced by the ovoid form). Surface divided into many quadrangular or polygonal areoles leading into funnel-shaped cavities or alveolae; more than sixteen were counted on one of the compressed faces, while immature heads show at least sixty, many of which would probably have failed to reach maturity. The margins of the areoles appear at the surface as broad nodular bands which sweep around the cavities forming ridges between them. Each areole contains a fruitlet. Length of head, 16 mm.; breadth, 13 mm.; length of peduncle, 6 mm. The measurements were made on an external cast, hence they give the dimensions before shrinkage which has invariably occurred in the actual specimens owing to drying. Length of a dried carbonaceous head, 12.5 mm.; breadth, 6.5 mm. Length of a second head, 8.5 mm.; breadth, 6 mm.

Fruitlets: Capsular, syncarpous, two-loculed, usually with antero-posterior locules, splitting and gaping loculicidally in the distal part above the top of the septum, the split extending across both locules (Pl. 9, fig. 21). Also splitting septicidally (partially at least) so that the distal end is four-partite with four rounded crescentic cusps not produced into awns. In immature fruits the cusps are well marked, and are often placed so as to lie accurately at the four corners of a square (Pl. 9, fig. 18). External surface of cusps much puckered covered by a shining epicarp of equiaxial cells, 0.012 mm. in diameter, showing also in parts large angular cells or puckerings about 0.05 mm. in maximum diameter. Septum traversed by a median fibrous axis. The pericarp is formed of sub-parallel fibres which diverge transversely or obliquely from the fibrous axis. The wall is cavernous in parts. The endocarp appears to have been persistent.

Seeds: Apparently pendulous, small, much shrivelled, striate with some coarse cells, but too ill-preserved for adequate description.

REMARKS AND AFFINITIES. Eighteen specimens from the Bournemouth Freshwater Beds have been examined, two of which have external moulds preserved. Three Bournemouth specimens (V.40499, V.40500, V.40501) are figured here for comparison with the four battered fruiting heads from Lake. All the Lake specimens are much compressed, abraded and sand-pitted, but the areoles on the surface are nevertheless clearly visible and the fruitlets with their four-partite distal extremities are sometimes preserved. One mature but imperfect specimen has a short striate peduncle (Pl. 9, fig. 22), but its areoles are empty, the fruits having been shed. The agglomerated heads, numerous two-loculed fruitlets and fibrous pericarp all indicate relationship with *Liquidambar* or *Altingia* of the family Hamamelidaceae. *Liquidambar* differs in its dehiscence, being septicidal only, the split dividing the apex of the elongate fruit into two segments which form a pair of long awns. As there is no loculicidal dehiscence these are not further divided into four segments.

In *Altingia* loculicidal and septicidal dehiscence both occur so that the distal ends of the fruitlets are divided into four segments as in the fossil but living species of *Altingia* are readily distinguished by the somewhat more attenuated apices of the fruitlets which produce four awns on splitting, whereas there is evidence in the shining epicarp of the Bournemouth (Sandbanks) specimens that the knob-like segments of the fossil fruits were never further prolonged. In *Altingia* the locules although normally antero-posterior sometimes lie side by side while in the fossil they are arranged antero-posteriorly (one above the other) generally. In a number of characters the fossils agree more closely with *Protoaltingia* from the London Clay than with living *Altingia* or *Liquidambar*. This genus, based on one somewhat larger ovoid fruiting head with fewer fruitlets than the Bournemouth heads, has fruitlets with antero-posterior locules and marked loculicidal dehiscence (more conspicuous than the septicidal dehiscence which probably preceded it). The worn state of the London Clay specimen gives no indication whether its fruits were originally awned or not but it reveals a cavernous structure in the endocarp which has been observed in some of the specimens from Sandbanks.

On the whole the evidence points to a closer affinity with *Protoaltingia* than with *Liquidambar* or *Altingia*. The fossils are therefore referred to a new species of that genus, *Protoaltingia hantonensis*.

A table showing the characters of several closely allied genera of composite fruited Hamamelidaceae is appended.

TABLE TO SHOW DISTINCTIVE FEATURES OF SEVERAL COMPOSITE FRUITED
HAMAMELIDACEAE

Characters	<i>Liquidambar</i>	<i>Altingia</i>	<i>Protoaltingia cocenica</i> R. & C. (London Clay)	<i>Protoaltingia hantonensis</i> (Lower Bagshot to Upper Eocene; Dorset and Hampshire coasts)
Form of Head	Globular	Globular or somewhat ovoid sometimes with short axis	Ovoid with short axis	Ovoid with short axis
Orientation of locules	Antero-posterior usually	Lateral sometimes, antero-posterior usually	Antero-posterior	Antero-posterior
Mode of dehiscence	Septicidal only at the distal end of fruit	Both septicidal (usually first) and loculicidal (usually second but often more obvious)	Loculicidal and septicidal, the former the most obvious extending across both locules above the septum	Loculicidal and septicidal, the former the most obvious extending across both locules above the septum
Character of awns	Two long awns formed by septicidal splitting of fruit apex	Four segments or awns	Surface abraded, awns if ever present worn away. Surface of endocarp as preserved two- to four-partite	Four short rounded cusps associated with the loculicidal and septicidal splitting. Surface of endocarp two- to four-partite
Character of carpel wall	Fibrous	Outer part of pericarp cavernous, inner fibrous	Oblique or transverse fibres and cavernous tissue	Fibrous largely but cavernous in parts in specimens from Sandbanks
Measurements	Length and breadth, 25 to 30 mm.	Length of head, 15-17.5 mm.	Length, 22 mm.; breadth, 16 mm.	Length, 16 mm.; breadth, 13 mm.

Altingia has about six species in the Old World in India, Siam, the Malay Peninsula and Islands, and China. *Liquidambar* has some five species in China, Formosa, North and Central America and Asia Minor.

- V.40502 Figured Pl. 9, fig. 22. A fragment of an agglomerated fruiting head showing remains of the peduncle and empty areoles from which the fruitlets have fallen.
- V.40503 Figured Pl. 9, fig. 23. An immature fruiting head exactly comparable with specimens from Bournemouth showing rather obscurely the four-partite fruits.
Figured Pl. 9, fig. 24. An immature head (incomplete). Now decayed.
- V.40504 Part of a battered fruiting head.
All the above from Lake.

Genus?

Plate 8, figs. 27, 28

DESCRIPTION. *Seed*: Elongate-ovoid, obliquely truncate at the broad end so as to produce a sharp angle at one margin, narrowed to a sharp point at the opposite end. At the broad hilar end there is a large, broad, oblique sunk facet extending for almost one-third of the length of the seed. Longer side of the seed markedly convex; shorter margin with a slight concavity towards the pointed end of the seed. Preservation too poor to show the raphe and chalaza. Surface originally smooth although now much worn, but still showing remains of longitudinally aligned and elongate cells which frequently taper at the ends and dovetail into one another. Walls of these cells definitely smooth, not digitate. Length of cells about 0.114 to 0.12 mm.; breadth about 0.028 to 0.038 mm. Where somewhat abraded a smooth coat of sinuous-walled or digitate more or less equiaxial cells is seen. They are about 0.027 mm. in diameter. Beneath this coat and over the worn surface of the large hilar facet oblique elongate cells and fibres are visible which appear to form the main thickness of the testa. The oblique fibres are also visible on the inner surface through the lining of the seed-cavity. The lining, rarely preserved, is of small angular equiaxial cells. Length of seed, 5.25 mm.; maximum breadth, 2.25 mm. Maximum length of hilar facet, 2 mm. Breadth across the obliquely truncate base of seed, 1.5 mm.

REMARKS. One valve of a seed (since decayed) which has split longitudinally. The specimen was crumbling and somewhat pyritized. Its hilar facet is larger and longer than that of *Hamelis* or *Sinowilsonia*, but not so long as that of *Corylopsis*. Although no generic name has been given the seed clearly belongs to the section Hamamelidoideae with one subovoid, wingless, obliquely faceted seed. From Arne.

Family LEGUMINOSAE

Genus?

Plate 9, fig. 25

A seed now collapsed so that the original form is obscure. Surface smooth and shining of equal and equiaxial fine cells about 0.005 mm. in diameter. Wall of two layers, an outer showing in section fine columnar cells corresponding to the surface pits, and coarser oblique cells which also give a columnar effect; the outer coat is about 0.05 mm. thick. Within is a coat

about 0.025 mm. thick with more obscure cell structure the cells appearing to lie longitudinally and to be formed by the incurved ends of the coarse cells in the outer layer. Maximum diameter of seed (as preserved), 3.25 mm. The specimen itself (V.40505) is so obscure that it is impossible to produce a convincing and satisfactory illustration of it. From Lake.

Family RUTACEAE

Genus PHELLODENDRON Rupr.

Phellodendron costatum Chandler

Plate 10, fig. 1

- 1925 *Phellodendron costatum* Chandler, p. 28, pl. 4, fig. 6a-c.
1961 *Phellodendron costatum* Chandler: Chandler, p. 75, pl. 7, figs. 10, 11.
1961b *Phellodendron costatum* Chandler: Chandler, p. 125.

DESCRIPTION. *Seed*: Bisymmetric, subovoid, somewhat constricted near the apex so as to form a slight apical knob which curves towards the ventral margin. Ventral margin broad, flat with a median strap-shaped sunk hilar scar with raised edges extending throughout its whole length. The entrance of the raphe into the testa is on this scar at the broad end of the seed. The micropyle is conspicuous at the opposite end of the scar on the apical knob. The seed is bluntly angled dorsally in the plane of symmetry. External surface ornamented with about twenty-four rather acute longitudinal ribs, most of which terminate at the apical constriction, with occasional obscure transverse spurs and conspicuous fine transverse striations, 0.03 mm. apart, formed by transversely oblong areas (cells?). A few shorter ribs tend to converge on the ventral facet towards the elongate hilar scar. Length of seed, 3.5 mm.; breadth and thickness, 2 mm.

REMARKS AND AFFINITIES. One perfect seed (V.40506) identical in every respect with *P. costatum* Chandler from the Lower Headon of Hordle. The relationship to *Phellodendron* was discussed by Chandler (1925: 28). From Arne.

Genus RUTASPERMUM Chandler, 1957: 102

Rutaspermum excavatum n. sp.

Plate 10, figs. 2-13

DIAGNOSIS. Seed markedly hooked at micropyle and hilum, the narrow triangular hilar scar, deeply sunk, on the short concave ventral margin. External coat of irregular flat cells also showing fine longitudinal striae. Inner coat rugose with conspicuously crested or nodular ridges. Length of seed, 2 to 3 mm.

HOLOTYPE. V.41932 from Bournemouth Freshwater Beds of Sandbanks.

Note: The species is based on better preserved material from the Bournemouth Freshwater Beds at Sandbanks. The description which follows is that of Sandbanks seeds but is equally applicable to the more poorly preserved Arne specimens. None has yet been found at Lake.

DESCRIPTION. *Seed*: Bisymmetric, reniform or sub-reniform, markedly hooked and pointed at micropyle and hilum; hilar scar narrowly triangular, deeply sunk on the concave ventral margin, with the hilar aperture at the broad end and the micropyle at the narrow end. Internal chalaza large, circular, situated at the opposite pole to the micropyle on the dorsal (convex) margin of the seed. Testa of several coats, external coat rarely preserved, thin, glistening, formed of regular flat equiaxial cells about 0.025 to 0.03 mm. in diameter with thin raised walls overlain by fine striae longitudinally aligned, 0.01 to 0.012 mm. apart, much as in *Zanthoxylon bungei*. Beneath the shining coat are the remains of a resinous substance, and within again is a thick hard coat which forms the surface usually preserved. This surface is rugose, the rugosities formed by nodules especially towards the ventral margin, or by interrupted nodular ridges about 0.2 mm. apart, tending, especially towards the dorsal margin, to be aligned parallel with that margin. The hard coat varies considerably in thickness in different parts of the seed, from 0.1 to 0.2 mm. for instance, in the places where it could be measured. It is formed of irregular equiaxial cells from 0.012 to 0.016 mm. in diameter as seen superficially. In section the cells are arranged in radial rows so as to produce a sub-columnar effect. Within again is a thin brown coat (tegmen?) of equiaxial cells, 0.02 to 0.025 mm. in diameter, arranged near the hilum in longitudinal rows.

The seeds vary considerably in size as indicated by the following dimensions from Sandbanks: 1) Length, 2.4 mm.; length of hilum, 1.2 mm. 2) Length, 2.75 mm.; breadth, 1.75 mm.; thickness, 1.25 mm. 3) Length, 2.25 mm.; breadth, 1.75 mm. 4) Length, 2.5 mm.; breadth, 2 mm.; length of hilum, 1.5 mm. 5) Length, 2.6 mm.; breadth, 1.75 mm. 6) Length, 3 mm. 7) Length, 2 mm. 8) Length, 2.75 mm.; breadth, 2.25 mm.; thickness, 2 mm.

REMARKS AND AFFINITIES. About thirty-six specimens from Arne all much pyritized and showing signs of decay, and a number of imperfect seeds. Also sixteen specimens from Sandbanks and two seeds and a fragment from Branksome Dene, Bournemouth. The characters are similar in the main to those of *Zanthoxylon* the living genus which they most resemble, but the seeds differ from any living species or genus in the marked superficial rugosities of the hard coat; and they have therefore been referred to the form-genus *Rutaspermum* as *Rutaspermum excavatum*. A related yet distinct species from Southbourne and Cliff End, Mudeford awaits publication.

Zanthoxylon(?) costatum Reid & Chandler from the Bembridge Beds (1926: 114, pl. 7, figs. 20, 21) has an ornamental surface. Its ridges are less marked, more regular and less nodular, while the hard coat of the testa is thicker (0.8 mm.) and the seed itself is somewhat larger.

Hofmann (1930: 50, pl. 5, fig. 28) figured from the Eocene Brown Coal of Geiseltal some ornamental seeds which she referred to *Drupa rhabdosperma* but she did not recognize their relationship with Rutaceae (section *Zanthoxyleae*). Without examination of actual material and on the slight published evidence alone, no precise comparison with any fossil from the Eocene or Oligocene of southern England can be attempted, but the Brown Coal species clearly falls within the limits of the form-genus *Rutaspermum*. Ornamental Rutaceae seeds of this kind were evidently common in Lower and Middle Tertiary deposits.

V.40515 Figured Pl. 10, fig. 13. A seed with outer shining coat preserved.

V.40516-18 Figured Pl. 10, figs. 6-8. Seeds showing the hard inner coat.

- V.40519 Figured Pl. 10, fig. 10. A seed which has split longitudinally as in germination so that the raphe, chalaza and micropyle can be seen.
- V.40520 About fifty well developed seeds showing the characteristic ornate surface of the inner hard coat. In some specimens the shining outer coat is seen. Most appear 'rusty' owing to pyritization.
All the above from Arne.

Rutaspermum striatum n. sp.

Plate 10, figs. 14, 15

DIAGNOSIS. Seed suboval in outline, somewhat inflated with short strap-shaped marginal hilar scar, surface ornamented with fine slightly sinuous longitudinal ridges which occasionally anastomose. Diameter of seed about 3.5 by 2.5 mm.; thickness about 1.75 mm.

HOLOTYPE. V.40507.

DESCRIPTION. *Seed*: Bisymmetric, somewhat inflated, suboval in outline but truncate on the ventral margin by a narrow strap-shaped hilar scar 2 mm. long, 0.4 mm. broad, micropylar aperture at one end of this scar, large; aperture for the entry of the raphe at the opposite end of it. Internal chalaza large, circular. Surface ornamented with numerous fine, slightly sinuous, longitudinal ridges often about 0.1 mm. apart which tend to anastomose, cells of surface equiaxial, 0.016 mm. in diameter. Maximum diameter, 3.5 mm.; breadth, 2.5 mm.; thickness, 1.75 mm.

REMARKS AND AFFINITIES. One seed and several fragments one of which shows the internal chalaza. The species has the form with relatively small hilar scar seen in *Zanthoxylon*, but the narrow strap-shaped form of this scar more nearly resembles that of *Phellodendron* although it is not so long as in that genus. The surface ridges are much finer than in any other species of fossil Rutaceae so far known viz. a species from Southbourne (Bournemouth Marine Beds) and two species from Hordle (Chandler, 1925: 26, 27, pl. 4, figs. 3a, b, 4a, b).

V.40507 Holotype, figured Pl. 10, figs. 14, 15. A seed.

V.40508 Two fragments of a second specimen.
Both the above from Lake.

Rutaspermum glabrum n. sp.

Plate 10, figs. 16-18

DIAGNOSIS. Seed suboval in outline, inflated, with triangular ventral facet associated with the hilar scar not sharply delimited by difference of surface or ornamentation from the surrounding testa. Testa smooth and unsculptured. Maximum diameter of seed about 2.8 to 3.5 mm.; diameter at right angles to this, 1.6 to 2.25 mm.; thickness, 2 mm.

HOLOTYPE. V. 40509.

DESCRIPTION. *Seed*: Bisymmetric, inflated, suboval in outline (similar to *R. striatum*, Pl. 10, figs. 14, 15), obliquely truncate on the upper part of the ventral margin by a flat triangular hilar scar about 2 to 2.75 mm. long and 0.8 to 0.9 mm. broad, not sharply delimited from the surrounding testa by difference of surface or ornamentation (Pl. 10, fig. 17). At one end of the scar is the aperture for the entrance of the raphe, here the ventral margin appears somewhat hooked owing to a protuberance formed by the raphe canal. A narrow median longitudinal furrow may occur on the hilar scar possibly marking the position of the funicle or the plane of

incipient splitting for germination. Surface smooth, unsculptured, formed of equiaxial cells 0.012 to 0.016 mm. in diameter. The walls vary considerably in thickness in different parts of the seed ranging from 0.4 mm. under the hilar scar to 0.05 mm. over the broad surfaces. The internal chalaza has a small circular opening in the hard testa and a circular thickened scar on the tegmen. It lies at the extremity of the longest axis of the seed away from the hilum. Tegmen translucent formed of elongate cells giving rise to striae about 0.012 mm. apart. Length of seed, 2.8 to 3.5 mm.; breadth, 1.6 to 2.25 mm.; thickness, 2 mm.

REMARKS AND AFFINITIES. Five seeds differing in the smooth testa, and in the character of the flat triangular hilar scar from *R. striatum* in which the linear scar is clearly differentiated from the ridged ornamented testa. The relationship to Rutaceae is clear from the form and structure but the seeds cannot be placed in a known living genus and have therefore been referred to the form-genus *Rutaspermum*.

V.40509 Holotype, figured Pl. 10, fig. 16. A seed, now broken.

V.40510 Figured Pl. 10, fig. 17. A seed figured to show the hilar facet and groove for funicle.

V.40511 Figured Pl. 10, fig. 18. A seed, now broken.

V.40513-14 Three seeds, V.40514 is imperfect.

All the above from Lake.

Rutaspermum magnificum n. sp.

Plate 10, fig. 19

DIAGNOSIS. Seed ovate in outline, truncate, or slightly excavated by a narrow-triangular hilar scar on the ventral margin. Surface ornamented with numerous fine slightly sinuous longitudinal rounded ridges having a tendency to anastomose. Whole surface pitted with equiaxial angular pits about 0.028 to 0.038 mm. in diameter. Maximum diameter of seed, 4.5 to 5.25 mm.; breadth in plane of symmetry, 3 to 3.5 mm.; thickness, 2.5 to 3 mm.

HOLOTYPE. V.40521.

DESCRIPTION. *Seed*: Bisymmetric, somewhat inflated, more or less ovate in outline but truncate or slightly excavated on the ventral margin by a narrow-triangular hilar scar, 2.75 to 3.5 mm. long and with maximum breadth of 1 mm. Micropyle situated at the pointed end of the seed on this scar, conspicuous. Large transverse aperture for the entry of the raphe at the opposite end of it. Scar having a median longitudinal furrow perhaps due to incipient splitting as for germination. Internal chalaza large, circular. Surface ornamented with numerous fine slightly sinuous longitudinal rounded ridges with a tendency to anastomose. They lie parallel with the outline of the seed on its dorsal surface and over the chalazal region. Whole surface including ridges pitted with equiaxial angular pits (cells) about 0.028 to 0.038 mm. in diameter. In section the testa is thick, black and crustaceous varying in thickness in different parts of the seed; maximum thickness seen near the micropylar end on the dorsal side, 0.7 mm., elsewhere 0.3 mm. was measured. Formed in section of rectangular cells so arranged that they may appear to be aligned parallel with the seed-cavity or radial to it according to the lighting of the specimen. They produce a columnar effect in sections of the wall in its inner half, but in its outer part are less regularly arranged. Typical cells measure 0.028 to 0.038 mm. in diameter. Seed-cavity lined by a closely adherent brown coat with a tendency to have a rough surface with fine transverse rugosities. It appears to be formed of more or less equiaxial cells.

Length (maximum diameter) of seed, 5·25 mm.; breadth, 3·5 mm.; thickness, 3 mm. Length of abraded seeds, 4·5 to 5·25 mm.; breadth, 3 to 3·25 mm.; thickness, 2·25 to 2·75 mm.

REMARKS. Three seeds. They differ from *R. excavatum* and *R. striatum* in their much larger size and from the former in their marked ovate outline. From the latter they differ also in the greater coarseness of the ornamentation. In respect of size and ornamentation they more closely approach *Zanthoxylon ornatum* Chandler from the Lower Headon of Hordle which may be considerably larger as well as smaller. *Z. ornatum*, however, differs in the presence of a well-defined smooth area adjacent to the hilar scar, also in the deeply excavated hilar scar. This gives a marked hooked outline to the seed. The orientation of the seed in relation to the hilar scar differs in the two species. Thus in *Z. ornatum* the angle between the line of the hilar scar and the line drawn through the micropyle and chalaza is usually not more than 20°, but in *Rutaspermum magnificum* it is over 30° so that the seed lies more obliquely in regard to the axis of the fruit.

- V.40521 Holotype, figured Pl. 10, fig. 19. A single seed which has broken irregularly longitudinally in fossilization so displaying the seed-cavity, chalaza and structure of the testa.
 V.40522 Two somewhat abraded seeds with the surface ornamentation largely worn away.
 All the above from Arne.

Family BURSERACEAE

Genus PALAEOBURSERA Chandler, 1961: 202

Palaeobursera lakensis n. sp.

Plate 10, figs. 20–26

1960 ?*Palaeobursera* sp. Chandler, p. 210, pl. 31, figs. 42, 43.

1961b *Palaeobursera lakensis* Chandler, p. 127, pl. 27, figs. 74, 75.

DIAGNOSIS. Pyrene suboval in outline, triangular in transverse section, fruit with three pyrenes. Germination valve extending from the apex for about two-thirds to four-fifths of the length. Placenta, hilum and chalaza contiguous at, or just below, or just above the middle, chalaza sub-triangular or obcordate. Length of pyrene about 3·5 to 5·25 mm.; breadth about 2·25 to 2·5 mm.; thickness, 0·5 to 1 mm.

HOLOTYPE. V.40523.

DESCRIPTION. *Fruit*: Originally syncarpous, apparently with three one-seeded pyrenes arranged tangentially on a three-sided transversely striate elongate axis to which they are attached at, just above, or just below their middles; placentas axile in a similar position. Seeds pendulous.

Pyrene: Pointed suboval in outline, flatly sub-triangular in transverse section; dorsal surface slightly convex; pointed oval in outline; lateral faces (or ventral facets) meeting to form a wide median ventral angle extending the length of the pyrene. Angle pierced at, just below, or just above the middle by a transverse upward curved aperture (attachment) through which the funicle passed to the contiguous ventral placentae. Germination by the opening of an oval

or ovate valve occupying the upper two-thirds or four-fifths of the dorsal face. Wall formed superficially of equiaxial polygonal cells, 0.03 mm. in diameter, and within of thick-walled sinuous cells about 0.025 mm. in diameter. Owing to the much compacted condition the regular hexagonal-celled layer so characteristic of Burseraceae has not been distinguished.

Thickness of wall as seen in section, 0.325 mm.; dimensions of several pyrenes: 1) Length, 5.25 mm.; dorsal breadth, 2.5 mm.; breadth of ventral facets, 0.75 and 1.75 mm.; length of ventral face between base and attachment, 2.25 mm. 2) Length, 4.5 mm.; breadth of ventral facets both 1.75 mm. 3) Length, 5.1 mm.; breadth (somewhat crushed), 2.5 mm.; length of dorsal valve, 4 mm. 4) Length, 3.5 mm.; dorsal breadth, 2.25 mm.; length of ventral face between apex and attachment, 2 mm.; length on internal surface (i.e. on the locule) from apex to top of chalazal scar, 1.25 mm. 5) Length, 5 mm.; breadth, 2.25 mm.; length of ventral face between base and attachment, 2.25 mm. The dorsiventral thickness varies from 0.5 to 1 mm.

Seed: Solitary when ripe (so far as seen), hilum ventral, adjacent to and just above the level of the placentas; chalaza ventral, broadly triangular or obcordate the pointed apex immediately overlain by the hilum. Testa with fine divergent striae around the chalaza.

REMARKS AND AFFINITIES. The form, arrangement of organs and character of germination valve indicate relationship with Burseraceae. The shape and number of the pyrenes recalls the trigonous fruits and carpels of the fossil *Tricarpellites* Bowerbank and the living *Canarium*. The obcordate or triangular chalaza is like that of *Tricarpellites*, *Bursera* or *Commiphora*, and is unlike the curved band seen in *Canarium*, *Protium* and the extinct *Protocommiphora* Reid & Chandler. The absence of an appreciable length of raphe separating hilum and chalaza recalls *Protocommiphora*, *Canarium* and species of *Bursera* such as *B. palmeri*. The characters of several genera are set forth in a table below although there appears from Herbarium sheets to be some confusion in the determination of some living material. There is considerable resemblance to *Bursera* except in shape but the fossil does not agree in every respect with any one genus. It is closely comparable with *Palaebursera bognoensis* Chandler (1961: 202, pl. 20, figs. 22, 23; text-fig. 24) but has a broader ventral angle which may indicate a smaller number of pyrenes. The same species occurs at Sandbanks and Branksome Dene (Bournemouth Freshwater Beds) and at Hordle (Lower Headon). The species *P. bognoensis* occurs in the London Clay at Bognor.

At the present day the family Burseraceae is almost confined to the tropics.

- V.40523 Holotype, figured Pl. 10, fig. 20. A detached carpel or pyrene showing attachment, and dorsal valve beginning to split.
- V.40524-26, V.40529 Figured Pl. 10, figs. 21-23, 25. Four carpels. One is still attached to part of the placenta (fig. 21), one (fig. 23) has lost the germination valve, one (fig. 22) is laterally flattened, one short broad endocarp shows the chalaza the testa having adhered to the carpel and the germination valve come away so exposing the interior of the ventral wall (fig. 25).
- V.40528 Figured Pl. 10, fig. 24. A typical carpel.
- V.40530 Figured Pl. 10, fig. 26. A pyrene with germination valve removed and the lower part transversely fractured. The chalaza can be seen as the testa adheres to the carpel wall. It is obscure in the photograph, but very clear on the specimen itself which has been macerated with nitric acid.
- V.40527, V.40531-32, V.41941 Numerous carpels. V.40532 *E. St. John Burton Coll.*
All the above from Lake.

TABLE SHOWING ARRANGEMENT OF CARPELS AND SEEDS IN CERTAIN LIVING AND FOSSIL GENERA OF BURSERACEAE

Characters	<i>Canarium</i>	<i>Tricarpellitites</i>	<i>Commiphora</i>	<i>Protocommiphora</i>	<i>Protium</i>	<i>Bursera</i>	<i>Palaeobursera lakensis</i>
Number of carpels	3	3	2	2	2 or more	Usually 2 or 3	Probably 3
Shape of fruit	Elongate sub-ovoid trigonous	Elongate sub-ovoid trigonous	Subovoid to elongate, bisymmetric	Subovoid, bisymmetric	Subovoid	Subovoid	Elongate sub-ovoid, trigonous
Form of germination valve	About $\frac{4}{5}$ of length of endocarp	Short	—	About $\frac{3}{4}$ the length of endocarp	—	Long	Long, about $\frac{2}{3}$ to $\frac{3}{4}$ of length of endocarp
Position of hilum	Upper part of endocarp	Upper part of endocarp	Upper part of endocarp in some	Above the middle	—	Just above the middle	Just below or above, or at the middle
Raphe	No appreciable length	Short	Short	No appreciable length	Short	Short, or may be no appreciable length	No appreciable length
Character of chalaza	Curved strap-shaped	Obcordate or triangular	Obcordate or triangular	Curved strap-shaped	Curved strap-shaped	Obcordate or triangular	Obcordate or triangular

Family EUPHORBIACEAE

The family Euphorbiaceae is represented at Lake by a large number of specimens amongst which at least five species can be distinguished. Genera and species are somewhat difficult to sort and diagnose. This is chiefly because of the much crushed and even broken and imperfect condition of many specimens. The seeds are often brittle (as indeed they are in many living species), moreover a considerable degree of distortion, seen in living fruits on drying apart from effects of fossilization, has also to be allowed for in the fossil material. Determination is made laborious and difficult by the large size of the family and of some genera within it and the difficulty of examining much living material microscopically. Cell structure must be relied upon to some extent in discriminating between fruits and seeds which may be superficially similar. Often it is impossible to make a close detailed study of herbarium material and in any case the time required for such a study on a large scale is prohibitive.

The few named species here described have distinctive characters which make them fairly readily recognizable and relatively easy to diagnose.

Three of the species based on fruits as well as seeds,—*Euphorbiotheca* (? *Andrachne*) *lakensis*, *E. platysperma* and *E. tuberculata* belong to a section of the family with two-seeded locules, the Phyllanthoideae (Pax). Almost one-quarter of living Euphorbiaceous genera belong to this section while the great majority of these genera occur in the tropics of the Old World. One species known from fruits and seeds, *Euphorbiotheca digitata*, belongs to one of the sections of the family with one-seeded locules. The characters of the four species represented by both fruits and seeds are summarized for convenience in the annexed table.

Section PHYLLANTHOIDEAE

Genus EUPHORBIOTHECA Reid & Chandler, 1933: 284

Euphorbiotheca (? *Andrachne* Linn.) *lakensis* n. sp.

Plate 11, figs. 1-6; Text-fig. 13

DIAGNOSIS. Fruit subglobular, slightly three-lobed, three-loculed, locules two-seeded. Seed subovoid, angled ventrally and at the margins of the dorsal surface so as to be somewhat triangular in transverse section, pointed or mucronate at the micropyle, rounded at the chalaza. Chalaza in the crushed seeds marked by a circular tumescence enclosing a flattened cavity which in the fossil state communicates with the exterior by a small circular aperture. Main thickness of testa formed of elongate cells with fine superficial transverse striae. Dimensions of fruit, 2.6 to 3.75 mm. Length of seed, 2 to 2.75 mm.

HOLOTYPE. V.40533.

DESCRIPTION. *Fruit*: (Pl. 11, figs. 1, 2) Subglobular but slightly three-lobed and dorsi-ventrally depressed, exocarp gummy? (or oily or resinous?), thin, rugose. Endocarp three-loculed, the locules corresponding with the three lobes, having six longitudinal ridges, one down the middle of each lobe and one down each of the grooves between the lobes. The ridges mark planes of loculicidal and septicial dehiscence. Surface of endocarp finely and evenly pitted,

TABLE TO SHOW DISTINCTIVE FEATURES OF CERTAIN FOSSIL EUPHORBIAEAE FROM LAKE

Characters	<i>Euphorbiotheca lakensis</i>	<i>E. platysperma</i>	<i>E. tuberculata</i>	<i>E. digitata</i>
Number of carpels	3	2-3	2-3	2-3 usually 3
Shape of fruit	Subglobular three-lobed smooth externally	Subglobular somewhat rugose	Subglobular somewhat rugose	Subglobular to ovoid, rough or wrinkled
Size of fruit	Diameter, 2.6 to 3.5 mm. Height, 2.5 mm. but most fruits too compressed for measurement	Diameter, 3.75 mm. Height, 3.25 mm.	Diameter, 3.5 mm. Height, 3.75 mm.	Diameter, 3 to 4.5 mm. Height, 3 to 5.5 mm.
Number of seeds per locule	2	2	2	1
Form of seed	Ovoid, with chalazal tumescence	Ellipsoid or ovoid	Subovoid	Oblong-ovoid
Surface of seed	Shining, transversely striate but with longitudinal cells. Testa shredding longitudinally	Rather smooth covered by pitted diaphanous aril	Surface formed of convex cells with convex centres and flat margins. Cell walls form ridges	Shining with digitate cells. Knob-like thickening around micropyle. Chalaza with external depression. Testa main thickness somewhat nodular shredding longitudinally
Size of seed	Length, 2 to 2.75 mm.	Length, 1.7 to 2.55 mm.	Length, 1.4 to 3.4 mm.	Length, 2.75 to 3.25 mm.
Peculiarities	Chalaza overlain by flat cavity in thickness of testa which communicates with the exterior by a small orifice			

the pits about 0.01 mm. in diameter arranged in rows so as to produce parallel oblique striae which diverge sharply from the suture lines; walls thin, about 0.1 to 0.15 mm. in section, showing oblique fibres in section. Septa formed of longitudinal or oblique fibres. Locule lining of elongate cells which diverge obliquely from the apical placentae producing oblique striations. Seeds pendulous, locules two-seeded (Pl. 11, fig. 3). Diameter of holotype, 3.5 mm.; height much diminished by compression. Diameter of a second fruit, 3.5 by 3.75 mm. Diameter of a third fruit, 2.6 mm.; height, 2.5 mm.

Seed: Subovoid having three longitudinal angles one being median and ventral, the others at the junction of the dorsal and lateral surfaces, hence in tranverse section the seed is triangular. Anatropous, pointed or mucronate at the micropyle, with chalaza at the opposite rounded end indicated externally (as preserved) by a circular tumidity about 0.7 mm. in diameter. The tumidity is pierced at its centre by a circular aperture about 0.1 mm. in diameter

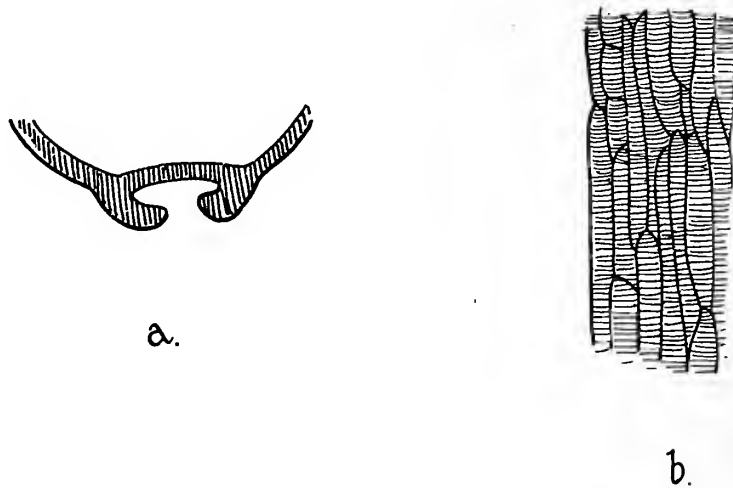


Fig. 13. *Euphorbiothea lakensis* n. sp.

- (a) Longitudinal section through chalaza. Diagrammatic.
 (b) Diagrammatic drawing of surface of testa showing elongate cells and transverse striae (? impression of aril).

(Pl. 11, figs. 3, 6). This was probably closed in life by the raphe and thin outer layers of testa now macerated or worn away. As seen in longitudinal section, the aperture leads into a flattened lenticular cavity in the thickness of the testa or between two layers of the testa (Text-fig. 13). It coincides with a circular internal chalaza scar with rough surface about 0.85 mm. in diameter. Raphe obscure owing to longitudinal cracking of the brittle testa (or possibly abraded with the missing outer integument). Testa as preserved showing externally fine transverse striae about 0.007 mm. apart which appear to be remains or impressions of the thin outer coat. Actual traces of a filmy light coloured coat are seen on the surface in a few specimens. Main thickness of testa formed of oblong, flat or somewhat convex cells, commonly about 0.05 mm. long and 0.016 mm. broad at the middle of the seed (Text-fig. 13), diverging from the chalaza and micropyle and diminishing in size towards these organs. This coat is extremely brittle and splits longitudinally when compressed showing coarse radially arranged cells in section, either straight and at right angles to the surface, or else oblique to the surface, or sometimes curved.

This columnar coat is lined by a layer which produces transverse striations. Within again are the obscure decayed remains of a thick coat of equiaxial shining cells about 0.019 mm. in diameter. Tegmen thin, translucent, showing longitudinal striae, 0.01 mm. apart, diverging from the chalaza. Dimensions of a number of seeds are: 1) Length, 2 mm.; breadth, 1.3 mm. 2) Length, 2.6 mm.; breadth, 1.5 mm. 3) Length, 2.75 mm.; breadth, 2 mm. 4) Length, 2.75 mm.; breadth, 1.5 mm. 5) Length, 2 mm.; breadth, 1.5 mm. 6) Length, 2.2 mm.; breadth, 1.25 mm.

REMARKS AND AFFINITIES. A few more or less complete fruits, numerous broken ones, and a large number of seeds as a rule more or less broken and usually crushed if complete. Fruits and seeds are typical of Euphorbiaceae. The two-seeded locules point to the section Phyllanthoideae. Smooth thin-walled capsules similar in character and only a little larger than the fossils occur in *Andrachne* Linn. and *Securinega* Comm. ex Juss. In both these genera the testa has a similar thick brittle integument closely comparable in character and cell structure with that of the fossil. There are similar transverse striae upon its surface due to a thin filmy outer layer. In its crushed condition it is difficult to form a precise and accurate idea of the shape of the fossil seed but there are certainly indications of three longitudinal angles as in *Andrachne*. Further the aperture over the chalaza was terminal more or less as in this genus, and not situated on the ventral side of the seed well below the greatest diameter as in *Securinega*. Neither *Andrachne* nor *Securinega* show a tumescence surrounding the chalazal aperture but it is highly probable that in the fossil the tumescence (which delimits the cavity over the inner chalaza) is emphasized and displayed largely as the result of shrinkage and crushing of the seeds and that it would not be apparent in fully inflated uncrushed seeds. In view however of the differences mentioned which may or may not be of much significance, the fossil has been placed in the form-genus *Euphorbiotheca* and referred tentatively only to *Andrachne*. The specific name *Euphorbiotheca* (? *Andrachne*) *lakensis* indicates the place of origin and has been given on account of the distinctive and recognizable character of the fossil. *Andrachne* occurs in tropical to warm temperate regions of the world. In Yunnan and western China it ascends to 9,000 and even 10,000 ft.

V.40533 Holotype, figured Pl. 11, figs. 1, 2. A fruit with exocarp abraded; loculicidal dehiscence has just begun so that one seed is exposed and shows the lateral angles. The two ends of the somewhat dorsiventrally compressed fruit are shown in the figures.

V.40534-36 Figured Pl. 11, figs. 4-6. Three seeds, all much crushed.

V.40537 Figured Pl. 11, fig. 3. A pair of seeds lying in a locule; one shows the chalaza (*ch*).

V.40538-42 Fruits and numerous seeds some embedded in fragments of fruits. V.40542 from base of section by ironstones in foreshore.

All the above from coarse sands, Lake.

Euphorbiotheca platysperma n. sp.

Plate 11, figs. 20-23

DIAGNOSIS. Fruit subglobular, two to three-loculed, locules two-seeded. Seeds ellipsoid or ovoid. Surface fairly smooth, outer coat diaphanous, inner coat columnar in section, transversely striate internally. Lining layer of equiaxial cells. Length of fruit about 3.25 mm. Length of seed, 1.7 to 2.55 mm.

HOLOTYPE. V.40569.

DESCRIPTION. *Fruit*: Subcircular (originally subglobular now laterally compressed in fossilization), clearly two-loculed and with traces of a third abortive locule. Seeds pendulous, locules two-seeded. Exocarp secreting, rugose superficially, thin. Length of fruit, 3.25 mm.; breadth (crushed), 3.75 mm.

Endocarp: Agreeing with the fruit in form. Having fine concave cells superficially, aligned in straight rows diverging at acute angles from longitudinal and septical sutures as in Euphorbiaceae. The angles open upwards over the septa. Thickness of endocarp in section, 0.07 mm. Locule lining obliquely striate, the striae being formed by elongate cells, 0.016 mm. broad, which diverge from the placenta. Septa gaping at the middle of the fruit in the lower part so that in the ripe fruit at least, the locules communicate with one another.

Seed: Ellipsoid or oval (flattening may be original or due to unripe condition?), anatropous, having a more or less smooth surface, rounded at the chalazal end, with a slight inconspicuous knob at the micropylar end surrounding the sunk micropylar aperture, exact position of hilum obscure. Outer coat diaphanous, closely adhering to the next within, sometimes projecting as a thin marginal flange around the circumference of the flattened seeds, it carries the longitudinal raphe, and is formed of equiaxial cells 0.016 mm. in diameter. Within is a relatively hard finely pitted coat, 0.025 mm. thick, which forms the greatest part of the thickness of the testa, its cells are arranged at right angles or oblique to the surface of the seed, occasionally they are slightly curved. The general effect in sections of the testa is of short, straight, or oblique, or curved columns, about 0.012 to 0.018 mm. broad. Within the hard coat is a layer of transversely elongate and aligned cells producing transverse striations 0.016 mm. apart. The innermost coat of all is formed of thin-walled equiaxial cells about 0.025 mm. in diameter. Dimensions of seeds: 1) Length, 2.5 mm.; breadth (much compressed), 1.3 mm. 2) Length, 1.8 mm.; breadth (much compressed), 1.3 mm. 3) Length, 1.7 mm.; breadth, 1.3 mm.

REMARKS AND AFFINITIES. A few fruits and fragments of fruits. The relationship is clearly with Euphorbiaceae, and the fossil has a somewhat similar appearance to *Euphorbiotheca digitata* (p. 86), but the locules are two-seeded so that it belongs to a different section of the family from that species. In addition the seeds are smaller, flatter (probably an original character) and without the thick hard shining outer coat of digitate cells so characteristic of the testa in that species, whereas the thin diaphanous coat outside the columnar layer is more conspicuously developed. The structure of the seed coats resembles that of *Breynia* Forst. in which the fine-celled filmy outer coat is like a thin soft skin. Within there is a harder layer formed superficially of rounded or square cells, about 0.018 to 0.027 mm. in diameter. They are arranged in longitudinal rows. The fruit is smooth, scarcely lobed and may be thin with papery texture. *Breynia* is a tree or shrub occurring in mixed woodlands and thickets in the tropics of Asia, Australia and the Pacific Islands. Herbarium sheets from China (Chekiang, Fukien, Hainan etc.) were examined at Kew. The small genus occurs in the mountains of Indo-Malaya. In view of limitations of knowledge of the fruits of other living genera, this fossil also is referred to the form-genus *Euphorbiotheca*, with the distinct specific name *Euphorbiotheca platysperma*.

V.40569 Holotype, figured Pl. 11, figs. 20, 21. A three-loculed fruit showing seeds and septa, one septum with characteristic diagonal split.

V.40570-71 Figured Pl. 11, figs. 22, 23. Two seeds and the remains of a carpel (now detached) from which one of them (V.40571) came.

- V.40572 Part of a fruit showing two locules with one of the seeds preserved in each locule. The seeds are much flattened but the transparent outer coat is clearly seen overlying the thicker coat within and on one seed the raphe forms a marked ridge.
- V.40573 A fragment of a carpel with a flattened seed showing the prominent raphe and the thin outer coat forming a projecting flange.
- V.40574 A fragment of a fruit (now in three pieces) with seed.
- V.40575 A seed, and the carpel from which it came.
All the above from Lake.

Euphorbiotheca tuberculata n. sp.

Plate 12, figs. 1-4

DIAGNOSIS. Fruit subglobular to ovoid, two- to three-loculed. Locules two-seeded. Seeds subovoid with marked longitudinal rounded raphe ridge, surface showing regular conspicuous convex cells forming low tubercles about 0.02 to 0.025 mm. in diameter. Testa coarsely columnar in section. Length of fruit about 3.75 mm.; breadth about 3.5 mm. Length of seeds, 1.4 to 3.4 mm.; breadth, 0.4 to 0.5 mm.

HOLOTYPE. V.40576.

DESCRIPTION. *Fruit*: Subglobular or ovoid, syncarpous, two- or three-loculed but with structure obscured by severe crushing. External surface unevenly rugose, walls in section more or less columnar with oblique columns near the apex. Septal surfaces with elongate cells diverging diagonally from the sub-apical placenta producing raised striae about 0.02 mm. apart. Septa thin. Seeds pendulous, two in each locule. Length of a crushed fruit, 3.75 mm.; breadth, 3.5 mm.

Seed: More or less subovoid, but angled longitudinally by mutual pressure and having a marked longitudinal rounded raphe angle (Pl. 12, fig. 3). Surface of testa formed of regular conspicuous convex cells about 0.02 to 0.025 mm. in diameter, the convexities sometimes occupying only the centres of the cells and surrounded by a flat margin, cell walls forming fine ridges between adjacent cells. Testa columnar in section, the coarse cells producing short stout columns about 0.02 to 0.025 mm. broad, the length of the columns (thickness of coat) being from 0.05 to 0.07 mm. Within the columnar coat there may be a thick light brown substance (endosperm or an inner coat?). Length of two seeds in a fruit, 3.4 and 1.4 mm.; respective breadths (compressed), 0.4 and 0.5 mm.

REMARKS AND AFFINITIES. Three specimens. One was originally more or less perfect (Pl. 12, fig. 1) but is now shattered (Pl. 12, fig. 4). A second was incomplete. A third crushed and broken, is two-loculed. One seed with conspicuous raphe is seen in one locule, two crushed seeds are seen in section in the other (Pl. 12, fig. 3). Again the characters indicate Euphorbiaceae, section Phyllanthoideae. The surface of the testa with its convex cells and the coarseness of its columnar structure in section, distinguish this species from all others found at Lake. Unfortunately the preservation is rather poor and the specimens recognized are few, but the characters seem clear and a new specific name has therefore been given, *Euphorbiotheca tuberculata*. More material may eventually be found but the crushed condition makes sorting of these rounded Euphorbiaceae very difficult and specimens may still remain among the unclassified material.

- V.40576 Holotype, figured Pl. 12, fig. 3. A two-loculed fruit broken so that one seed with raphe ridge is seen in surface view in one locule and two in section closely squeezed together in the other locule.

- V.40577 Figured Pl. 12, figs. 1, 2. A fruit now in fragments, much crushed but showing seeds with characteristic surface.
- V.40578 Figured Pl. 12, fig. 4. Originally a two-loculed fruit, now much shattered showing part of a seed.
- V.40579 Several fragments of fruits with remains of seeds.
All the above from Lake.

Section?

Euphorbiotheca digitata n. sp.

Plate 11, figs. 7-19; Text-fig. 14

DIAGNOSIS. Fruit subglobular or subovoid, with two or three one-seeded locules. Seeds elongate-ovoid, or ellipsoid, raphe conspicuous, micropyle surrounded by a knob-like thickening. Seed covered by a shining aril or external integument one cell thick of finely digitate cells, within is a thin diaphanous coat of equiaxial cells, and inside that a nodular coat of longitudinally aligned cells which tends to shred longitudinally. Lining of this coat with transverse striae. Innermost coat of equiaxial often hexagonal cells. Length of fruit, 3 to 5.5 mm.; length of seed, 2.2 to 3.25 mm.

HOLOTYPE. V.40543.

DESCRIPTION. *Fruit*: Three-loculed (or sometimes two-loculed?), subglobular or subovoid (usually much distorted in fossilization, often almost flattened so that the locules are difficult to distinguish) having a rough or wrinkled exocarp, usually thin, sometimes 0.5 mm. thick, formed of oily or gummy cells arranged radially as seen in section. The exocarp tends to split longitudinally into six segments; it also readily splits away from the endocarp. Length of fruit, 3 to 5.5 mm.; breadth, 3 to 4.5 mm.

Endocarp: Subglobular or ovoid sometimes obscurely three-lobed with six longitudinal ridges marking the sutures for loculicidal and septicial dehiscence, formed superficially of fine equiaxial cells, 0.01 mm. in diameter, aligned so as to produce oblique superficial striae, those of adjacent segments meeting at sharp angles along the planes of splitting, the angles opening downwards over the loculicidal, and upwards over the septicial sutures. In section the endocarp is about 0.1 mm. thick at the middle of the fruit, with its cells arranged so as to produce a radially or obliquely columnar effect. Surfaces of the sutures smooth and finished, about 0.3 mm. broad with radially aligned cells. Locules lined by elongate cells which diverge obliquely from the apical placentae, one-seeded with pendulous seeds (Pl. 11, figs. 7, 8). Septa formed of several layers of oblique elongate cells or fibres, differently oriented in different layers; when septicial dehiscence occurs, an oblique downwardly directed split develops from the placenta diagonally across the septum (Pl. 11, fig. 12) as in many Euphorbiaceae. Also a short oblique canal directed upwards, occupied by a stout fibre, can be seen passing across the plane of septicial dehiscence from the placenta to a sub-apical aperture at the surface of the endocarp (Pl. 11, figs. 10, 11); this is another characteristic of many genera within the family.

Seed: Anotropous, more or less elongate-ovoid, or ellipsoid; raphe ventral marked by a longitudinal rounded ridge, hilum sub-terminal surrounded by a small brown thickening (part of aril?), micropyle terminal marked by a knob-like thickening with central depression leading into the aperture closed by a small plug (Pl. 11, figs. 16-19), chalaza terminal at the opposite end marked externally by a depression. Outer coat (aril?) hard, shining, formed of

finely digitate cells, 0.025 mm. in diameter near the chalaza, larger over the middle of the seed, elongate over the raphe; this coat is apparently formed of a single layer of cells, and, in section, is about 0.012 mm. thick; it is readily detached from the layer next within it (Pl. 11, figs. 7, 10, 14, 15). Inside is a thin diaphanous skin, formed of equiaxial cells, closely adherent to a rough somewhat nodular coat which is pitted superficially. The arrangement of the cells in this thick coat is such that it readily shreds longitudinally in fossilization (Pl. 11, figs. 17, 19). A somewhat similar thick longitudinally striate integument is seen in the living *Petalostigma*. The nodular coat appears in section to be formed of a layer or layers of cells arranged at right angles to the surface so as to produce a coarsely columnar effect. The columns are about 0.012 to 0.018 mm. broad. It is their outer ends which give rise to the pitting of the surface. The coat is only about 0.05 mm. thick at the middle of the seed, it thickens considerably around the micropyle where the columns of cells become longer and curved. On this coat the chalaza sometimes appears as an obscure circular scar, sometimes with a central mucro, the surrounding cells being radially and concentrically aligned. Within the hard coat is a thin shining black



Fig. 14. *Euphorbiotheca digitata* n. sp.

Longitudinal section through micropylar end of a small seed showing plug *p*, and columnar arrangement of testa cells.

coat of transversely aligned and elongate cells producing transverse striae 0.012 to 0.016 mm. apart. The innermost coat of all is a thin shining black layer of oval, rounded equiaxial or often hexagonal cells, 0.025 to 0.05 mm. in diameter, the flat or convex surfaces being separated by sunken cell walls. The cell contents may perhaps have been oily or gummy? Dimensions of several seeds: 1) Length, 2.75 mm.; breadth, 1.3 mm. 2) Length, 2.2 mm.; breadth, 0.9 mm. 3) An isolated much crushed seed probably referable to this species, length, 3.25 mm.; breadth, 2.5 mm. 4) A second isolated seed, length, 2.75 mm.; breadth, 2.25 mm.

REMARKS AND AFFINITIES. Numerous fruits, some fragmentary, many so crushed that they are difficult to identify with certainty. But a glimpse of the seeds within showing the distinctive shining integument with its digitate cells makes the identity clear. A few isolated seeds have also been found which have lost this outer integument. They show the almost equally characteristic rugose coat with pitted surface and tendency to longitudinal shredding and probably belong to this species in spite of their slightly larger size. The fossil must belong to one of the sections of Euphorbiaceae with one-seeded locules. The enormous number of genera and species in this family make it impossible to carry out an exhaustive comparison with the living material. Rugose seeds with highly polished outer integument occur in the one-seeded genus *Alchornea*, highly polished outer integuments in the one-seeded *Petalostigma*,

Buraevia and others. An inner integument with cells so arranged that it would readily shred longitudinally on maceration is seen in *Alchornea* and *Petalostigma*. Digitate cells form the outer surface of the hard coat in the one-seeded *Stillingia* but they are concave with upstanding walls and are covered by a thin translucent white coat of straight-sided equiaxial cells which forms the outermost surface of the seed. In *Agyneia* (two-seeded) parts of the carpel wall which adhere to the seed show a smooth shining surface of digitate cells. The shining outer integument of *Alchornea* compares closely in general appearance with that of the fossil and in places perhaps shows a digitate cell structure. But in no genus so far examined are the clearly delimited smooth cells with well-defined digitate sutures between them apparent in the outer coat of the seed. It is necessary therefore, temporarily at least, to refer the fossil to the form-genus *Euphorbiotheca*, with the distinctive specific name *Euphorbiotheca digitata*. On the whole the closest resemblance is to the genus *Alchornea*, which is widespread in the warmer parts of both hemispheres. It is possible that if more of the Recent species could be examined in detail reference to this genus might ultimately be possible.

- V.40543 Holotype, figured Pl. 11, figs. 7-9. A fruit now fractured to show locules and seeds.
 V.40544 Figured Pl. 11, fig. 13. An uncrushed fruit with exocarp preserved, now dissected to show locules and seeds. A fragment of the shining digitate-celled coat was clearly seen.
 V.40545 Figured Pl. 11, fig. 12. A carpel which has split septicidally showing the characteristic oblique break in the septum.
 V.40546 Figured Pl. 11, fig. 17. A perfect but compressed seed with hard coat exposed by the abrasion of the outer layer of digitate cells.
 Figured Pl. 11, fig. 19. An imperfect seed which shows the inner integument of polygonal cells and the nature of the micropylar plug and surrounding thickening. The seed has now decayed.
 V.40547 Figured Pl. 11, fig. 16. A small rather stunted seed showing the apical scar and basal rim.
 V.40548 Figured Pl. 11, fig. 18. An imperfect seed showing the well-preserved rugose or rippled surface exposed by the removal of the shining coat of digitate cells.
 V.40549-50 Figured Pl. 11, figs. 14, 15. Two seeds, one incomplete. V.40549 which shows the chalaza and raphe is small, flattened, and probably abortive. V.40550 complete but abortive? shows the form; it has lost part of the outer coat of digitate cells, but remains of carpel wall are adhering to it in places.
 V.40551 Figured Pl. 11, figs. 10, 11. A fragment of a fruit with well-preserved seed showing the shining black coat of digitate cells and the inner fibrous pitted coat. The strand of fibres and the canal through which it passes from the placenta through the carpel wall to the exterior of the fruit are clearly seen.
 V.40557 An ovate carpel (flattened in fossilization), possibly two-loculed.
 V.40558-64, V.40566-67 Several fruits, or portions of fruits, some with seeds preserved, also several fragments of carpel and seed.
 V.40565 A segment of a fruit which has split septicidally showing the characteristic diagonal split in the septum and the seeds within the locule. Abrasion has made the septum very thin.
 V.40553, V.40555 Four seeds, two mature and two immature, one with adherent remains of the carpel embracing it.
 V.40554, V.40556 Part of a fruit with exocarp showing two circular scars opposite the longitudinal median line of the locules near one end. Also part of a two-loculed distorted fruit with thick exocarp. Both doubtfully referable to this species.
 All the above from Lake.

Euphorbiotheca spp.

Plate 11, figs. 24, 25

Several endocarps clearly referable by their general structure to the family Euphorbiaceae. They vary in shape and size but all show six characteristic longitudinal ribs or angles delimiting six longitudinal facets the walls of which are formed externally of parallel obliquely oriented fibres so that those of adjacent facets meet the longitudinal rib between them at sharp angles.

In section the walls appear columnar, and are formed of fibres which are radially directed. No seeds have been seen. The evidence is insufficient for discrimination of genera and species.

V.40583 Figured Pl. 11, fig. 24. A subglobular endocarp, 2.25 mm. long, 2 mm. broad.

V.40582 Figured Pl. 11, fig. 25. An ovoid endocarp, 4.5 mm. long, 2.25 mm. broad.

Both the above from Lake.

V.40580 Numerous fragments of fruits belonging to a number of indeterminable species. Arne.

Genus EUPHORBIOSPERMUM Reid & Chandler, 1933: 289

Euphorbiospermum punctatum n. sp.

Plate 12, fig. 5

DIAGNOSIS. Seed obovoid-pointed, hilum mucronate. Surface of concave equiaxial cells about 0.03 mm. in diameter. Length of seed about 2.25 mm.

HOLOTYPE. V.40581.

DESCRIPTION. *Seed*: Obovoid-pointed, markedly mucronate at the hilar end, somewhat flattened at the chalazal end. Surface formed of concave equiaxial cells about 0.03 mm. in diameter, showing a rough longitudinal alignment; over the chalaza the surface appears finely granular and there are no polygonal cells. Length of seed, 2.25 mm.; breadth, 1.5 mm.

REMARKS AND AFFINITIES. The structure and form of the seed (V.40581) indicate relationship with Euphorbiaceae. Somewhat similar cell structure is seen in *Acalypha* and *Stillingia* but closer determination requires comparison with a larger range of living material than is available and without knowledge of the fruit characters also would be extremely difficult, laborious and perhaps unsatisfactory. *E. St. John Burton Coll.*, from Lake.

Euphorbiospermum sp.

Plate 12, fig. 6

A smaller seed (V.40585) than that of *E. punctatum*. Length, 1 mm.; breadth, 0.7 mm. with somewhat coarser surface pitting the pits being angular, rather irregular. The whole surface is finely longitudinally striate. It is subovoid with hilar mucro, somewhat flattened at the chalazal end. It differs from *E. punctatum* also in having the greatest breadth nearer the hilar end and probably represents another distinct form. From fine silt at base of section, western end, Lake.

Family EUPHORBIACEAE?

Genus WETHERELLIA Bowerbank, 1840: 84

Wetherellia variabilis Bowerbank

Plate 12, figs. 7-9

1840 *Wetherellia variabilis* Bowerbank (pars), p. 84, pl. 12, figs. 1-5, 8-40.

1933 *Wetherellia variabilis* Bowerbank: Reid & Chandler, p. 251, pl. 9, figs. 7-22.

1954 *Wetherellia variabilis* Bowerbank: Chandler, p. 173.

1961 *Wetherellia variabilis* Bowerbank: Chandler, p. 210, pl. 19, fig. 23.

Half a coccus (V.40586) the remains of a two-loculed ellipsoid fruit which has broken septically first and then loculicidally. Ventral face (= plane of septical dehiscence) flat, dorsal rounded. Locule tangentially compressed, flattened along its dorsal and ventral margins but not at the base and apex, showing an elongate ovate hollow where the long narrow seed lay. The seed was clearly narrowed to the hilar end at the upper end of the locule but the surface is here slightly broken and much corroded so that the arch of the long funicle is not preserved. The distal end lay nearer to the axis than the proximal. Wall a mass of coarse angular parenchyma, the cells varying (where they could be measured) from 0.05 to 0.1 mm. in diameter. Locule lining smooth shining originally (but now cracked all over) formed of delicate fibres the majority transversely aligned where visible. Length of valve, 12 mm. Breadth of locule, 5.5 mm.; breadth of coccus (and therefore of fruit), 8 mm. (estimated) from thickness of valve (4 mm.).

A full account of the structure of *Wetherellia* is given by Reid & Chandler (1933) and a revised estimate of the relationship by Chandler (1954). The specimen is much impregnated with pyrites in the cell cavities. It would have been difficult to interpret and describe if the numerous cocci from the London Clay had not first been handled. The identity with *Wetherellia* appears to be clear and the species forms another link between the London Clay and Lower Bagshot floras. From Arne.

Family ANACARDIACEAE

Section SPONDIEAE

Genus DRACONTOCARYA nov.

DIAGNOSIS. Endocarp subglobose, smooth surfaced, fairly thin-walled, five-loculed with unequally developed locules some of which may be abortive, locules closed by plugs which extend throughout their length. Paired foramina occur at about the equator of the endocarp between the locules; resin or secreting sacs are arranged in longitudinal rows flanking the locules (exposed by decay in fossilization of the tissues surrounding them).

TYPE SPECIES. *Dracontocarya glandulosa* n. sp.

Dracontocarya glandulosa n. sp.

Plate 12, figs. 10-21

DIAGNOSIS. As for the genus. Diameter about 4 to 12.5 mm. (Exact measurements difficult to ascertain owing to distortion and crushing). Commonly about 7 or 8 mm.

HOLOTYPE. V. 40587.

DESCRIPTION. *Endocarp*: Woody but thin-walled, syncarpous, multilocular, usually five-carpelled although one or two locules may develop at the expense of the others, some being very small and abortive thereby giving a marked asymmetry to the endocarp. Subglobular, sometimes irregularly angled (always much distorted partly through unequal development of the carpels, largely through compression in fossilization which has so flattened the endocarps

that it is most difficult to interpret their structure). Attachment basal. Locules arranged in a ring and opening to the exterior by large, usually elongate, subapical apertures closed by plugs with somewhat rugose surface. The plugs appear to extend for the whole length of the locules or for almost their whole length. They vary greatly in size and shape in individual endocarps according to the degree of development of the locules, sometimes extending almost to their base (Pl. 12, figs. 10, 13, 16). Pairs of smaller external foramina can frequently be seen approximately half-way between apex and base of the endocarps, lying, as in *Dracontomelon*, between the locules. Like the locules and plugs they too are unequally developed and cannot always be distinguished all round the circumference (Pl. 12, figs. 10, 13, 14, 17).

When the plugs are removed a smooth inner coat with a median longitudinal slit or groove is occasionally visible (Pl. 12, fig. 12).

The locules are usually longitudinally elongate and tangentially compressed or sub-cylindrical, slightly curved in longitudinal profile so as to be concave towards the exterior of the endocarp and convex towards its axis. They are narrowed below. But they vary greatly in form according to the degree of development (Pl. 12, figs. 18, 20, 21). Seeds not seen, but the testa may have been represented by a brown, semi-translucent, loosely attached lining seen adhering to one isolated plug.

Endocarp tissues obscure through the intense compression undergone, often so decayed as to be full of cavities between the stout longitudinal fibres lying between the locules at the surface. The fibres branch upwards from the attachment (Pl. 12, fig. 11). Locule lining of very small fine sinuous cells which tend to be transversely oriented. Flanking the locules longitudinal lines of closely adpressed resin sacs occur. They were originally bolster-shaped but have generally been flattened in fossilization. The resin content is clearly visible when fractured surfaces are examined. They open towards the exterior of the fruit and when partially freed by maceration from surrounding tissues they resemble lines of parietal seeds (Pl. 12, figs. 15, 21). Length of the sacs about 0.912 to 1.9 mm.; breadth about 0.68 to 1.1 mm.

Diameter of fruits, 4 to 12.5 mm. or more as compressed. True dimensions are obscured by crushing. A typical flattened specimen measures about 7 or 8 mm. in diameter.

REMARKS AND AFFINITIES. Numerous crushed and distorted endocarps, some much macerated and full of cavities due to differential decay. The resin sacs when projecting as seed-like bodies were most difficult to understand until their contents revealed their true nature, while the discovery of the crushed locules showed that they could not be seeds. No comparable macerated living material has been available for study, and such secreting sacs would only be clearly visible as separate entities after prolonged maceration had occurred. Once the relationship between the locules, plugs, and lines of resin-cavities had been discovered the connexion with the section Spondieae of Anacardiaceae was at once apparent. Five locules may occur in *Dracontomelon*, *Chaerospondias* and *Cryptocarpha*. The small paired foramina at the middle recall *Dracontomelon*. The rows of glandular cavities in longitudinal lines flanking the locules recall the presence in *Chaerospondias axillaris* of longitudinal rows of small paired apertures between the locules throughout the length of the endocarp. The markedly unequal development of the locules and consequent asymmetry of the endocarp recalls *Cryptocarpha*. The fossil differs from all genera seen in the length of the plugs which may extend almost or quite to the base of the locules. It has therefore been referred to a new genus *Dracontocarya* to indicate the general relationship. The specific name *Dracontocarya glandulosa* calls

attention to the peculiar and well-developed secreting cavities communicating with the exterior.

- V.40587 Holotype, figured Pl. 12, fig. 13. An endocarp crushed and partially split longitudinally, showing the unequally developed plugs and paired lateral apertures.
- V.40588 Figured Pl. 12, fig. 12. A crushed endocarp with a plug removed showing a smooth lining beneath with a longitudinal furrow.
- V.40589 Figured Pl. 12, fig. 14. Another much crushed endocarp. It shows very clearly a pair of lateral foramina.
- V.40590 Figured Pl. 12, fig. 19. A small endocarp, imperfect on one side. Along the fractured margin a double line of resin glands can be seen in the actual specimen.
- V.40591 Figured Pl. 12, figs. 10, 11. Another distorted endocarp. One plug is loose. Three plugs are small and poorly developed. A fourth has fallen from its aperture which is enlarged by breaking and distortion.
- V.40592 Figured Pl. 12, figs. 16, 17. Another distorted specimen with five unequal plugs preserved. It is compressed and deformed so that the apex occupies most of one flat surface and the base lies near the margin.
- V.40593-95 Figured Pl. 12, figs. 18, 20, 21. Three endocarps which have been split longitudinally. All show a locule, one shows two locules very unequally developed. V.40593 shows the resin sacs standing out like rows of seeds through decay of the surrounding tissues.
- V.40596 Figured Pl. 12, fig. 15. A fragment showing the bolster-shaped (albeit now flattened) seed-like bodies in a row. These, when fractured, were full of resin.
- V.40597-V.40601 Numerous endocarps. V.40601 *E. St. John Burton Coll.*
All the above from Lake.

Genus LANNEA A.Rich.

? *Lannea* sp.

Plate 12, fig. 22

A crushed woody endocarp (V.40602), now fractured, formed of gnarled fibres, the strands being twisted or divided to enclose hollows. One-loculed, one-seeded, with a single finely pitted ill-preserved seed. The condition of the specimen is too poor to permit of closer determination, but as the form and structure recall the much larger *Lannea caffra*, it has been referred doubtfully to the genus *Lannea*. Length of endocarp, 9.75 mm.; breadth, 5.1 mm.; thickness (crushed), 2 mm. From Lake.

Section RHOIDEAE Engler

Genus RHUS (Tourn.) L.

A number of compressed, broad-oval, one-loculed, single-seeded endocarps are evidently referable to the section Rhoideae, either to *Rhus* or to some closely allied genus. Undoubtedly more than one species is represented judging by the cell structure, but both generic and specific diagnoses are difficult on account of the decayed and abraded condition of the specimens and the necessity for treating them with nitric acid to reveal the interior. Even in living material it may be difficult to distinguish between the genera and species. On the whole, however, a relationship with *Rhus* seems the most likely. A larger range of fossil material is much to be desired, but so far collecting has produced very few specimens.

Rhus lakensis n. sp.

Plate 12, figs. 23-26

DIAGNOSIS. Outer and inner coats of the endocarp readily separable. Inner coat with coarsely pitted outer surface, pits about 0.05 mm. in diameter. Locule lining of cells with finely digitate walls. Dimensions of fruit about 3.5 by 3 mm.

HOLOTYPE. V. 40603.

DESCRIPTION. *Fruit*: One-loculed, with one pendulous seed, flattened, lenticular originally, bisymmetric, dehiscing around the margin into equal valves (Pl. 12, fig. 23), transversely oval with a slight asymmetric prominence marking the style and placenta on the broad apical margin. Wall formed of two coats, an outer coat about 0.05 mm. thick, apparently of obscure cells about 0.016 mm. in diameter, an inner coat, 0.15 mm. thick, somewhat columnar as seen in section, the columns about 0.012 mm. in diameter. The surface of the inner coat shows deep polygonal equiaxial pits, 0.05 mm. in diameter, when the outer coat has been detached as tends to happen in fossilization (Pl. 12, figs. 24, 25). Locule lining shining formed of cells about 0.05 mm. in diameter with finely digitate walls.

Transverse diameter of fruit, 3.5 mm.; diameter at right angles to this (i.e. along the axis of the fruit), 3 mm.

Seed: (Pl. 12, figs. 24, 25) Conforming to the locule in shape, anatropous, micropyle asymmetrically situated on the broad margin adjacent to the stylar canal and prominence of the fruit. Chalaza at the opposite pole extending on to the two surfaces of the seed, raphe lateral along the longer margin where it forms a distinct marginal thickening; testa thin, semi-translucent, finely striate, the striae, oriented from the micropyle to the chalaza, about 0.01 mm. apart, formed by equiaxial cells with thickened longitudinal (lateral) walls.

REMARKS AND AFFINITIES. One fruit, split into two valves so as to show the seed with its characteristic raphe and chalaza. There is also a second broken specimen. The structure appears to be that of *Rhus*. It differs from species hereafter described in the ready separation of the two coats of the endocarp and in the coarse evenly pitted outer surface of the inner coat, also in the rounder and less transversely elongate form.

V.40603 Holotype, figured Pl. 12, figs. 23-25. An endocarp now split into symmetric valves.

V.40604 Figured Pl. 12, fig. 26. A second endocarp probably referable to this species.

Both the above from Lake.

Rhus sp.

Plate 12, fig. 27

DESCRIPTION. *Fruit*: Flattened, lenticular originally, sub-quadrangular in outline, orientation obscure owing to the high degree of crushing which has caused one side of the endocarp to appear concave, the other retaining much of the original convexity of the surface. A slight prominence and concavity may mark the style. Surface much abraded with some evidence of an obscure broad marginal rim, and hints of fine surface pitting and of fine equiaxial cells now largely destroyed. Greatest (transverse) diameter, 5 mm.; longitudinal diameter, 4.75 mm.

The main thickness of the wall is formed of light brown tissue with adherent remains of a superficial thin black coat. The pitted surface shows remains of a white secretion in some of the hollow cells.

REMARKS. The single crushed specimen (V.40607) is more quadrangular in outline and relatively longer in proportion to the breadth than the other species described. It is also appreciably larger. These differences taken together suggest that another distinct species is represented. From Lake.

Rhus sp.

Plate 12, fig. 28

DESCRIPTION. *Fruit*: One-loculed, one-seeded, with pendulous seed, flattened, lenticular originally, bisymmetric, splitting marginally into two symmetric valves, transversely oval with an asymmetric angle on the apical margin marking the style and placenta. External surface evenly pitted, the pits or cells, 0.025 mm. in diameter, being filled with a white secretion. In section the carpel wall shows two layers, an inner, compact, lignified, shining layer, 0.05 mm. thick, in which structure is difficult to see, and an outer layer, 0.15 mm. thick, with a somewhat columnar arrangement of cells in section. Locule lining shining, formed of cells with long digitations, each cell (including the digitations) about 0.05 mm. in diameter. Longest (transverse) diameter of fruit, 3.25 mm.; longitudinal diameter, 2.25 mm.

Seed: Conforming to the locule in shape, having a surface with fine slightly sinuous striae, anatropous, with marginal raphe along the lateral margin, hilum asymmetric on the broad margin closely adjacent to the stylar-placental prominence of the fruit. Chalaza large at the opposite pole to the micropyle (i.e. near the attachment of the fruit) extending on to both surfaces of the flattened seed.

REMARKS AND AFFINITIES. The specimen (V.40605) was macerated in nitric acid so as to expose the internal structure, it unfortunately shattered on dissection. It differs from other species here described in its surface of fine pits of equal size which were filled with white secretion before maceration. It differs also in the more pointed stylar end. From *R. lakensis* it differs in the less ready separation of the two coats of the endocarp. The outer surface of the inner coat has not been clearly seen therefore, and there is at present no evidence of polygonal pits as in *R. lakensis*. They may or may not be present. The cells of the locule lining have long digitations, not fine ones as in *R. lakensis*. From Lake.

Rhus sp.

Plate 12, fig. 29

DESCRIPTION. *Fruit*: Flattened, lenticular originally, transversely oval with an asymmetric prominence marking style and placenta on the broad margin. The outline is more transversely elongate than that of *R. lakensis* and *Rhus* sp. (see Pl. 12, fig. 27) and more asymmetric and unequal on the two sides of the stylar prominence. Surface much abraded and sand-pitted but where preserved in small patches showing fine equiaxial pits or cells, 0.008 mm. in diameter. There is an obscure marginal rounded rim along the broad upper margin. As the fruit has not spilt in spite of treatment with nitric acid, the internal structure has not been seen. Longest (transverse) diameter, 4 mm.; diameter at right angles to this, 3 mm.; thickness, 0.7 mm. The specimen (V.40606) probably represents a distinct species. From Lake.

Family ICACINACEAE

Genus IODES Blume

Iodes acutiformis n. sp.

Plate 13, figs. 1-5

DIAGNOSIS. Endocarp elongate-ovate in outline, narrowed to the attenuated apex. Boldly ornamented on each side with about fifteen deep concavities separated by sharp ridges. Style flanked by two long conspicuous horn-like prominences. Papillae of locule lining close-set. Length of endocarp about 6 mm.; breadth about 3.5 to 4 mm.

HOLOTYPE. V.40608.

DESCRIPTION. *Endocarp*: Elongate-ovate in outline, bisymmetric, lenticular in transverse section, narrowed to the apical style, rounded at the basal attachment, splitting marginally into equal valves. Boldly ornamented externally with about fifteen deep concave areas on each valve, the areas being irregular in form, size, and arrangement, and separated by a network of sharp ridges. A strong rounded rib on one margin indicates the position of the lateral funicle, the opposite margin being sharp. Style flanked on each side of the funicular ridge by a horn-like hollow projection (now much flattened). Endocarp wall thick and woody, about 0.2 mm. thick near the margin. Concavities of the exterior corresponding with internal convexities. Locule lining with close-set rounded papillae sometimes almost contiguous, in other parts separated by their own breadth from one another. There are two, three or four papillae in 0.05 mm. Length of endocarp with style about 6 mm.; breadth, 3.5 to 4 mm.; thickness incomplete. Seed not seen.

REMARKS AND AFFINITIES. Two endocarps from Lake, one imperfect at the stylar end the other slightly imperfect at the base, in both of which one valve is missing the specimens having broken longitudinally but somewhat obliquely. Three endocarps, one slightly broken at the stylar end and represented by one valve only, and several fragments from Arne. The form, surface sculpture, and position of the organs indicate relationship with Icacinaceae, section Iodeae. The papillate locule lining is typical of *Iodes*. In form and sculpture these endocarps closely resemble *Iodes corniculata* from the London Clay when that species is preserved with its endocarp intact (Chandler, 1961: 219, pl. 22, figs. 1, 2). Nevertheless there are slight differences which are perhaps of specific rank although the near relationship of the two species must be emphasized. *I. corniculata* is larger (length of most perfect, 10 mm.; breadth, 6.25 mm.) and often somewhat broader relative to its length, with somewhat less attenuated apex. The difference in size probably signifies little, for the pyritized London Clay specimens are unshrunk, whereas the carbonaceous Lower Bagshot specimens have shrunk considerably on drying so that their original size might well have agreed with that of *I. corniculata*. But the greater relative breadth of *I. corniculata* and its shorter apex probably mark a real specific difference. The surface sculpture of the two is so alike that it is tempting to unite them as a single species in spite of the differences indicated above. On the whole it seems wiser to regard them as distinct but closely related species of *Iodes*. Hence the Lower Bagshot fruits are distinguished by the name *Iodes acutiformis*.

Iodes is a genus of climbers in China, Burma, Indo-China, the Malay Peninsula and Islands, the Philippines, tropical Africa and Madagascar.

- V.40608 Holotype, figured Pl. 13, fig. 1. An endocarp, perfect at the style. The lower three-quarters of one valve is missing.
- V.40609 Figured Pl. 13, fig. 2. A second endocarp, represented by one valve imperfect at the stylar end. Both the above from Lake.
- V.40610 Figured Pl. 13, fig. 3. A much sand-pitted endocarp, otherwise perfect.
- V.40611 Figured Pl. 13, fig. 4. One valve incomplete at the extreme apex above the horn-like projection. The surface is better preserved than in V.40610.
- V.40612 Figured Pl. 13, fig. 5. A slightly distorted endocarp.
- V.40613 Fragments of several endocarps. All the above from Arne.

Genus NATSIATUM Buch.-Ham.

Natsiatum eocenicum Chandler

Plate 13, figs. 6-16

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

1961 *Natsiatum eocenicum* Chandler: Chandler, pp. 76, 102, pl. 7, figs. 14-17, pl. 10, figs. 23-26.

DIAGNOSIS. Endocarp broadly oval in outline, only slightly inflated, boldly ornamented with a network of prominent acute ridges. Placenta marked externally by a broad thickening. Locule lining finely papillate. Length of endocarp about 9 to 10.5 mm; breadth about 4 to 7.5 mm.

NEOTYPE. V.40614 from Lower Headon of Hordle (Holotype decayed).

DESCRIPTION. *Endocarp*: Bisymmetric, splitting into equal valves, broadly oval in outline, compressed, one margin sharp, the other also rather narrow but rounded. Style terminal marked by a transverse opening surrounded by a more or less prominent thickening, attachment basal, funicle lateral in the thickness of the wall within the rounded margin (Pl. 13, figs. 6, 8, 9, 13), frequently exposed in the lower half of the endocarp where the external wall is so thin that it is readily broken away (Pl. 13, figs. 12, 15, 16); placenta apical adjacent to the stylar canal, marked externally by a broad thickening lying athwart the margin (Pl. 13, figs. 6, 8, 9). External surface ornamented with a network of prominent acute ridges separated by concavities which correspond with less marked internal convexities (Pl. 13, figs. 11, 12). Some ridges give off short branches which end abruptly in the hollow of a concavity. Wall thin, hard, brittle, formed superficially of equiaxial concave cells about 0.012 mm. in diameter, but within of cells, about 0.025 mm. in diameter, with interlocking digitate outlines. Locule lining semi-translucent, finely papillate, with short rounded papillae usually separated from one another by about their own width. The papillae are often about 0.025 mm. in diameter, in places about three papillae were counted in 0.1 mm. They arise from cells with long digitations and appear much broader when collapsed and worn. The translucent locule lining has usually disappeared in the Hordle specimens. Testa formed of approximately equiaxial angular cells 0.016 mm. in diameter. Length of the most perfect endocarp, 9 mm.; breadth, 7.25 mm. Length of a larger endocarp, 10.5 mm.; breadth (imperfect) estimated at about 7.5 mm. Thickness much diminished by compression in fossilization.

REMARKS AND AFFINITIES. One perfect endocarp, one almost perfect valve, another endocarp almost perfect but fractured transversely, also the basal ends of three specimens. These have been compared with actual specimens of *Natsiatum eocenicum* from Hordle with which they are identical in every respect (Pl. 13, figs. 13-16). *N. eocenicum* bears some resemblance to *Iodes multireticulata* (Reid & Chandler, 1933: 325, pl. 15, figs. 1-11; Chandler, 1961: 219, pl. 22, figs. 3-5). Careful comparison of specimens shows that *N. eocenicum* is larger, less inflated and usually relatively broader. It has a broader, flatter, marginal flange in the lower part near the attachment (Pl. 13, fig. 13) and the ridges of the external network may be sharper, thinner and more prominent when unworn. The papillae of the locule wall are generally finer, often adjacent and less distinctly separated from one another. Actually the appearance of the papillae varies somewhat with the degree of abrasion and the state of preservation. In the Lake endocarps the papillae appear somewhat coarser than in a specimen of *N. eocenicum* from Tooting (Chandler 1961: 76, pl. 7, figs. 14-17). There can be little doubt that *N. eocenicum* and *I. multireticulata* are quite distinct. Before the precise boundaries between *Natsiatum* and *Iodes* can be finally settled on fruits alone, detailed examination of more living fruiting material than is at present available must be made. Fragments of Recent *Natsiatum sinense* Oliver studied microscopically, after treatment with nitric acid, show a papillate locule lining with papillae more irregularly arranged and less rounded (perhaps owing to partial collapse) than those of *N. eocenicum* or of the genus *Iodes*, living or fossil. Whether this is a persistent characteristic of living *Natsiatum* cannot at present be said. *N. sinense* is a large climber in the Chinese mountains. Other species, of which the fruits present considerable differences in appearance, occur in Assam, Burma, the Himalayas and Indo-China.

- V.40617 Figured Pl. 13, fig. 6. An almost perfect but worn specimen. At the apex it has split along the stylar canal; the outer wall over the funicle has broken away for the lower three-quarters of its length, thus exposing the canal.
- V.40618 Figured Pl. 13, figs. 11, 12. One of the valves of a large endocarp. It is slightly broken along the funicular margin thus exposing the canal for the lower two-thirds of its course. It has split down the stylar canal. It is more broken along the opposite margin.
- V.40619 Figured Pl. 13, figs. 7-9. An endocarp broken transversely. The apex shows the stylar canal and the thickening over the placenta very well preserved. The funicular canal is exposed by the breaking away of its outer wall.
- V.40620 Figured Pl. 13, fig. 10. Basal end of an endocarp which has been fractured transversely.
- V.40621-22 Basal halves of two endocarps and a few fragments, one showing the locule surface.
All the above from Lake.

Section PHYTOCRENEAE Engler

Genus PALAEOPHYTOCRENE Reid & Chandler, 1933: 333

?*Palaeophytocrene foveolata* Reid & Chandler

Plate 13, figs. 17-19

1933 *Palaeophytocrene foveolata* Reid & Chandler, p. 333, pl. 15, figs. 24-32.

DESCRIPTION. *Endocarp*: Incomplete (lower half missing) represented by the upper half of both valves, oval, compressed, the degree of compression exaggerated in fossilization,

woody, obscurely pitted externally showing six or seven rows of longitudinally elongate and aligned deep narrow depressions from 0.5 to 1 mm. long. Style at one end flanked by an obscure projection at one side perhaps representing a horn-like process or a thickening over the placenta; but much distortion has occurred. Inner surface of endocarp where exposed formed of small shining digitate or interlocking cells. Length (estimated) about 15.5 mm.; breadth (actual) about 10 mm.

REMARKS. The structure indicates section Phytocreneae of the family Icacinaceae. There is a very close resemblance to *Palaeophytocrene foveolata* from the London Clay both in size and pitting. (*P. foveolata*, length, 15 to 27 mm.; breadth, 14 to 17 mm.; preserved in pyrites, hence unshrunk). The somewhat narrower appearance of the pits superficially in the Lake endocarp may be due to shrinkage. As there is only one incomplete specimen (V.40623) it has been referred doubtfully to *P. foveolata*. From Lake.

Genus ICACINICARYA Reid & Chandler, 1933: 344

Icacinicarya inornata n. sp.

Plate 13, figs. 20-24; Pl. 14, figs. 1, 2; Text-fig. 15

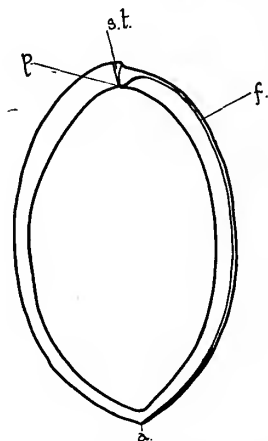


Fig. 15. *Icacinicarya inornata* n. sp.

Longitudinal section through endocarp in plane of symmetry showing lateral funicle *f*, exposed near base by abrasion; placenta *p*; style *st*; and attachment *a*.

DIAGNOSIS. Endocarp suboval in outline, much compressed. Surface almost smooth, sometimes with an obscure network of ridges especially near the base. Funicle extremely close to the external surface for most of its length. Locule lining of sinuous cells. Length of endocarp from about 11 to 12.5 mm.; breadth about 5.5 to 9 mm. (considerable shrinkage on drying has since occurred).

HOLOTYPE. V.40624.

DESCRIPTION. *Endocarp*: Suboval in outline, more or less pointed at the base and apex which correspond closely with one another in form; bisymmetric, much compressed, more or

less sharp around the margin, sometimes narrowly rimmed, splitting marginally into equal valves. External surface almost smooth, but the better preserved specimens show a few inconspicuous ridges forming an obscure network especially at the base (Pl. 13, figs. 21, 22); the network may originally have been more conspicuous and extensive, but if so, it is now largely obliterated by abrasion. Style terminal, apical, marked by a slight prominence. Funicle marginal passing within the wall from the basal attachment to sub-apical placenta, lying close to the external surface for the greater part of its length (hence often broken away except at the apex, cf. Pl. 14, figs. 1, 2), traversing the wall diagonally near the apex, then turning abruptly so as to enter the locule adjacent to the flattened apical stylar canal which is lined by a shining coat of elongate cells (Text-fig. 15). The placenta is indicated externally by a pair of slight thickenings one on each side of the margin (Pl. 13, fig. 21). Endocarp woody, compact, surface of equiaxial cells about 0.01 mm. in diameter. Locule lining of sinuous cells about 0.025 mm. in diameter. Thickness of endocarp, as seen in transverse section about the middle, 0.2 mm.; breadth of marginal suture near the middle about 0.35 to 0.5 mm. Testa cells equiaxial, angular, about 0.016 mm. in diameter. Length of four typical endocarps, 12.5, 11, 11.25 and 12.25 mm. respectively; breadths of the same, 7, 7.5, 5.5 and 7 mm. The endocarps show a striking reduction of size by shrinkage on drying.

REMARKS AND AFFINITIES. Numerous endocarps, varying slightly in relative proportions. They are the most abundant of the Lake fossils and could at one time be picked out in handfuls from some of the carbonaceous seams *in situ*, one poorly preserved endocarp only was found at Arne. The form and arrangement of organs clearly indicate Icacinaceae. No comparable living genus has so far been traced and the species has therefore been referred to the form-genus *Icacinicarya*. *I. platycarpa* from the London Clay is of similar appearance with an almost smooth surface (Reid & Chandler, 1933: 345, pl. 16, figs. 11-18) but is a much larger species, commonly twice the size (length, 16 to 26 mm.; breadth, 11.5 to 21 mm.) and it tends to be relatively broader. It is possible that the two represent distinct species of a single genus as yet unrecognized and undefined or they may even belong to a single species since the carbonaceous endocarps of the Lower Bagshot may have shrunk to about half their natural size. On the whole, however, the Lower Bagshot endocarps are broader relative to their length than those from the London Clay. Hence they are provisionally separated under the specific name *Icacinicarya inornata*. But the two species must at least be closely related. The family Icacinaceae is entirely tropical at the present day.

V.40624 Holotype, figured Pl. 13, fig. 20. A more or less perfect endocarp.

V.40625-27 Figured Pl. 13, figs. 21-23. Three endocarps showing variation of form and remains of surface ornamentation.

V.40628-29 Figured Pl. 14, figs. 1, 2. Two endocarps (each broken at the base showing the funicle and stylar canal).

V.40630 An endocarp (one valve only) showing funicle and placenta.

V.40631-32 Numerous endocarps. V.40632 *E. St. John Burton Coll.*

All the above from Lake.

V.40633 Figured Pl. 13, fig. 24. An endocarp battered and with impacted sand grains obscuring the surface. Length, 12.5 mm.; breadth, 9 mm. Arne.

Family SABIACEAE

Genus MELIOSMA Blume

Meliosma sp. (? *M. sheppeyensis* Reid & Chandler)

Plate 14, figs. 3, 4

1933 *Meliosma sheppeyensis* Reid & Chandler, p. 378, pl. 18, figs. 31-33.1961 *Meliosma sheppeyensis* Reid & Chandler: Chandler, p. 243, pl. 24, fig. 10.

DESCRIPTION. *Endocarp*: One-loculed, subglobose, bisymmetric about a plane through the ventral attachment and style. At the stylar end the two sides meet at an angle in the plane of symmetry to form a rounded prominence. This angle is continued to the ventral margin at the opposite end to the style but is greatly exaggerated by the lateral compression which the only specimen seen has undergone at right angles to the plane of symmetry. Dorsal surface highly convex. Ventral surface somewhat flattened so as to appear more or less straight in profile (Pl. 14, fig. 3), gaping owing to the loss of a large ventral plug associated with hilum and placenta (Pl. 14, fig. 4). Wall woody. Locule lining poorly preserved but showing in places elongate cells with short broad digitations. External surface where seen of fine parenchymatous cells, about 0.011 mm. in diameter. Dorsiventral diameter of endocarp, 3.2 mm. Maximum diameter in plane of symmetry at right angles to the last, 4 mm.

Seed: Not seen.

REMARKS. One specimen only (V.40634), crushed and damaged as described. It agrees in form and size with *Meliosma sheppeyensis* and probably belongs to that species, but on the evidence of one crushed specimen alone it seems wiser to leave the specific determination doubtful. From Lake.

Family VITACEAE

Genus VITIS (Tourn.) L.

Vitis pygmaea Chandler

Plate 14, figs. 5-31

1961 *Vitis pygmaea* Chandler, pp. 77, 333, pl. 8, figs. 6, 7; pl. 34, figs. 5-11.

DESCRIPTION. *Seed*: Obovoid, contours smooth, not channelled at the apex, stipitate at the base, ventral face faceted, raphe ridge sharp, ventral infolds diverging upwards, occupying about half the length of the seed, slightly concave towards the raphe ridge. Dorsal surface convex longitudinally without a marked groove between apex and chalaza so that the raphe is prominent. The raphe merges gradually into the oval chalaza situated in a shallow depressed area at or just above the middle of the dorsal face. There is a shallow furrow between the chalaza and the base. Surface showing in places on the ventral side of a few specimens hexagonal cells, 0.05 to 0.075 mm. in diameter. Elsewhere beneath the outer skin finely pitted, the pits being small and thick-walled, about three pits in 0.05 mm. Length of seed, 2.25 to 2.6 mm. (Sand-

banks) and up to 3.25 mm. (Lake); breadth, 0.5 to 1.25 mm. (Sandbanks) and 1.75 to 2.25 mm. (Lake). Thickness of wall near base of seed, 0.1 mm.; thickness nearer chalaza, 0.03 mm.

REMARKS AND AFFINITIES. Numerous seeds from Lake. Twenty-one from Sandbanks (cf. Pl. 14, figs. 20-27) and three (originally four) from Branksome Dene (Pl. 14, figs. 28-31) both Bournemouth Freshwater Beds (Lutetian?). The outstanding character of the species is its uniformly small size, the smallest living species in the Reid Collection of Recent seeds is about twice as large. A poorly preserved seed from the Woolwich Beds of Tooting Broadway so much resembled this species that it was described as *V. pygmaea*? It was less stipitate possibly because the extreme base was broken and it therefore appeared less slender. This seed may before distortion have been less sharply angled on the ventral face.

V.34675 Holotype, figured Pl. 14, figs. 24, 25. A typical seed. Sandbanks.

V.40641-46 Figured Pl. 14, figs. 5-16. Six typical seeds, figured to show the two surfaces.

V.40647-50 Numerous seeds. V.40648 extracted from fallen blocks at top of section at its eastern end towards Poole. V.40649 from base of section near ironstones in foreshore. V.40650 *E. St. John Burton Coll.*
All the above from Lake.

V.40651-53 Figured Pl. 14, figs. 17-19. Three seeds, two figured to show the dorsal surface and chalaza, one to show the ventral surface with infolds.

V.40654 Numerous seeds.

All the above from Arne.

Vitis goodharti n. sp.

Plate 14, figs. 32-44

DIAGNOSIS. Seeds obovoid, more or less stipitate; not channelled at the apex, ventral infolds occupying about half the length of the seed, concave to the raphe ridge. Median chalaza elongate-oval, raphe broad, dorsal face grooved between the base and chalaza. Surface with numerous close, fine interrupted ridges or rugosities diverging from the chalaza and ventral infolds. Length of seed, 2.75 to 3 mm.; breadth, 1.8 to 2.5 mm.

HOLOTYPE. V.40655.

DESCRIPTION. *Seed*: Obovoid, more or less stipitate, not channelled at the apex. Ventral face rounded or sharply faceted, raphe ridge rounded or sharp, ventral infolds occupying about half or less than half the length of the seed, not extending to the base, situated in the lower two-thirds of the seed, concave towards the raphe ridge so situated that the ridge itself is fusiform and broader above than below. Dorsal surface convex, grooved between base and chalaza and around the elongate-oval chalaza which is more or less median, passing gradually into the broad raphe. Surface ornamented with numerous close, fine, interrupted ridges or elongate rugosities which diverge from the chalaza on the dorsal face, and from the lateral infolds on the ventral face. Dimensions of typical seeds: 1) Length, 2.75 mm.; breadth, 1.8 mm.; thickness, 1.75 mm. 2) Length, 3 mm.; breadth, 2.4 mm.; thickness, 1 mm. 3) Length, 3 mm.; breadth, 2.25 mm.; thickness, 1.25 mm. 4) Length, 2.75 mm.; breadth, 2.5 mm.; thickness, 1.25 mm.

REMARKS AND AFFINITIES. Numerous seeds. The finely rugose character is peculiar and has not so far been seen in other fossil or living species.

V.40655 Holotype, figured Pl. 14, figs. 32, 33. A typical seed.

V.40656-59 Figured Pl. 14, figs. 34-41. Four seeds showing variation of form.

- V.40660-63 Numerous seeds. V.40661 from fallen block at top of section, eastern end towards Poole. V.40662 from base of section near ironstones in foreshore. V.40663 *E. St. John Burton Coll.*
All the above from Lake.
- V.40664-65 Figured Pl. 14, figs. 42, 43. Two seeds, one figured to show the dorsal and the other to show the ventral surface.
- V.40666 Figured Pl. 14, fig. 44. Upper part of a large seed of similar type possibly an abnormally large specimen of the same species.
- V.40667 About a dozen typical seeds.
All the above from Arne.

Vitis cuneata n. sp.

Plate 14, figs. 45, 46

DIAGNOSIS. Seed narrowly obovate, smooth, deeply channelled at its apex, base stipitate. Ventral surface sharply faceted. Ventral infolds almost straight, diverging upwards, situated in the lower three-quarters of the seed. Dorsal and ventral faces meeting at a sharp angle. Chalaza elongate-oval occupying nearly one-third of the length, situated near the apex of the dorsal surface. Length of seed, 4.25 mm.; breadth, 2 mm.

HOLOTYPE. V.40668.

DESCRIPTION. *Seed*: Narrowly obovate in outline with smooth contours, deeply channelled at the apex, somewhat stipitate at the base, ventral face sharply faceted, raphe ridge sharp dying out towards the apex, ventral infolds almost straight, diverging upwards, occupying the lower three-quarters of the seed (Pl. 14, fig. 46). Dorsal surface delimited from the ventral by a sharp angle, convex, with a shallow groove between chalaza and base. Chalaza elongate-oval situated in the upper half of the dorsal surface occupying almost one-third of its length (Pl. 14, fig. 45). Equiaxial cells of the surface about 0.01 mm. in diameter. Length of seed, 4.25 mm.; breadth, 2 mm.; thickness, 1.75 mm.

REMARKS AND AFFINITIES. One seed (V.40668) distinguished by the form and position of the chalaza and ventral infolds from other species described. From Lake.

Vitis lakensis n. sp.

Plate 14, figs. 47, 48

DIAGNOSIS. Seed oboval in outline, scarcely channelled at the apex, scarcely stipitate at the base. Ventral infolds narrow, almost straight and parallel-sided for three-quarters of the length of the seed but diverging somewhat at their extremities so that they are slightly convex to the raphe ridge. Chalaza median, large, ovoid. Dorsal surface flat, with shallow grooves between the chalaza and apex and base. Surface ornamented with flat scale-like rugosities. Length of seed, 8.75 mm.; breadth, 6 mm.

HOLOTYPE. V.40669.

DESCRIPTION. *Seed*: Oboval in outline, much compressed (flatness increased probably by compression in fossilization) scarcely channelled at the apex or stipitate at the base, both faces now more or less flat; ventral face with long narrow raphe ridge parallel-sided almost from the base for about three-quarters of the length of the seed above which it rapidly widens and dies out; in a corresponding manner the narrow ventral infolds are approximately straight and parallel-sided for three-quarters of the length of the seed, but they diverge at their upper ends

and quickly die out. As they are also slightly divergent below they are somewhat convex towards the raphe ridge. Dorsal surface probably originally slightly convex, having shallow grooves between the chalaza and the apex and base. Chalaza median, large, ovoid, rather flat, only obscurely differentiated from the surrounding surface, about 2 mm. broad. Surface ornamented with fine irregular flat rugosities giving a scale-like effect especially over the chalaza around which the rugosities diverge; on the ventral surface they diverge from the longitudinal infolds. Surface cells more or less equiaxial, concave, about 0.016 mm. in diameter. Length of seed, 8.75 mm.; breadth, 6 mm.

REMARKS AND AFFINITIES. One seed and a fragment of a second. The species is readily distinguished by its form and characteristic ornamentation from any fossil seed previously seen. It bears some resemblance in general appearance and roughness of surface to *Vitis teutonica* A. Braun as defined by Kirchheimer (1938: 335, pl. 4, figs. 14, 15) but it has a larger chalaza than that species and the seed itself is larger (*V. teutonica*, length 4 to 5 mm.).

V.40669 Holotype, figured Pl. 14, figs. 47, 48. A seed, compressed condition partly due to fossilization. *E. St John Burton Coll.*

V.40670 The basal end of a second compressed specimen.
Both the above from Lake.

Vitis glabra n. sp.

Plate 14, figs. 49-53

?1960 *Vitis* sp. Chandler, p. 210, pl. 31, figs. 44, 45.

DIAGNOSIS. Seed obovoid, markedly stipitate, apex channelled, contours smooth and rounded. Chalaza oval median, slightly sunk with a furrow between it and the hilum. A few inconspicuous shallow furrows diverge from the chalaza. Ventral surface faceted, infolds deep, broad, short, sub-parallel. Length of seed, 3.25 to 4.1 mm.; breadth, 2.25 to 2.75 mm.

HOLOTYPE. V.40671.

DESCRIPTION. *Seed*: Obovate in outline, much inflated, markedly stipitate, channelled at the apex, contours smooth and rounded. Dorsal surface convex, chalaza oval, more or less median, slightly sunk, raphe sunk, there is also a median furrow between hilum and chalaza, surface with a few shallow furrows diverging from the chalaza separating inconspicuous rounded divergent lobes. Ventral surface faceted with fairly conspicuous rounded sub-parallel sided raphe ridge, ventral infolds deep, broad, short, not reaching the base, sub-parallel but with a tendency to broaden and diverge slightly upwards, extending to about one-quarter of the length of the seed from the apex. Testa smooth and shining, cells equiaxial, concave, about 0.025 mm. in diameter. Dimensions of three specimens: 1) Length, 4.1 mm.; breadth, 2.75 mm.; thickness, 1.25 mm. 2) Length 3.75 mm.; breadth, 2.75 mm.; thickness, 1.5 mm. 3) Length, 3.25 mm.; breadth, 2.25 mm.; thickness, 1.25 mm.

REMARKS. Three seeds of a type comparable with *Vitis thunbergii* and *V. lanata*, more especially with the latter with which they agree not only in size and form but in the character and size of the chalaza. In *V. thunbergii* the chalaza is larger and there is scarcely any trace of a furrow between it and the base of the seed as in the fossils. *V. lanata* is native to the eastern and western Himalayas and Assam at heights of 1,200 to 1,500 m. *Vitis lusatica* Czeccott (1959: 103, 124, pl. 17, figs. 4-12) from the Miocene of Turów, Poland has very similar

characters but is apparently larger (5.5 by 3 mm.). It is probable that *Vitis* sp. from Hengistbury (reference above) should be referred to *V. glabra* but there is only one poor specimen.

- V.40671 Holotype, figured Pl. 14, figs. 49, 50. A well-preserved seed.
 V.40672 Figured Pl. 14, figs. 51, 52. A second seed.
 V.40673 A third smaller seed.
 V.40674 Figured Pl. 14, fig. 53. A fourth large but imperfect seed which may belong to this species as indicated by the form and infolds, but the chalaza is not preserved. Length, 5.25 mm.; half the breadth measured from the raphe ridge, 2.25 mm.
 All the above from Lake.
 V.40675 Remains of a seed. Arne.

Vitis platysperma n. sp

Plate 15, figs. 1-5

DIAGNOSIS. Seeds initially much compressed laterally, lateral outline sub-obovate, lateral faces broad meeting at an acute angle to form the sharp narrow ventral raphe ridge. Lateral infolds diverging markedly upwards, curved sharply towards the dorsal side at their upper extremities. Dorsal face narrow with a median longitudinal furrow separating rounded narrow lobes. Chalaza narrowly elongate-oval, terminating below at the middle of the seed. Length of seeds, 5.1 to 5.5 mm.; breadth, 1.5 mm.; dorsiventral thickness, 2.5 to 2.75 mm.

HOLOTYPE. V.40676.

DESCRIPTION. Seed much compressed laterally as if by the mutual pressure of a whorl of seeds during growth, appearing in outline asymmetrically sub-obovate, the base being slightly stipitate and the apex rounded, the ventral edge straight or slightly convex, the dorsal edge convex. Lateral faces (Pl. 15, figs. 2-5) broad, flat, or slightly concave, sometimes unequally developed, meeting at an acute angle to form the sharp narrow ventral raphe ridge which extends the whole length of the seed. Lateral infolds diverging markedly upwards, curved sharply towards the dorsal side at the upper ends, extending almost from the base for about three-quarters of the length of the seed, shallow, forming slight ridges internally, sometimes indicated externally by a raised curved line owing to the projection of one side of the fold beyond the other, usually completely obscured by the rough outer integument of the seed when this is preserved. Dorsal face narrow, bilobed throughout its length owing to a median longitudinal furrow separating rounded narrow lobes. (Pl. 15, fig. 1). Apex smooth or channelled, chalaza and raphe sunk within the furrow, chalaza narrow, elongate-oval, passing imperceptibly into the raphe, terminating below at the middle of the seed. Outer integument frequently preserved, rough, formed of cells 0.03 to 0.1 mm. in diameter. Inner integument hard, finely and evenly pitted, pits about 0.012 mm. in diameter, in section regularly columnar and about 0.1 mm. thick. Length of seeds, 5.1 to 5.25 mm.; breadth, 1.5 mm.; dorsiventral thickness, 2.5 to 2.75 mm.

REMARKS AND AFFINITIES. Fifteen seeds and a few broken specimens. The peculiar laterally compressed form is unlike anything hitherto seen. It is present in a less marked degree in the living *Cissus elongata*, an Indian species.

- V.40676 Holotype, figured Pl. 15, figs. 1, 2. A seed.
 V.40677-78 Figured Pl. 15, figs. 3, 4. Two seeds.
 V.40679-80 Several seeds and fragments. V.40680 from ironstones at base of section in foreshore.
 All the above from Lake.

- V.40681 Figured Pl. 15, fig. 5. A seed, much cracked and now breaking up.
V.40682 Two other seeds, now bursting and cracking, probably of this species.
All the above from Arne.

Vitis symmetrica n. sp.

Plate 15, figs. 6, 7

DIAGNOSIS. Seed obovate in outline, not stipitate, not channelled at the apex, margins somewhat lobed on the ventral side beyond the infolds. Infolds long divergent upwards extending from base to apex. Dorsal surface gently convex, chalaza median narrow-oval, surface slightly furrowed between it and the base and apex. Length of seed, 4.5 mm.; breadth, 3.25 mm.

HOLOTYPE. V.40683.

DESCRIPTION. *Seed*: Obovate in outline, not stipitate, not channelled at the apex, surface more or less smooth but slightly lobed on the ventral side between the margins and the ventral infolds. Ventral face slightly concave as preserved, possibly due to crushing, perhaps originally flat or slightly convex. Ventral infolds markedly divergent upwards, extending from the base almost to the apico-lateral margin. Raphe ridge flat. Dorsal surface gently convex. Chalaza median narrow-oval, slightly sunk, gradually narrowing into the raphe. There is a shallow furrow between the chalaza and base and above the chalaza extending almost to the apex. Surface somewhat rough, the roughness diverging from the chalaza. Length of seed, 4.5 mm.; breadth, 3.25 mm.; thickness, 1.5 mm.

REMARKS. Although only one seed (V.40683) is known, it appears to be distinctive and the name *Vitis symmetrica* has been given. The description and diagnosis will nevertheless require slight extension when more material shows the range of variation of the species. From Lake.

Vitis triangularis n. sp.

Plate 15, figs. 8-13

DIAGNOSIS. Seed rounded-triangular or pointed obovate in outline, not stipitate, scarcely furrowed at the apex, somewhat compressed dorsiventrally. Dorsal surface convex with small median broadly ovate chalaza, smooth. Ventral surface flattened. Raphe ridge broadening upwards; ventral infolds convex to the ridge diverging rapidly at two-thirds of the length from the base and extending to the margin. Length of seed, 5.25 to 7 mm.; breadth, 4.5 to 6 mm.; thickness, 1.5 mm.

HOLOTYPE. V.40684.

DESCRIPTION. *Seed*: Rounded-triangular or pointed obovate in outline, scarcely furrowed at the apex, pointed but not stipitate at the base, somewhat compressed dorsiventrally as if there had been two seeds in the berry. Dorsal surface somewhat convex with large median broadly ovate sunk chalaza (somewhat obscured by abrasion). A shallow groove lies between the chalaza and the base in a slight concavity of the surface. Surface smooth without radiating lobes. Ventral surface flattened the two sides equally or unequally developed. Raphe ridge broad, rather flattened, broadening upwards. Ventral infolds convex to the raphe ridge, diverging rapidly at about two-thirds of the length of the seed from the base. Surface much worn so

that the cell structure is obscure. Dimensions of seeds: 1) Length 5.25 mm.; breadth, 4.5 mm.; dorsiventral thickness as preserved, 1.5 mm. 2) Length, 7 mm.; breadth, 6 mm.; dorsiventral thickness, 1.5 mm.

REMARKS. Six seeds much abraded dorsally so that the actual outer chalazal scar is partly or wholly worn away leaving the sunk area which it occupied exposed. It is quite unlike any other species described from the Lower Bagshot Beds or the London Clay.

- V.40684 Holotype, figured Pl. 15, figs. 8, 9. A rather worn seed.
 V.40685 Figured Pl. 15, figs. 12, 13. Another seed.
 The much crushed seed figured Pl. 15, figs. 10, 11 has now decayed.
 V.40686 Half a seed (upper end).
 V.40687 Two seeds, one distorted, one imperfect below, doubtfully referred to this species.
 All the above from Arne.

Vitis sp. (*V. triangularis*?)

Plate 15, figs. 14, 15

DESCRIPTION. *Seed*: Pointed obovate in outline, scarcely channelled at the apex, pointed or shortly stipitate at the base; surface smooth, not fluted, slightly biconvex on the rather broad dorsal face. The chalaza which is large, ovate and extends almost from the apex for more than half the length is situated in the hollow between the two convexities of this surface. Ventral surface faceted with sharply angled raphe ridge extending upwards for about three-quarters of the length and broadening upwards. The facets which are almost equal are deeply concave with sharp ridge-like marginal rim. Ventral infolds scarcely distinguishable; they appear to follow the outline of the raphe ridge and to diverge upwards extending for two-thirds or more of the length of the seed. Length of seed, 5 mm.; breadth and thickness, 3 mm. A second broader specimen; length, 5 mm.; breadth, 4 mm.; thickness, 1.75 mm. may belong to the same species.

REMARKS. A distinct species may here be represented but in the absence of more material no diagnosis can be attempted. If the seed (V.40688) described were perfect it would closely resemble *Vitis triangularis* although somewhat smaller and differing in the concavity of the ventral facets with their rimmed margins. From Arne.

Vitis poolensis n. sp.

Plate 15, figs. 16-19

DIAGNOSIS. Seed obovoid, base narrowed to the hilum and micropyle but not distinctly stipitate, apex slightly channelled. Contours smooth and rounded. Chalaza oval more or less median, scarcely sunk with a shallow median furrow above and below. Ventral surface scarcely faceted, infolds, deep, broad, short, parallel. Surface rough. Length of seed, 3.25 to 3.75 mm.; breadth, 2.5 mm.

HOLOTYPE. V.40689.

DESCRIPTION. *Seed*: Obovate in outline, now somewhat dorsiventrally compressed but originally somewhat inflated. Narrowed to the micropyle but not distinctly stipitate. Apex slightly channelled, contours smooth and rounded. Dorsal surface somewhat convex, chalaza

oval, narrowed gradually into the raphe, situated slightly above the middle, scarcely sunk with a shallow median furrow above and extending to the hilum below. Ventral surface scarcely faceted, originally more or less rounded with parallel-sided rounded raphe ridge. Ventral infolds deep, broad, short, parallel, not reaching to the base but extending to a quarter of the length of the seed from the apex. Testa rough, cells equiaxial, about 0.018 mm. in diameter. Dimensions of two seeds: 1) Length, 3.75 mm.; breadth, 2.5 mm. 2) Length, 3.25 mm.; breadth, 2.5 mm.

REMARKS. Two seeds which somewhat resemble *Vitis glabra* (p. 103) in size and in the character of the ventral infolds. They are distinguished by the absence of distinct stipitation at the base and by the broader chalaza and rough surface.

V.40689 Holotype, figured Pl. 15, figs. 16, 17. A seed.

V.40690 Figured Pl. 15, figs. 18, 19. A second seed.

Both the above from fine silt, base of section, western end, Lake.

Vitis arnensis n. sp.

Plate 15, figs. 20-26

DIAGNOSIS. Seed narrowly obovate or triangular in outline, attenuate but not stipitate below, rounded at the apex; ventral face sharply faceted almost throughout its length, ventral infolds straight below diverging slightly upwards occupying the lower three-quarters of the length. Dorsal surface convex sharply delimited from the ventral, chalaza large median elongate-ovate, about 3 mm. long; 1.5 mm. broad, occupying almost half the length of the seed. Length of seed, 6.5 to 7.5 mm.; breadth, 3.1 to 4 mm.; thickness about 1.5 to 3 mm.

HOLOTYPE. V.40691.

DESCRIPTION. *Seed*: Narrowly obovate or triangular in outline, rounded at the apex, attenuated to a point below but not stipitate, ventral face sharply faceted, raphe ridge sharp reaching almost to the apex. Ventral infolds almost straight, diverging very slightly upwards, occupying the lower three-quarters of the seed (Pl. 15, figs. 21, 26) sometimes very inconspicuous. Dorsal surface convex, delimited from the ventral by a marked angle, chalaza elongate-ovate, about 3 mm. long and 1.5 mm. broad occupying almost half the length of the seed at about the middle of the dorsal surface. Surface rough and uneven, finely pitted, but too worn to show clear details of cell structure. Dimensions of seeds: 1) Length, 6.5 mm.; breadth, 3.9 mm.; thickness, 2 mm. 2) Length, 6.75 mm.; breadth, 3.5 mm.; thickness, 2 mm. 3) Length, 7 mm.; breadth, 4 mm.; thickness, 1.5 mm. 4) Length, 7 mm.; breadth, 3 mm.; thickness, 3 mm. 5) Length, 7.5 mm.; breadth, 3.1 mm.; thickness, 2.3 mm.

REMARKS. Six seeds, all poorly preserved and cracking. One specimen shows a pyrites cast within the carbonaceous testa. The surface is usually corroded so that in several seeds the outline of the chalaza is obscure. This species has not yet been found at Lake.

V.40691 Holotype, figured Pl. 15, figs. 22, 23. A Seed.

V.40694 Figured Pl. 15, figs. 24-26. Another seed.

V.40692-93 Seeds, now decaying.

The slightly distorted seed figured Pl. 15, figs. 20, 21 has now decayed.

All the above from Arne.

Vitis ambigua n. sp.

Plate 15, figs. 27, 28

DIAGNOSIS. Seed obovate in outline, shortly stipitate, slightly channelled at the apex, smooth, sharply faceted on the ventral surface, raphe ridge angled, ventral infolds extending from the base for two-thirds to three-quarters of the length, diverging upwards; chalaza oval, dorsal surface slightly grooved between it and the base. Length, 4.5 mm.; breadth, 2.75 mm.

HOLOTYPE. V.40695.

DESCRIPTION. *Seed*: Obovate in outline, somewhat stipitate, slightly channelled at the apex, smooth and unlobed. Ventral face sharply faceted, the two facets unequal in size, raphe ridge sharply angled. Ventral infolds occupying two-thirds to three-quarters of the length arising near the base and diverging upwards. Dorsal surface somewhat flattened, slightly grooved between the base and the chalaza and around the chalaza which is median and oval narrowing gradually into the raphe (now largely broken away). Length of seed, 4.5 mm.; breadth, 2.75 mm. Thickness as preserved (somewhat crushed and distorted), 1.25 mm.

REMARKS. One seed (V.40695), slightly distorted in growth? and in fossilization also which may account for flattening of one ventral facet and folding of the other, also for the flattening of the dorsal face. The seed differs in its characters from all others described and has been named *Vitis ambigua*. From Lake.

Vitis excavata n. sp.

Plate 15, figs. 29, 30

DIAGNOSIS. Seed transversely suboval, broadest at the basal end which is concave in outline but stipitate. Margin and raphe ridge forming prominent raised walls embracing a pair of broad deep ventral concavities. Chalaza elongate-oval above the middle of the seed. Length of seed, 4.25 mm.; breadth about 4.5 mm.; thickness, 1.25 mm.

HOLOTYPE. V.40696.

DESCRIPTION. *Seed*: Transversely suboval, broadest at the basal end, base slightly concave in outline but with a marked stipitation at the hilum, apex grooved, the basal concavity and apical groove producing an almost bilobed effect. Ventral face with a conspicuous narrow parallel-sided prominent raphe ridge merging above and below into the prominent narrow margin of the seed. Between the marginal ridges and the raphe ridge lie a pair of deep concavities as if almost the whole of the lateral faces formed broad lateral infolds. Dorsal face gently convex, chalaza elongate-oval, situated in the upper half of the seed, merging gradually into the raphe. Surface shining, but somewhat uneven, formed on the dorsal face of equiaxial cells about 0.016 to 0.025 mm. in diameter. Length of seed, 4 mm. (4.25 including the stipitation); breadth of half the seed measured from the raphe ridge, 2.25 mm. (estimated total breadth about 4.5 mm.); thickness, 1.25 mm.

REMARKS AND AFFINITIES. One seed (V.40696), perfect on one side of the raphe ridge, very imperfect on the other. The breadth, and the excavated ventral surface are peculiar. Species of *Cayratia* are sometimes concave ventrally on each side of the raphe ridge but not deeply excavated as in the fossil. No comparable fossil or living species has hitherto been seen. From Lake.

Vitis sp.

Plate 15, figs. 31, 32

DESCRIPTION. *Seed*: Pointed obovate in outline with markedly stipitate base, scarcely channelled at the apex. Surface smooth, scarcely fluted around the chalaza. Dorsal surface with deep longitudinal furrow for the chalaza extending throughout the length. Chalaza large, ovate, median. Ventral surface faceted, facets meeting at a sharp angle. Raphe ridge rounded extending for three-quarters of the length of the seed. Facets slightly concave. Ventral infolds narrow, parallel below diverging sharply at the end of the raphe ridge. Length of seed, 5 mm.; breadth, 3.5 mm.; thickness, 3 mm.

The species represented by one seed (V.40698) somewhat recalls *Vitis glabra* but lacks the short broad sub-parallel infolds of that species. No name has been given pending the discovery of more material. From Arne.

Vitis sp.

Plate 15, figs. 33, 34

DESCRIPTION. *Seed*: Slender, narrow, obovoid, rather truncated at the apex which has only a shallow groove, base tapering into a short stipitation. Dorsal surface convex, raphe long and stout, chalaza elongate-narrow at about the middle of the seed. Ventral surface rather rounded probably angled when perfect but part of the narrow raphe ridge is broken. It extends for three-quarters of the length from the base. Ventral infolds broad, slightly divergent upwards. Surface smooth and unfurrowed, cell structure obscure. Length of seed, 4 mm.; breadth, 2 mm.; thickness, 2 mm.

REMARKS. This seed (V.40699) appears to differ from other species described in its slender form, thick raphe scarcely broadening where it passes into the chalaza, and broad, short, scarcely divergent lateral infolds. It may be an ill-developed poorly preserved seed of *Vitis glabra* but the material is not sufficiently well preserved for satisfactory determination. From Arne.

Vitis sp.

Plate 26, figs. 23, 24

DESCRIPTION. *Seed*: Pear-shaped in outline, mucronate, almost stipitate at the base, the mucro being recurved towards the ventral side. Dorsal surface narrow, convex from base to apex, delimited from the ventral surface by rounded angles throughout its length. Chalaza large oval, occupying the upper half of the seed and half the breadth of the dorsal face. Apex slightly imperfect, almost certainly channelled. Ventral surface with conspicuous angle along the raphe ridge extending throughout the length of the seed, flanked by two somewhat unequal facets. The larger of these is gently concave, the smaller gently convex. Ventral infolds obscure arising a short distance above the base and diverging upwards sharply but not reaching the apico-lateral margin. Length of seed, 6 mm.; maximum diameter (dorsiventral), 4 mm.; breadth across dorsal surface, 2.5 mm.

REMARKS. The solitary seed (V.41961) is poorly preserved. In its narrow dorsal surface it recalls *Vitis platysperma* and *Vitis arnensis* but is a shorter, relatively broader seed than either

and has an exceptionally large chalaza. It may therefore represent a distinct species but better material is needed to confirm this suggestion. From Arne.

Genus TETRASTIGMA Planchon

?*Tetrastigma lobata* Chandler

Plate 15, figs. 35-38

1925 *Tetrastigma lobata* Chandler, p. 32.

1926 *Tetrastigma lobata* Chandler, pl. 5, fig. 3a-c.

1961b *Tetrastigma lobata* Chandler: Chandler, p. 134, pl. 28, figs. 96, 97.

DESCRIPTION. *Seed*: Obovate in outline, deeply channelled at the apex, sub-stipitate, chalaza and raphe sunk in a groove which is continued between the chalaza and the base. Dorsal surface convex with rounded lobes diverging from the small circular median chalaza. Ventral surface faceted, with conspicuous fusiform raphe ridge; a few lateral lobes diverge outwards from the infolds. Surface rough, structure obscure owing to poor preservation, cells about 0.016 mm. in diameter. Length of seed, 4.5 mm.; breadth, 3 mm.; dorsiventral thickness, 1.75 mm. (reduced somewhat by crushing).

REMARKS AND AFFINITIES. One seed, and a doubtful distorted specimen. The lobed surface indicates relationship with *Tetrastigma*. The specimen has been compared carefully with similar seeds of *Tetrastigma lobata* from the Lower Headon of Hordle. These seeds are somewhat larger and less deeply lobed at the apex although more distinctly furrowed on the ventral side. But the differences appear to be of degree only and such as occur among individuals of a single species. They are not greater than the differences between individual seeds from the Hordle deposits. The Lake seed has therefore been united tentatively with *T. lobata*. It is only one of several species of plants common to Lake and Hordle if the suggested determination is correct.

V.40700 Figured Pl. 15, figs. 35, 36. A single seed.

V.40701 Figured Pl. 15, figs. 37, 38. A distorted, laterally compressed seed of *Tetrastigma* probably belonging to the same species.

Both the above from Lake.

Tetrastigma acuminata n. sp.

Plate 15, figs. 39, 40

DIAGNOSIS. Seed lobed as in *Tetrastigma*, obovate-acuminate with sharply angled raphe ridge and deep divergent ventral infolds. Length of seed, 4.75 mm.; breadth and thickness, 2.5 mm.

HOLOTYPE. V.40702.

DESCRIPTION. A lobed vine of small size appears to differ from *Tetrastigma lobata* or from any other species in its long narrow attenuated obovate form. Like *T. lobata* it is deeply channelled at the apex, but the pointed basal end is markedly attenuate and forms a pronounced stipitation. The apical groove is continued as a deep furrow to the base. In it the chalaza is sunk although the chalazal scar itself is obscure. Dorsal surface with rounded lobes separated by deep furrows, about four or five lobes on each side of the chalaza and diverging from it. Ventral surface sharply faceted with raphe ridge extending from the base to the apical

groove, narrow and sharp in the lower two-thirds of the seed, broadening in the upper third. Lateral infolds deep, diverging markedly and broadening at their upper ends where they become obscure owing to the radial lobing of the seed. A few lobes diverge on the outer sides of the infolds towards the lateral margins of the seed and from their apices towards the upper end of the seed. Length of seed, 4.75 mm.; breadth, 2.5 mm.; thickness, 2.5 mm.

REMARKS. One seed (V.40702) whose characteristic rounded lobes suggest relationship with *Tetrastigma*. The seed is much more slender in form and more sharply pointed than *T. lobata* and the lobes are more deeply divided from one another. The ventral angle in this seed is narrower and much sharper, but this feature may be due to development of four seeds in a grape which apparently did not occur in *T. lobata*. On the whole it seems advisable to separate it from *T. lobata* and although the solitary specimen is but poorly preserved, its characters appear to be so distinctive that a new name *Tetrastigma acuminata* has been given. From Arne.

Family DILLENIACEAE

Genus ACTINIDIA Lindl.

Actinidia sp.

Plate 16, fig. 1

DESCRIPTION. *Seed*: Ovate in outline (much compressed in fossilization). Hilar end incomplete, chalazal end rounded. Surface deeply foveolate with equiaxial hexagonal or polygonal pits varying in size in different parts of the seed, 0.05 mm. in diameter at the chalazal end, and from 0.1 to 0.125 mm. over most of the surface. The cells are longitudinally aligned, about twelve rows can be counted on the flattened surface, the ridges between them are sharp but show clear sutures along which fracture tends to occur, a pattern of small polygonal areoles is seen within the hollows of the pits. The testa, about 0.025 mm. thick, is apparently formed of a single layer of cells, the pits being impressed so as to form corresponding convexities on the inner surface separated by sutures. Length of seed (incomplete), 1.85 mm.; breadth (compressed), 1.25 mm.

REMARKS AND AFFINITIES. One incomplete seed (V.40703). The form (so far as it is preserved) and the structure of the testa are typical of *Actinidia*. In the absence of more perfect material it is described merely as *Actinidia* sp. From Lake.

Family THEACEAE

Section TAONABEAE

Genus CLEYERA DC.

Cleyera? obliqua n. sp.

Plate 17, fig. 7

DIAGNOSIS. Seed roundly triangular in outline. Seed-cavity inverted U-shaped with markedly unequal limbs separated by a straight but oblique condyle. Diameters of seed, 1.5 by 1.25 mm.

HOLOTYPE. V.40728.

DESCRIPTION. *Seed*: Roundly triangular in outline, much compressed, hilum marginal near the middle of one of the sides of the triangle; seed-cavity inverted U-shaped with unequal limbs separated by a long straight oblique condyle arising from the hilum and formed by the contiguous fused walls of the curved seed. Surface shining, cell-structure of testa obscure in many places, formed over the condyle close to the hilum of equiaxial cells about 0.03 mm. broad and often up to 0.1 mm. long. Over the limbs of the seed the cells are difficult to distinguish, but they appear to diverge from the condylar region and show a tendency to lie concentric with the margin of the seed. Diameters of seed, 1.5 by 1.25 mm.

REMARKS AND AFFINITIES. A single seed (V.40728), showing the characteristic inverted U-shaped form and coarse cells of *Cleyera*. In the absence of fuller information regarding the seed characters in the Taonabeae it has been referred to the genus *Cleyera*? with the specific name *Cleyera obliqua*. From Lake.

Genus HORDWELLIA Chandler, 1960: 228

Hordwellia crassisperma (Chandler)

Plate 17, figs. 8-61

1926 *Actinidia crassisperma* Chandler, p. 34, pl. 6, fig. 2; text-fig. 15.

1960 *Hordwellia crassisperma* (Chandler) Chandler, p. 229, pl. 34, figs. 140-44.

1961b *Hordwellia crassisperma* (Chandler): Chandler, p. 140.

DESCRIPTION. *Fruit*: Inferior with persistent calyx of several (four?) short rounded sepals (Pl. 17, fig. 8). Sub-circular or oval in outline, sometimes somewhat flattened above and below so as to give an ellipsoidal form. Sometimes subglobular or ovoid, syncarpous, three-loculed, many-seeded; placentation axile, seeds adpressed to form agglomerated seed-masses in each locule on the outer surfaces of which several (three or four) seeds can be seen (Pl. 17, fig. 11). Diameter of a three-loculed seed-mass from Sandbanks from which the carpel wall has been abraded, 3 mm. A similar specimen from Lake measured 1.3 by 1.6 mm. in transverse diameter, 1.6 mm. in longitudinal diameter. Length of fruit from Branksome Dene with calyx preserved about 5.5 mm.; breadth, 3.75 mm. (specimen much laterally flattened in fossilization).

Seed: Bisymmetric, sub-obovate, cuneate or irregular in outline, usually obliquely truncate at the base, ventral margin usually straight, sometimes concave, dorsal margin convex; seed inflated, usually somewhat cuneate in section the inflation being greatest on the dorsal side, splitting on germination in the plane of symmetry which passes through hilum, micropyle and raphe. Anotropous, sometimes angled along the ventral margin over the raphe, hilum terminal on the angle, often forming a projection, micropyle at the opposite corner of the truncate base to the hilum, and separated from it internally (as seen in section) by a thickening of the testa 0.35 mm. deep near the hilum to 0.125 mm. deep near the micropyle; raphe extending from one-third to three-quarters the length of the seed lying in a thickening of the ventral wall at the proximal end. External surface ornamented with conspicuous hexagonal pits, 0.075 to 0.1 mm. in diameter, equiaxial except along the ventral margin where they are narrower and longer. Testa formed throughout of radially aligned parenchyma (cells about 0.016 mm. in

diameter), thickness varying from 0.05 to 0.07 mm. at the bottom of the pits and about 0.1 mm. when measured through the ridges which separate the pits. An inner thin coat adhering in places to the testa shows equiaxial cells about 0.02 to 0.025 mm. in diameter. Length of seeds about 1 to 1.5 mm.; breadth, 0.75 to 1 mm.; thickness about 0.5 to 0.75 mm.

REMARKS AND AFFINITIES. Seven fruits, one from Branksome Dene (Bournemouth Freshwater Beds) crushed but with part of the superior perianth preserved (Pl. 17, fig. 8). The others from Sandbanks (Bournemouth Freshwater Beds) (cf. Pl. 17, figs. 9, 10) and from Lake are so abraded that the external walls have been removed exposing the edges of the septa and the seed-masses delimited by them (Pl. 17, figs. 9-11). In the first mentioned fruit, the degree of compression makes it difficult to be certain how many perianth segments were originally present; but there appear to be three rounded, short, incompletely united sepals actually preserved with a space where a fourth has been broken away. Numerous isolated seeds have also been found (cf. Pl. 17, figs. 12-61), some perfect, others split as for germination into two valves. While the seeds may vary both in size and shape, they show no histological differences on which different species could be based.

Seeds from the Lower Headon, Hordle (cf. Pl. 17, figs. 20-27), identical in all respects with those here described were formerly named *Actinidia crassisperma* Chandler. Comparison of actual specimens from the different localities shows them to be indistinguishable. But the ascription to *Actinidia* must now be corrected in the light of further information. The resemblance to the foveolate seeds of similar shape in *Actinidia* is superficial only for in this genus the testa is not formed of fine regular parenchyma but the coarse external pits which correspond with internal convexities appear to be formed by large cells which separate accurately along the middle lamella on fracture of the testa. The cell-structure of the fossil described above with coarse external pits and compact inner layers of fine equiaxial cells is found in the section Taonabeae, family Theaceae e.g. in *Eurya* and *Cleyera*, but these genera have characteristic curved seeds. No genus with anatropous seeds has yet been seen, nor is the superior perianth typical of the Taonabeae. However in *Visnea* and *Anneslea* there is the appearance of a superior perianth due to the fruit being sunk in the torus. In the absence of living seeds of comparable form the fossils are referred to a new genus *Hordwellia*. In the first description from Hordle the seeds were erroneously described as subovate where sub-obovoid would have been more accurate. The greater range of seeds now available shows a far greater variety of form than was originally observed. No cell measurements were then given, and the size of one seed only was recorded. The species is also present in the Bournemouth Marine Beds at Southbourne, in the beds at Cliff End, Mudeford (Auversian?) and in the Barton Beds of Barton.

V.40740 Figured Pl. 17, fig. 11. Fruit, side view, with pericarp abraded exposing the relatively uncrushed seed-masses.

V.40741-46, V.44776 Figured Pl. 17, figs. 12-19. Seven seeds of varying size and shape. Fig. 17 decayed.

V.40748-49 Two somewhat abraded fruits and part of another. V.40749 shows seeds five of which are now detached from the specimen.

V.40750 A crushed fruit and several seeds. Basal beds by ironstones in foreshore, east end of section.

V.40747, V.40751 Thirteen seeds. V.40751 *E. St. John Burton Coll.*

All the above from Lake.

Section?

Genus? (cf. GORDONIA)

Plate 16, figs. 2-4

DESCRIPTION. *Fruit*: Ovoid, a three-loculed woody capsule, with three loculicidal thick-walled valves which split from the apex downwards but remain attached to a basal receptacle. Basal scar of attachment triangular. Valves triangular in cross-section, united to a short, thick, three-angled columella (length, 2.5 mm.; breadth, 2 mm.) by their septa. Columella longitudinally striate. Surface of carpel much obscured by sand-pitting. Length of fruit, 4 mm.; breadth, 2.75 mm.; breadth of a single segment, 1.75 mm.

REMARKS AND AFFINITIES. The characters of this single capsule (V.40704) are those seen in Theaceae of *Gordonia* type. *Gordonia* itself is much larger and five-partite with an elegant slender columella. The generic relationship has not so far been discovered. No seeds are preserved. More material is needed for satisfactory diagnosis. From Lake.

Family FLACOURTIACEAE

Genus ONCOBA Forsk.

Oncoba rugosa n. sp.

Plate 16, figs. 5-10; Text-fig. 16

Note: The species is based on much better developed and preserved material from the Bournemouth Freshwater Beds and Cliff End, near Mudeford (Auversian?). The diagnosis and description given here make use of this material.

DIAGNOSIS. Seed obovoid, truncate at the chalazal end, external chalaza scar large, circular, rimmed, with median mucro. Surface of testa irregularly rugose or nodular, the rugosities sometimes merging to produce a reticulate pattern. Length of seed, 2.75 to 4.25 mm.; breadth, 2.25 to 3.3 mm.

HOLOTYPE. V.42366 from Bournemouth Freshwater Beds of Sandbanks.

DESCRIPTION. *Seed*: Subovoid or obovoid, more or less pointed at the hilar end, truncate at the chalazal end by a circular external scar with raised rim and central mucro. Surface ornamented with irregular nodules or tubercles which sometimes merge partially so as to produce an irregular network of raised ridges. Testa formed superficially of cells, usually equiaxial, about 0.016 mm. in diameter, the coat being one cell thick; sometimes the cells are longer than broad; sometimes they show slightly sinuous outlines. Within the external layer are elongate cells which pass into the surface rugosities (Text-fig. 16). Lining of testa formed of longitudinally aligned elongate cells about 0.004 to 0.012 mm. broad; these cells diverge from the internal chalaza scar, a sub-circular scar with median depression which immediately underlies the conspicuous external chalaza scar. Chalaza formed in section of equiaxial cells about 0.016 mm. in diameter.

REMARKS AND AFFINITIES. An uncrushed specimen (Pl. 16, figs. 5, 6) from Cliff End near Mudeford was originally intended for the holotype but has seriously deteriorated since. A seed from the Bournemouth Freshwater Beds has been chosen therefore in its place. A

stunted and perhaps immature seed has lately been found at Arne in the Lower Bagshot. The form and peculiarly large chalazal scar together with the detailed structure of the testa is seen in the genus *Oncoba*. *O. echinata* is a smoother and larger-seeded species (length, 6 to 7.5 mm.;

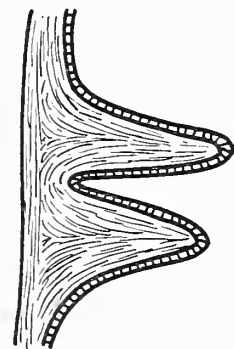


Fig. 16. *Oncoba rugosa* n. sp.

Testa (diagrammatic) in longitudinal section showing thin outer coat (its thickness exaggerated in diagram) and inner striate coat.

breadth, 4 to 4.75 mm.). The fossil has been named *O. rugosa*. *Oncoba* occurs at the present day in Arabia, tropical and South Africa, Madagascar and South America. It is recorded fossil from the London Clay and Reading Beds.

V.42027 Figured Pl. 16, fig. 10. A shrivelled, possibly immature seed, length, 4.25 mm.; breadth, 2.25 mm.

V.42026 Chalazal end of a seed.

Both the above from Arne.

Family THYMELAEACEAE

The family Thymelaeaceae is represented in the Lower Tertiary Beds of the Hampshire Basin by remains of the characteristic smooth, shining, anatropous seeds. The hard crustaceous integument (tegmen according to Lubbock) is alone preserved as a rule, and is usually incomplete and often very fragmentary owing to its brittle character. Four specimens from Lake show the pointed micropylar end, three others clearly indicate an obovoid form which may or may not be somewhat curved or asymmetric at the micropyle and hilum (Pl. 16, figs. 11, 12). Another fragment shows the superficial lateral raphe at its junction with the chalaza, the actual chalaza scar having broken away at its circumference. Yet another shows the knob-like hollow projection at the chalazal end (Pl. 16, figs. 13, 14), and one shows the chalazal end complete although crushed (Pl. 16, fig. 15).

The fragmentary condition makes precise determination difficult although cell-structure may in some cases prove to have generic or specific significance. The cell-structure actually shows slight variations which may be due in part to the degree of abrasion. Thus whereas the coat is always hard, dark and shining, the surface may show cells which appear concave, convex or flat. They may or may not (in a single fragment) show the small lumen with diameter only equal to the thickness of the walls. In some abraded specimens the lumen produces a

conspicuous central dot or depression at the centre of each cell giving the coat a highly characteristic appearance. In section the integument is thick especially at the chalaza end and near the middle (about 0.25 mm.); it is thinnest at the micropylar end. It shows a columnar structure (Pl. 16, fig. 14) the columns being approximately at right angles to the surface near the micropyle, but elsewhere they are obliquely curved with their inner ends directed towards the chalaza near which they may be curved through an angle of more than 45°. There is a tendency for the walls to split into concentric inner and outer layers; there are at least two layers of cells in the thickness. Inside the thick crustaceous coat the remains of a thinner integument is sometimes present.

The specimens have been compared with seeds of *Thymelaea*, *Pimelea*, *Wikstroemia*, *Gnidia*, *Daphne*, *Aquilaria*, *Peddiea* and *Leucosmia*. The peculiar punctate surface formed by the thick-walled cells with small cavity has been seen in *Daphne* and *Aquilaria*. *Daphne laureola*, *D. gnidium* and *Aquilaria* seeds taper gracefully towards the micropyle. In all the Recent species examined the tegmen, where it could be seen in section, is thinner than in the fossil. In view of the difficulty of distinguishing seeds from such incomplete or crushed material the fossils have been referred to a form-genus *Thymelaeaspermum* to indicate relationship to the family Thymelaeaceae. The presence of more than one species cannot be excluded among the many fragments. The most perfect seeds are referred to a new species *Thymelaeaspermum lakense*.

Genus THYMELAEASPERMUM nov.

DIAGNOSIS. A form-genus for seeds referable to Thymelaeaceae of which the nearer relationship cannot be determined.

TYPE SPECIES. *Thymelaeaspermum lakense* n. sp.

Thymelaeaspermum lakense n. sp.

Plate 16, figs. 11-15

DIAGNOSIS. Seed pointed-obovoid without evidence of flattening on one side. Micropylar end straight or curved. Chalaza with a knob-like projection, raphe lateral, superficial on the tegmen. Tegmen crustaceous, its surface cells with small central pit. Large depressions few or absent. Length (estimated), 7.5 to 8 mm.; breadth (as crushed and flattened), 4.25 to 4.5 mm.

HOLOTYPE. V.40705.

DESCRIPTION. *Seed*: Pointed-obovoid, anatropous. Micropyle at the pointed end which may be straight or curved. Chalaza marked externally by a knob-like prominence at the rounded end (usually broken away). Testa not preserved. Tegmen thick, crustaceous, shining when unabraded, about 0.25 mm. thick at the chalazal end and middle thinning towards the micropyle. Surface cells usually flat-topped superficially or convex, equiaxial, about 0.027 mm. in diameter with small central pit (lumen). Section of tegmen showing columnar cells curved at the chalazal end with inner ends directed towards the chalaza. Although one specimen shows deep hemispherical depressions with sub-circular outlines, about 0.03 mm. in diameter, at infrequent intervals over the surface, they are quite unlike the conspicuous depressions, often arranged in lines or groups, which form a conspicuous feature in Thymelaeaceae seeds awaiting description from the Bournemouth Marine Beds. Actual length of most perfect seeds (in-

complete at chalaza), 6.5 and 5.5 mm. Estimated complete length about 7.5 to 8 mm. Breadth (increased by compression in fossilization), 4.25 to 4.5 mm.

- V.40705 Holotype, figured Pl. 16, fig. 11. A large part of a compressed seed with only the extreme chalazal end missing. Estimated complete length, 7.5 mm. (actual length preserved, 6.5 mm.). Breadth (as crushed), 4.25 mm.
- V.40706 A second similar specimen with curved micropylar end. Surface abraded so that the external cells walls have gone.
- V.40708 Figured Pl. 16, fig. 12. A fragment 4.25 mm. long, 3.25 mm. broad representing the micropylar end of a seed. It is incomplete on one side and burst open. Cells concave superficially about 0.025 mm. in diameter. Some show a dot representing the lumen, others do not. Deep hemispherical depressions with sub-circular outlines about 0.03 mm. in diameter occur at infrequent intervals over the surface but they are quite unlike the conspicuous depressions seen in seeds from the Bournemouth Marine Beds.
- V.40709 Figured Pl. 16, figs. 13, 14. The chalazal end of a seed showing the knob-like hollow of the chalaza and the crustaceous integument with its two layers as seen in section. Surface shows equiaxial "cells" about 0.02 to 0.05 mm. in diameter each apparently made up of much smaller cells or areas which are not always visible. The outer layer is formed, in section, of columnar cells at right angles to the surface except near the chalaza where they are oblique (Pl. 16, fig. 14) their inner ends directed towards the chalaza. Maximum thickness of this coat near the chalaza, 0.2 mm., at the opposite extremity of the fragment only 0.1 mm. Columnar cells from 0.02 to 0.025 mm. broad with small lumen equal to the thickness of the wall. Inner layer of equiaxial parenchyma about 0.05 mm. thick near the chalaza, 0.02 mm. thick at the other end. A thin inner integument is also seen, lighter brown than the hard integument, formed of more than one layer of cells. Indications of equiaxial cells about 0.016 mm. in diameter can be detected and there are traces of fine longitudinal and transverse striae (due to crushing?). Length and breadth of fragment, 3.3 and 1.8 mm. respectively.
- V.40707 Figured Pl. 16, fig. 15. Chalazal end of a somewhat compressed seed, breadth, 5 mm. (length actually preserved, 3.5 mm.). Surface much worn, equiaxial flat-topped cells where seen, 0.018 to 0.027 mm. in diameter with very small lumen. Fine pits are discernible in places.
- V.40710 Two fragments of a single seed with slightly convex cells 0.03 mm. in diameter at the middle, 0.025 mm. in diameter nearer the narrow end. Micropyle and hilum broken. A few large depressions (as described in V.40708) are also present. They have the appearance of patches of decay in the surface cells.
- V.40711 A fragment of a seed near the chalazal end showing flat cells about 0.025 mm. in diameter.
- V.40712 Another fragment from the chalazal end of a seed showing flat cells, somewhat irregular in size and shape but on the whole about 0.025 mm. in diameter.
- V.40713 A much crushed fragment with equiaxial cells 0.02 mm. in diameter.
Possibly belonging to another species:
- V.40714 Two fragments of a seed with slightly concave cells, 0.025 mm. in diameter. Cells with thick walls and small lumen as seen superficially.
- V.40715 Middle part of a seed with concave cells arranged in irregular longitudinal lines.
- V.40716 Two fragments of a seed showing two coats in section formed of columnar cells, curved in part. Superficially formed both inside and out of concave cells 0.03 mm. in diameter. Internally a coat of fine equiaxial cells, about 0.015 mm. in diameter is also seen.
All the above from Lake.
- V.40717 Seed fragments, the tegmen columnar in section, but superficially the polygonal ends of the columns are very obscure, masked by a finely pitted glossy surface, the adjacent equiaxial pits not more than 0.006 mm. in diameter. The ends of the columns where visible are represented by cells about 0.027 mm. in diameter. The distinctly different surface of these fragments may indicate another species or may be the true unabraded surface of *T. lakense*. The fragments are too small for certain determination. Arne.

Thymelaespermum (?) *sulcatum* n. sp.

Plate 16, fig. 16

DIAGNOSIS. Seed ovoid. Surface with sharp longitudinal furrows alternating with gently convex ribs, 0.2 to 0.3 mm. broad at the middle of the seed. Testa of fine concave cells about

0.016 mm. in superficial diameter, in section of curved columns. Internal surface finely transversely striate. Innermost coat of equiaxial cells. Length of seed, 0.85 mm.; breadth, 0.7 mm. (as flattened).

HOLOTYPE. V.40718.

DESCRIPTION. *Seed*: Originally ovoid (now flattened by fossilization and beginning to split in the plane of flattening at the edges). Terminating at one end in a truncated point with a rounded depression about 0.15 mm. in diameter, burst at the other end so that the structure is obscure, but the convergence of cells and furrows indicates an organ at each end. Surface ornamented with sharp longitudinal furrows, separated by gently convex longitudinal ribs, 0.2 to 0.3 mm. broad at the middle of the seed. It is formed of cells with central concave depressions giving a punctate effect, the cells being about 0.016 mm. in diameter. Testa as seen in section 0.05 mm. thick, formed of bent oblique columns, about 0.012 mm. broad, which produce a herring-bone pattern on the fractured surface. Internal surface with fine transverse striations about 0.01 mm. apart, formed of transversely elongate cells, within which is a coat of equiaxial cells about 0.012 mm. in diameter. Length of seed, 0.85 mm.; breadth, 0.7 mm. (as compressed).

REMARKS AND AFFINITIES. One seed (V.40718), now crushed and with part of one side removed to show the internal structure. The structure of the testa, more especially the peculiar bent columns seen in section, and the succession of coats recall Thymelaeaceae. If this really is the relationship, then the depression at the truncated end marks the chalaza. No comparable living genus has been seen. From Lake.

Family LYTHRACEAE

Genus AMMANNIA (Houst.) L.

Ammannia lakensis n. sp.

Plate 16, figs. 17-19

DIAGNOSIS. Seeds closely resembling those of the living *Ammannia japonica* but with more conspicuously tubercled surface. Length about 1.25 mm.; breadth (as crushed), 0.5 mm.

HOLOTYPE. V. 40719.

DESCRIPTION. *Seed*: Anatropous, elongate suboval in outline, but more or less parallel-sided, somewhat flattened, the flattening being exaggerated by compression in fossilization which has caused the seed to burst at top and bottom and to crack longitudinally. Micropyle and hilum contiguous at one end indicated by a projecting point or snout and by the convergence of the surface sculpture. Chalaza at the other end indicated by an obscure rounded scar which is surrounded by a flange-like projection of the testa and by the tendency of the surface sculpture to converge here also. Raphe longitudinal on one of the flat faces, asymmetrically placed nearer one side than the other, indicated, as in the living *Ammannia*, by a narrow band of longitudinal striations. Surface ornamented with prominent somewhat pointed tubercles with rounded outlines where they arise from the testa. The tubercles are almost contiguous in longitudinal rows each tubercle base about 0.027 mm. in diameter. There are about eighteen

rows visible on one side lying about 0.036 mm. apart. Length of seed, 1.25 mm.; breadth (crushed), 0.5 mm.

REMARKS. One seed (V.40719). In size and arrangement it closely resembles the cosmopolitan *Ammannia* and it is clearly referable to this or some very similar genus of Lythraceae. *A. japonica* lacks the conspicuously tubercled surface. Seeds of *Lythrum japonicum* also bear some resemblance to the fossil but less close than *Ammannia*. From basal beds in foreshore, Lake.

Genus ALATOSPERMUM nov.

DIAGNOSIS. Seeds similar to those of *Diclidocarya* E. M. Reid emend. but with thin equally or unequally developed lateral wings. Germination valve long oval or oboval, extending for the whole length of the seed-body but gaping at its lower end only and remaining attached to the seed at the chalazal end.

TYPE SPECIES. *Alatospermum lakense* n. sp.

Alatospermum lakense n. sp.

Plate 16, figs. 20-25; Pl. 17, figs. 1-6

DIAGNOSIS. Seed winged, seed-body extending throughout the length of the seed; lateral wings (which may be equally or unequally developed) very thin, raphe more or less parallel-sided below, branching in the chalazal region at the distal end. Seed not stipitate, triangular, sub-quadrangular, oboval, or irregular in outline. Germination valve narrow extending throughout the length of the seed-body but gaping for germination at the lower end of the seed only, remaining attached in the upper half. Length of seed, 0.075 to 1.55 mm.; breadth, 0.85 to 1.8 mm. Breadth of valve, 0.4 to 0.55 mm.

HOLOTYPE. V.40720.

DESCRIPTION. *Fruit*: Not known definitely, possibly represented by *Carpolithus* sp. (p. 151, Pl. 25, figs. 3-10).

Seed: Anotropous, dorsiventrally compressed, broadly triangular, oboval, sub-quadrangular, or irregular in outline sometimes emarginate at the apex, and perhaps at the base as well (?). Hilum marginal, in the triangular seeds situated at one angle. Seed having a median elongate-oval or oboval body and thin but stiff lateral wings of variable breadth. The wings may form a narrow marginal flange or a broader triangular area on each side of the body, or there may be a narrow flange on one side of it, and a broader one on the other. There appears to have been a narrow rim-like continuation of the wing around the apex of the seed-body. Dorsal surface slightly convex, ventral more or less flat or slightly convex. Raphe ventral, median, forming a striate ridge which extends from base to apex, giving off divergent branches near the apex over the chalazal area. Germination by a long narrow oval valve on the dorsal surface extending the whole length of the seed-body and displaying superficially characteristic coarse equiaxial pits aligned in six or seven regular longitudinal rows. Diameter of pits about 0.05 mm. As in the living genus *Decodon* the valve gapes in the lower half of the seed, remaining attached in the upper half. Hence it does not break away to form an operculum with smoothly finished margin all round its circumference as in *Diclidocarya* E. M. Reid. Testa formed superficially over the wings of large elongate oblique cells or areas transversely aligned or diverging

from the seed-body and raphe. These cells are about 0.016 mm. to 0.025 mm. broad. They may be made up of smaller equiaxial cells aligned in rows. Beneath them fine striae can be seen. Internal structure of seed not displayed. Dimensions of three seeds are as follows: 1) Length, 1.5 mm.; breadth, 1.8 mm.; breadth of valve, 0.45 mm. 2) Length, 1.55 mm.; breadth, 1.1 mm.; breadth of valve, 0.4 mm. 3) Length, 0.075 mm.; breadth, 0.85 mm.; breadth of valve, 0.4 mm.

REMARKS. Eight seeds clearly related to the fossil genus *Diclidocarya* Reid emend. (*in* Nikitin, 1929) and to the living *Decodon* J. F. Gmel., both belonging to the family Lythraceae. The broad form recalls *Diclidocarya* but the Lake seeds are much thinner and flatter owing to the thinness of their broad wings. The gaping of the germination valve is like that of *Decodon* and distinguishes the fossil from *Diclidocarya* with its relatively short, completely detachable operculum. The seeds of *Decodon* are, however, thick at right angles to the valve and narrow parallel with the valve, not thin, broad, and winged as is the fossil. The evidence therefore indicates that these fossils from Lake should be referred to a distinct genus, and since no comparable living or fossil form has yet been found the new name *Alatospermum lakense* has been given. Although there is some resemblance in form to *Pemphis* Forst. the wing in *Pemphis* is thicker and more corky, while the surface cells of the wing do not form conspicuous transverse or oblique striations. In this genus no valve on the seed-body is apparent although germination might reveal its presence. The seed-body of *Pemphis* is more broadly oval than that of the fossil.

- V.40720 Holotype, figured Pl. 16, figs. 20, 21. A typical seed with equally developed wings showing incipient opening of the germination valve in the lower half.
 V.40721 Figured Pl. 16, figs. 22, 23. Another specimen with pitted valve surface especially well preserved.
 V.40722 Figured Pl. 16, figs. 24, 25. A small symmetric seed.
 V.40723 Figured Pl. 17, figs. 1, 2. A seed with unequally developed wings.
 V.40724 Figured Pl. 17, fig. 3. A triangular seed. The tip of one wing is now fractured.
 V.40725 Figured Pl. 17, figs. 4, 5. A smaller symmetric seed.
 V.40726 Figured Pl. 17, fig. 6. An asymmetric seed.
 V.40727 Eight seeds with varying width of wing. One specimen shows the lower gaping part of the valve broken away so that the locule is exposed; the upper part of the valve still adheres to the seed-body.
 All the above from fine silt, base of section, western end, Lake.

Family NYSSACEAE

Genus NYSSOIDEA nov.

DIAGNOSIS. Endocarp one-loculed with broad rounded longitudinal ribs separated by narrow furrows. Locule having a short longitudinal ridge on the dorsal wall below a short sub-triangular germination valve situated at the upper end of the dorsal wall of endocarp. Length of fruit about 12 to 19.5 mm.; breadth about 5 to 7.5 mm.

TYPE SPECIES. *Nysoidea eocenica* n. sp.

Nysoidea eocenica n. sp.

Plate 20, figs. 5-21

DIAGNOSIS. That of the genus.

HOLOTYPE. V.41942 from Bournemouth Freshwater Beds of Bournemouth.

DESCRIPTION. *Fruit*: Elongate-ellipsoid but somewhat dorsiventrally compressed (compression increased in fossilization), one-loculed, inferior, with accrescent perianth the apical limit of which is marked by a small terminal disc (Pl. 20, figs. 7, 18). Surface with broad, low longitudinal rounded ribs separated by narrow furrows which converge towards base and apex. Strands of fibres are embedded in the substance of the exocarp in these furrows. Exocarp formed of elongate inflated cells with a general transverse alignment; maximum diameter of the cells, 0.1 mm.; diameter at right angles to this, 0.03 mm. Length of fruit about 12 to 19.5 mm.; breadth, 5 to 7.5 mm.

Endocarp and seed: Agreeing with the fruit in shape. Germination by the opening of a small sub-triangular valve near the apex on the dorsal side, the valve extending from one-fifth to one-third of the length of the endocarp (Pl. 20, figs. 5, 9, 14, 19). Longitudinal rounded ridges like those of the fruit are seen superficially. One or more of the furrows between them may be continued on to the surface of the valve which is outlined on each side by furrows slightly deflected out of their straight course so as to conform to its convex lateral margins. Wall formed superficially of transverse fibres; in transverse section it shows radially aligned fibres within (the structure is often obscured by carbonization). Thickness of wall where measured, 0.4 mm. Locule wall bearing a short longitudinal ridge which arises just below the valve and dies out about the length of the valve from its lower margin. The ridge is expanded and rounded along its inner end near the valve (Pl. 20, figs. 12, 15, 21) but appears to become narrower and sharper towards its lower extremity. The ridge shows no indication of longitudinal splitting as in *Mastixioideae* and it appears to be formed by a thickening of the endocarp and not by infolding of it. In section the fibres in the ridge diverge towards the expanded inner end. Inner surface of endocarp transversely striate within, and partially fused with this striate coat (?) is a fine-celled longitudinally striate integument (testa?).

Tegmen formed of square or quadrangular cells usually longer than broad but arranged in well-defined transverse rows about 0.025 to 0.03 mm. apart, producing transverse striae.

Dimensions of endocarp scarcely less than those of the fruit. Length of best developed endocarp, 16.5 mm.; greatest diameter, 5.25 mm.; diameter through the internal ridge, 2.5 mm. Length of valve, 4 mm.

REMARKS AND AFFINITIES. The species is identical with specimens from the Bournemouth Freshwater Beds and Cliff End near Mudeford. A Bournemouth specimen has been taken as the holotype because the external characters are preserved best in this material (cf. also Pl. 20, figs. 7-19), the exocarp being present with cell-structure preserved. The cell-structure of the locule is also well preserved. The longitudinal infold is best seen in an endocarp from Lake.

The one-loculed endocarp with dorsal germination valve and fibrous texture appears to be related either to the *Mastixioideae* of the family Cornaceae or to the *Nyssaceae*, a relationship confirmed by the fragments of seed with the characteristic transversely-aligned tegmen cells found in these two groups. The longitudinal ridge on the dorsal wall of the locule differs in its structure from the infold of *Mastixioideae* and in its short length relative to the locule. The short apical germination valve and the transverse fibres of the endocarp agree with those of *Nyssa*. The relationship appears, therefore, to be with *Nyssaceae* rather than with *Mastixioideae*, but the fossil differs from *Nyssa* in its relatively long and narrow form and in the short internal dorsal ridge. It has been named *Nysoidea eocenica*.

- V.41948 Figured Pl 20, figs. 14, 15. A well-preserved endocarp showing the valve and longitudinal rounded ridge projecting into the locule. The valve has begun to separate. The endocarp has broken transversely just above the base of the valve which still adheres to the apical fragment.
- V.41956-58 Five endocarps, one small, probably immature. V.41957 is fragmentary with remains of seed showing the tegmen cells. V.41958 relatively broader and shorter without germination valve and showing ridge on locule wall. Length, 9.5 mm.; breadth, 4.75 mm. Surface much worn so that some of the furrows and fibres have been obliterated.
All the above from Lake.
Figured Pl. 20, fig. 16. A large endocarp (length, 19.5 mm.; breadth, 7.5 mm.) now decayed and broken at the lower end showing the infold in section. The germination valve had come away exposing the internal cast of the endocarp. The exterior of the endocarp shows clearly the transverse fibres. (Decayed.)
- V.41949 Figured Pl. 20, fig. 17. A smaller but perfect specimen with germination valve (closed) obscurely seen.
- V.41950 Figured Pl. 20, fig. 18. A small but inflated fruit showing apical perianth disc (much abraded).
- V.41951-55 Five specimens, one very small, another large but broken. Another has cracked on drying and shed its germination valve and part of the dorsal wall just below revealing the extent of the longitudinal ridge on the locule wall.
All the above from Arne.

Family CORNACEAE

The family Cornaceae is represented in the Lower Bagshot of Lake and Arne by at least seven species, some of which are referred to the section Mastixioideae and others to the Cornioideae. All but *Mastixia* and *Cornus* belong apparently to extinct genera, but the family characters are clear and unmistakable in all. The section Mastixioideae is virtually exclusively tropical in its present-day distribution, the only living representative, *Mastixia*, being confined to Indo-Malaya although it may ascend up to 4,000 ft. It is represented by a species at Arne. The extinct genera *Eomastixia* and *Mastixicarpum* were originally founded on endocarps from the Lower Headon of Hordle. In recent years better preserved material showing the characters of fruit as well as endocarp have been available from the Bournemouth Freshwater Beds.

The Cornioideae have a wider distribution at the present time, occurring in both tropical and extratropical regions, but it is perhaps significant that the extinct genus *Dunstania* belonging to this section, has hitherto been found only in floras which indicate tropical, sub-tropical, or at least warm temperate conditions. It is one of the most characteristic plants of the London Clay while the youngest beds in which it has yet been recorded are the Upper Eocene Lower Headon of Hordle. It has lately been recognized not only at Lake, but also in the Bournemouth Freshwater and Marine Beds and in the Lower Headon of Hordle.

Section MASTIXIOIDEAE

Genus MASTIXIA Blume

?*Mastixia cantiensis* Reid & Chandler

Plate 18, figs. 1-3

1933 *Mastixia cantiensis* Reid & Chandler, p. 448, pl. 25, figs. 1-6.

1961 *Mastixia cantiensis* Reid & Chandler: Chandler, p. 282, pl. 28, figs. 21-26.

DESCRIPTION. *Fruit*: Ellipsoid (or perhaps obovoid), inferior, with perianth accrescent for most of the length. At the apical end there is an obscure apical perianth disc or scar.

Eight or nine longitudinal strands of fibres can be seen on the sides of the fruit. They terminate at the perianth disc. In the areas between these fibres there is slight transverse corrugation of the surface possibly due to abrasion on tissues of differing structure. Epicarp entirely worn away, exocarp thin, about 0.5 mm. thick but varying somewhat in thickness where it fills the irregularities of the endocarp surface. It is compact, formed as seen in section, of equiaxial cells which can only be seen obscurely. Length of fruit, 22.5 mm.; diameter, 12.5 by 9 mm. (inequality due to slight distortion and flattening in fossilization?).

Endocarp: Agreeing with the fruit in shape, hence ellipsoid (or obovoid), surface not exposed but evidently rugose or uneven to some extent as shown by the transverse section; one-loculed with a single longitudinal infold which causes the locule to be U-shaped in transverse section. The infold forms the inner face of a large germination valve. In section this valve can be seen to split longitudinally down the middle which is filled with coarse parenchyma. Wall of endocarp woody, fibrous, formed largely of radially aligned fibres or elongate cells which comprise the main thickness. Locule lining, as seen on the surface of the cavity, of very elongate somewhat sinuous cells arranged on the whole longitudinally but with groups of cells varying in direction like the lines of a finger-print. These cells average about 0.057 mm. in breadth. There are abundant traces of resin, but the actual ducts are obscure in the much weathered specimen. Dimensions somewhat less than those of the fruit.

Seed: Represented by remains of the testa only, showing square or equiaxial cells about 0.038 mm. in diameter with resinous contents.

REMARKS. One specimen (V.40762) which had broken as it lay in the matrix. Most of the fragments were collected and fitted together. The fruit had been flattened obliquely longitudinally so that the infold of the valve was folded back longitudinally towards the dorsal wall of the locule instead of standing out from it at a right angle. The external surface is so much abraded that the perianth disc was detected only with difficulty. The size and appearance of the specimen suggest comparison with *Mastixia cantiensis* Reid & Chandler from the London Clay (length, 14 to 22 mm.; breadth, 7 to 9 mm.). But precise comparison cannot be made on account of the very limited Lower Bagshot material and the different mode of its preservation. In it only the worn surface of the exocarp is seen tightly adhering to the endocarp whereas in the London Clay material it is the surface of the endocarp which is exposed. In the London Clay specimens there appears to be much parenchyma in the endocarp wall which is made clear by the pyritization. In the Lower Bagshot fruit the only place in which parenchyma is well seen is the middle of the infold as in the smaller *Mastixicarpum crassum*. Also it is not apparent whether there is an external groove corresponding with the internal infold, hence the doubtful reference to *Mastixia*. The London Clay species *M. cantiensis* appears to be somewhat broader relative to its length, but it must be noted that the dimensions given for the Lower Bagshot endocarp are based on one specimen only from which the variation in size cannot be gauged. On the whole the specific relationship appears probable. It should be borne in mind that a Menispermaceous species allied to *Tinospora excavata* of the London Clay also occurs in this deposit, as well as *Anemia poolensis*, *Palaeococculus lakensis*, ?*Meliosma sheppeyensis*, *Vitis pygmaea*, ?*Palaeophytocrene foveolata*, *Wetherellia variabilis* and *Rhamnospermum bilobatum* also found in the London Clay. ?*Mastixia cantiensis* is considerably larger than *Mastixicarpum crassum* so reference to this species is definitely excluded. From Arne.

Genus *EOMASTIXIA* Chandler, 1926: 37

EMENDED DIAGNOSIS. Fruits belonging to the section Mastixioideae of the family Cornaceae; endocarps two- or more loculed, syncarpous, germinating by dorsal valves which extend the whole length of the locules. Valves bearing on the internal surface a median longitudinal infold which corresponds with a groove on the external surface.

Eomastixia rugosa (Zenker)

Plate 18, figs. 4-41; Pl. 19, figs. 1-7

- 1833 *Baccites rugosus* Zenker, p. 12, pl. 1, figs. 9, 10.
 1926 *Eomastixia bilocularis* Chandler, p. 37, pl. 6, fig. 6a-e.
 1935 *Plexiplica Reidii* Kirchheimer, p. 293, fig. 18.
 1936 *Plexiplica Reidii* Kirchw.: Kirchheimer, p. 292, pl. 8, fig. 1a-e.
 1938 *Plexiplica Reidii* Kirchw.: Kirchheimer, pp. 635-39, figs. 13-15.
 1938a *Plexiplica Reidii* Kirchw.: Kirchheimer, p. 344, fig. 3.
 1939 *Plexiplica Reidii* Kirchw.: Kirchheimer, p. 415, fig. 10.
 1939a *Plexiplica Reidii* Kirchw.: Kirchheimer, pp. 279-80, pl. 2, fig. 6.
 1940 *Plexiplica Reidii* Kirchw.: Kirchheimer, pp. 287-88, fig. 4c, d.
 1957 *Plexiplica rugosa* (Zenker) Kirchheimer, pp. 259-60, pl. 9, fig. 47b, pl. 40, fig. 161a-e.
 1960 *Eomastixia rugosa* (Zenker) Chandler, p. 234.
 1961b *Eomastixia rugosa* (Zenker): Chandler, p. 141.

DESCRIPTION. *Fruit*: (Based on material from the Bournemouth Freshwater Beds) Syncarpous, ovoid, inferior with perianth accrescent almost to the apex, but terminating against an apical disc or scar with a central prominence which represents the base of the style (Pl. 18, figs. 23, 25). Perianth (exocarp) with ten to eighteen longitudinal strands of fibres extending from the base of the fruit to the margin of the scar, the fibres occasionally branching and anastomosing (Pl. 18, figs. 21-24, 39-41). Epicarp smooth, shining, formed of polygonal or rectangular cells, 0.03 to 0.05 mm. in diameter. Exocarp penetrating into the furrows and irregularities of the endocarp surface, hence varying in thickness; formed of equiaxial cells about 0.025 mm. in diameter, filled by a glistening black resinous or oily secretion. It also has large longitudinal ducts, containing a yellow semi-translucent resin, near the inner surface on the same radii as the deep longitudinal grooves and infolds of the endocarp, and near the outer surface beneath the fibro-vascular strands (Pl. 18, fig. 8; Pl. 19, fig. 5). Owing to the shrinkage of the carbonaceous tissues on drying, perhaps also to the expansion of resin on solidification, the surface of the exocarp has frequently burst over these ducts exposing the resin as irregular elongate longitudinally aligned masses. Dimensions of fruits: 1) Length, 13 mm.; breadth, 7.5 mm. 2) Length, 9.5 mm.; breadth, 7.5 mm. 3) Length, 16 mm.; breadth, 9 mm.

Endocarp: Ovoid, somewhat rugose, the rounded rugosities usually elongate and longitudinally aligned, and separated by branching and anastomosing furrows, two- to three-, rarely four-loculed, each locule one-seeded with pendulous seed. A large longitudinal infold on the dorsal wall of each locule projects into the cavity causing it to be C-shaped in transverse section (Pl. 19, figs. 1-3). The infold forms the inner face of a large dorsal germination valve extending almost the whole length of the nut, the outer face of which bears a corresponding groove filled with loose tissue and enclosing a large resin duct as above described. Walls thick, woody, formed largely of radially aligned elongate cells (or fibres) with a few embedded

masses of fine parenchyma. Around the locules there is a narrow layer of closely compacted transverse fibres. Scattered cavities in the thickness of the wall contain resin. Locule lining of transversely-elongate cells. Dimensions of endocarps from Lake: 1) Length, 11.5 mm.; breadth, 10.5 mm. 2) Length, 11 mm.; breadth, 9.5 mm. Thickness of wall about 2.5 mm. Endocarps from the Lower Headon of Hordle measure: Length, 9.5 to 15 mm.; breadth, 5.5 to 8.5 mm.

Seed: Anatropous, with median ventral raphe; testa more or less fused with locule lining and impressed upon it, formed of polygonal or quadrangular cells with transverse alignment, 0.05 to 0.1 mm. in diameter, filled originally with a thick gummy or resinous secretion since their cavities show the remains of a black shining substance. Inner integument (tegmen) formed of transversely aligned cells producing a marked transversely striate effect. The seed is represented only by fragments adhering to the locule wall (Pl. 18, fig. 14).

REMARKS AND AFFINITIES. The species is common in the Eocene beds of the Dorset and Hampshire coast. Specimens from the Lower Headon of Hordle were described by Chandler (1926: 37) as *Eomastixia bilocularis* (cf. Pl. 18, figs. 9-16; Pl. 19, figs. 1-3). Others from the Brown Coal of Germany were described by Kirchheimer first as *Plexiplica Reidii* Kirchheimer, and later as *P. rugosa* (Zenker). Subsequently material from Hordle was sent to Dr. Kirchheimer who replied that it and his *Plexiplica* were identical and that under the rules of nomenclature the species must now be named *Eomastixia rugosa* (Zenker).

In the Lower Bagshot endocarps are known from Lake and Arne, those from Lake being much obscured by crushing. The description of the fruit (as opposed to the endocarp) is based on specimens from the Bournemouth Freshwater Beds (cf. Pl. 18, figs. 21-25; Pl. 19, fig. 5) where endocarps (cf. Pl. 18, figs. 17-20; Pl. 19, fig. 4) occur as well. Endocarps are also found in the Bournemouth Marine Beds (cf. Pl. 18, figs. 26-30) and in Lignites at the base (Pl. 18, fig. 31) and top (Pl. 18, fig. 32) of the Boscombe Sands and in the Highcliff Sands (Pl. 18, figs. 33, 34; Pl. 19, fig. 6). Poorly preserved fruits have been found at Barton (Pl. 18, figs. 35-41; Pl. 19, fig. 7), but their mode of preservation quickly causes deterioration and they soon disintegrate. The Hordle (Lower Headon) endocarps are usually less crushed than the Bournemouth specimens and are better developed but the exocarp is always missing. Up to the present the species has not been recorded from beds younger than the Lower Headon. German specimens are from the Brown Coal of Altenburg (Thuringia) and Saxony and are stated by Kirchheimer (1957: 260) to be of Lower to Middle Oligocene age whereas the British examples are all Eocene but in a letter dated June 1957 he writes that the horizon for this species and his *Mastixicarpum compactum* is oldest Oligocene or possibly even Upper Eocene. These woody endocarps with long dorsal germination valves bearing median longitudinal infolds are clearly related to *Mastixia* but differ from this living genus in having almost invariably more than one locule. In view of the tendency for a larger number of locules to occur in extinct representatives than in the living members of a genus, the distinction between *Mastixia* and *Eomastixia* may be an artificial one which will ultimately have to be discarded.

V.40770-72 Figured Pl. 18, figs. 4-6. Three endocarps.

V.40773 Valve of an endocarp, now fractured.

V.40774 Twelve endocarps of varying size, some small and slender, all much compressed. The smaller show evidence of three locules. Some are clearly immature.

All the above from Lake.

V.40775-76 Figured Pl. 18, figs. 7, 8. Two endocarps.

V.40777 Several endocarps and a few broken specimens.

All the above from Arne.

Eomastixia urceolata n. sp.

Plate 19, figs. 8-13; Text-fig. 17

DIAGNOSIS. Accrescent perianth terminating at a small apical disc bearing three to four perianth segments. Fruit sub-urceolate. Endocarp obovoid, three- or four-loculed, with an elongate resin duct in the external sulcus of each germination valve and a pair of resin ducts in each septum. Length of fruit, 6 to 13 mm.; breadth, 3.75 to 5.5 mm.

HOLOTYPE. V.41970.

DESCRIPTION. *Fruit*: Inferior, with thin accrescent calyx terminating above in three or four small perianth segments which spring from the margin of a small apical disc, sub-urceolate being pointed below and contracted to form a short neck above (Pl. 19, figs. 8, 9, 12). There is considerable variation in size. The following are typical measurements: 1) Length, 13 mm.; breadth, 5.5 mm. 2) Length, 9.75 mm.; breadth, 3.75 mm. 3) Length, 7 mm.; breadth, 4.5 mm. 4) Length, 9.25 mm.; breadth, 5 mm. 5) Length, 6 mm.; breadth, 4.25 mm.

Endocarp: Obovoid, pointed below, three- or four-loculed, the locules lying opposite the perianth segments and opening by large dorsal valves which extend from the apex to the base. On each valve there is a deep longitudinal median external groove (Pl. 19, fig. 10) corresponding with a longitudinal median infold which projects into the locule (Pl. 19, fig. 13; Text-fig. 17). The inner margin of the infold is slightly furrowed so that there is sometimes a tendency to longitudinal bifurcation of the ridge. There is a marked tendency for splitting to occur down the middle of the infold. The presence of the infold causes the locule to be C-shaped in transverse section. There are conspicuous longitudinal resin ducts in the median external grooves of the valves, the contents of which are often exposed at the surface of the fruit owing to contraction and splitting of the carbonaceous cells of endocarp and calyx which originally covered them. Hence the resin is seen as a hard yellow substance of irregular thickness lying in the groove. There is also a pair of small ducts in each of the septa; these are conspicuous in transverse sections (Text-fig. 17). Carpel wall compact, thick, formed in part of elongate fibre-like cells well seen in transverse sections of the septa parallel with the septal surfaces; elsewhere of sinuous cells, about 0.03 mm. in diameter, arranged radially on the external walls of the locules and diverging from the large resin ducts in the infolds of the valves. Dimensions closely approximating to those of the fruits.

Seed: Solitary in the locules, represented only by fragments of testa and tegmen which are translucent, thin, formed of transversely elongate cells giving a transversely striate effect.

REMARKS AND AFFINITIES. Numerous fruits, usually much compressed in fossilization, with or without the free perianth segments preserved. In the majority of fruits the resin in the longitudinal grooves is conspicuous owing to the bursting of the walls which cover it. The much compressed condition suggests flexibility such as would occur in a leathery carpel.

The inferior thick-walled fruit germinating by dorsal infolded valves and the character of the seed indicate relationship with Mastixioideae. Three- or four-carpelled fruits of *Mastixia* are unknown among living forms, but occur among the extinct genera of the London Clay and

later Tertiary horizons. There is some resemblance to *Lanfrancia* (Reid & Chandler, 1933: 457, pl. 25, figs. 37-40) but in that genus the endocarp splits into pyrenes along the median planes of the septa. The urceolate form is distinctive as is the abundance of resin in the two series of ducts described. There is a close resemblance to *Eomastixia rugosa* which suggests generic identity. Thus in *E. rugosa* the endocarp may be two- or three-, rarely four-,

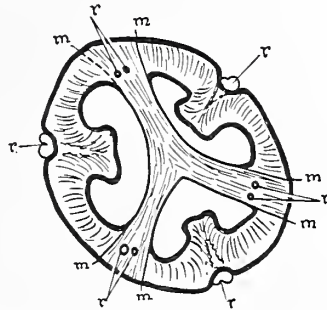


Fig. 17. *Eomastixia urceolata* n. sp.

Transverse section of a three-loculed endocarp.
r, resin ducts; m, margins of germination valves.

loculed, the locules are C-shaped in transverse section and germinate by dorsal valves with infolds corresponding to external grooves along which there is a tendency to split longitudinally; also in *E. rugosa* resin occurs in the external grooves and sparsely in the septa. But the form of *E. urceolata* and the very small apical disc are distinctive and there is a greater development of resin than in *E. rugosa*. Moreover *three* is the normal number of locules, whereas in *E. rugosa* two-loculed forms are more usual. This fossil is therefore regarded as a new species of the extinct genus *Eomastixia* to which the name *E. urceolata* is given.

- V.41970 Holotype, figured Pl. 19, fig. 8. A relatively small but uncrushed fruit showing three perianth segments.
V.41971 Figured Pl. 19, fig. 9. A four-partite fruit.
V.41972 Figured Pl. 19, fig. 10. A fruit showing a valve beginning to split away, the perianth appears to have been largely abraded.
V.41973 Figured Pl. 19, fig. 11. An endocarp with one valve detached showing the locule.
V.41974 Figured Pl. 19, fig. 12. A large crushed fruit.
V.41975 Figured Pl. 19, fig. 13; Text-fig. 17. A fruit sectioned transversely showing three locules and the distribution of resin ducts.
V.41977-78 Numerous fruits in different stages of compression and abrasion. V.41978 *E. St. John Burton Coll.*
All the above from Lake.

Genus MASTIXICARPUM Chandler, 1926: 35

EMENDED DIAGNOSIS. Fruits belonging to section Mastixioideae of the family Cornaceae ornamented externally with a network of fibres, ovoid, one-loculed. Germination valve extending the whole length of the locule and bearing a large longitudinal infold on its inner face as in *Mastixia*. Distinguished from *Mastixia* by the absence of any external sulcus corresponding to the infold. Length of fruits about 10.5 to 19 mm.; breadth about 7 to 11 mm.

Mastixicarpum crassum Chandler emend.

Plate 19, figs. 14-23; Pl. 20, figs. 1-4

1926 *Mastixicarpum crassum* Chandler, p. 36, pl. 6, fig. 5a-d; text-fig. 18.1960 *Mastixicarpum crassum* Chandler: Chandler, p. 215.1961b *Mastixicarpum crassum* Chandler: Chandler, p. 142, pl. 30 fig. 161.

DIAGNOSIS. That of the genus.

HOLOTYPE. V.20074a from Lower Headon of Hordle.

DESCRIPTION. *Fruit*: (Pl. 19, figs. 14, 16-18) Inferior, ovoid, ornamented with a network of branching and anastomosing fibres among which are a few well-marked longitudinal somewhat irregular and sinuous strands, the meshes of the network are on the whole longitudinally elongate (Pl. 19, figs. 16-18). Style represented by a small mucro at the narrower end towards which the fibres converge. Epicarp shining with surface formed of equiaxial cells with raised walls, 0.03 to 0.1 mm. in diameter. Length of fruit, 11.5 to 17 mm.; breadth, 8 to 10 mm. As seen in section the exocarp is 0.05 to 0.15 mm. thick and is formed of closely compacted, equiaxial cells, about 0.025 mm. in diameter, with shining black contents.

Endocarp: (Pl. 19, figs. 15, 19-22) Ovoid, closely invested by the exocarp, one-loculed, with a large deep longitudinal infold projecting into the cavity giving a C- or U-shaped cross-section. The infold forms the inner face of a large dorsal germination valve which extends almost the whole length of the endocarp. In unweathered specimens there is no groove on the exterior of the valve corresponding to the internal infold as in living *Mastixia*. Walls thick relative to the size of the cavity, formed of radially directed fibres except around the locules where they lie transversely; occasional resin-cavities are interspersed among the fibres. The infold tends to split longitudinally down the middle where it is formed of loosely compacted tissue liable to decay. Seed solitary. Dimensions approximating to those of the fruit but somewhat smaller.

Seed: Represented by remains of the testa usually fused with the endocarp, formed of one or two layers of equiaxial cells, 0.025 mm. in diameter, with shining black contents. Tegmen thin, structure obscure.

REMARKS AND AFFINITIES. As in the case of *Eomastixia* numerous specimens are known from various horizons and localities along the Dorset and Hampshire coasts. The only fruit (V.41976) from Lake is crushed and flattened. Nevertheless it shows remains of the external network of fibres (Pl. 19, fig. 23), and in section the exocarp can be distinguished surrounding the one-loculed endocarp with its median infold. Careful examination also reveals a plane of weakness flanking the infold on each side thus affording evidence of the germination valve. The crushed condition makes it impossible to obtain an adequate photograph of these features which are visible under the microscope. The endocarp is formed of fibres and parenchyma as in *M. crassum* from the original type locality at Hordle.

The material from the Bournemouth Freshwater Beds (cf. Pl. 19, figs. 14-18) is indistinguishable from *M. crassum* from Hordle in its specific characters. Although more compressed than the Hordle material (cf. Pl. 20, figs. 19-22), the Bournemouth specimens have undergone less abrasion so that in them the exocarp is frequently preserved.

The relationship to living *Mastixia* is very close, the only distinguishing feature being the absence in the fossil of an external sulcus corresponding to the internal infold even in abraded

material. As the sulcus is given as a generic character of the living genus, the fossil has been described as a distinct genus *Mastixicarpum*. Possibly this character is not truly of generic rank and the fossil should be referred to *Mastixia*. The nearest living species is *M. euonymoides* a native of north-west Malaya and Upper Burma. *M. crassum* also occurs in the Lignites above the Boscombe Sands (Pl. 20, fig. 1), in the Upper Hengistbury Beds (Pl. 20, fig. 2), at Cliff End (Pl. 20 figs. 3, 4) and at Barton (Chandler, 1961*b*, pl. 30, fig. 161). Specimens have been sent to Dr. Kirchheimer who states that they are generically identical with, but specifically distinct from, *Mastixicarpum compactum* Kirchheimer from the Brown Coal of Saxony and Thuringia (Kirchheimer, 1957: 225). From Lake.

Section CORNOIDEAE

Genus DUNSTANIA Reid & Chandler, 1933: 459

Dunstania lakensis n. sp.

Plate 20, fig. 22; Text-fig. 18

DIAGNOSIS. Endocarp ovoid but relatively longer and narrower than that of *Dunstania multilocularis*. Length about 10 mm.; breadth, 5.5 mm.

HOLOTYPE. V.41992.

DESCRIPTION. *Endocarp*: Ovoid with large circular depression at the apex (about 0.75 mm. deep and 0.9 mm. wide). Three-loculed, apparently each locule has a dorsal germination valve, occupying about three-quarters of the length of the endocarp, with smooth finished edges at apex and sides. Wall woody, thick, formed of tortuous or sinuous cells, surface smooth, formed of equiaxial cells 0.4 mm. in diameter, thickness of wall enclosing numerous large,

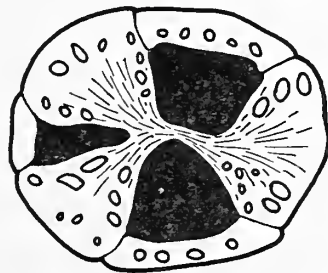


Fig. 18. *Dunstania lakensis* n. sp.

Transverse section of endocarp showing three unequally developed locules, germination valves opposite each and resin cavities in thickness of walls.

oval or subglobular or irregular resin-cavities with smooth surfaces formed of large irregular cells with sinuous walls. Locule lining of irregular or sinuous cells. Length of endocarp, 10 mm.; breadth, 5.5 mm.

REMARKS AND AFFINITIES. One endocarp and a doubtful specimen. The species closely resembles *D. multilocularis* from the London Clay but is relatively longer and narrower than average specimens of that species.

The relationship of *Dunstania* with *Cornus* is fully discussed by Reid & Chandler (1933: 461) and again by Chandler (1961b: 145).

- V.41992 Holotype, figured Pl. 20, fig. 22. An endocarp, now fractured transversely to show the locules, valves and secreting cavities. *E. St. John Burton Coll.*
 V.41993 A crushed endocarp showing valves and glands, probably this species.
 Both the above from Lake.

Genus CORNUS (Tourn.) L.

Cornus quadrilocularis n. sp.

Plate 20, figs. 23–26

- 1926 ? *Carpolithes* sp. 4, Chandler, p. 45, pl. 8, fig. 2a, b.
 1961b *Cornus quadrilocularis* Chandler, p. 144, pl. 29, figs. 129–133.

DIAGNOSIS. Endocarp subglobular, four-loculed with apical hollow or depression. Length of endocarp about 3.5 mm.

HOLOTYPE. V.41988.

DESCRIPTION. *Endocarp*: Subglobular (now compressed) with a small apical depression, four-loculed, each locule opening by a large dorsal valve from the apex almost to the base where the valve breaks away irregularly. Seeds solitary, pendulous. External coat represented by a few superficial black cells only; surface of endocarp pitted, the equiaxial cells measuring 0.016 mm. in diameter, texture of wall spongy, homogeneous, formed of slightly sinuous more or less equiaxial cells about 0.016 to 0.025 mm. in diameter, locule lining formed of cells with slightly sinuous or digitate walls, 0.016 mm. in diameter, sometimes transversely elongate. Seeds solitary, pendulous. Length of endocarp, 3.5 mm.; diameter, 3.75 by 2 mm. (variation due to compression).

Seed: Anatropous, ovate (sometimes compressed) pointed at the hilum, rounded at the opposite extremity. Testa semi-translucent, cells transversely elongate, sub-parallel sided, producing a transversely striate effect, the striae being about 0.016 mm. apart. A sub-terminal thickening on one side of the pointed hilar end may represent an abortive seed, thickened raphe, or a placenta. Raphe lateral, chalaza terminal at the rounded extremity, small.

REMARKS AND AFFINITIES. Four specimens. The woody, plurilocular endocarp with simple dorsal valves, and the pendulous seed suggest relationship with section *Cornoideae* of the family *Cornaceae*. The normally two-loculed living *Cornus* seems to be the nearest ally. There is a resemblance to *Carpolithes* sp. 4 from Hordle (Chandler, 1926: 45, pl. 8, fig. 2a, b) in the form, number of locules, character of the valves and size, the two being now regarded as identical (Chandler, 1961b: 144).

- V.41988 Holotype, figured Pl. 20, figs. 23–26. An endocarp showing the four locules, one valve has been detached showing the locule lining and seed. Another is beginning to gape.
 V.41989–91 Three endocarps. From one, part of one valve has been detached. Another specimen (if the same species) shows one valve clearly, but is sectioned so as to expose part of an apical central hollow extending for about one-third of the length of the endocarp.
 All the above from Lake.

Family CORNACEAE?

Genus?

Plate 20, fig. 27; Text-fig. 19

DESCRIPTION. *Endocarp*: Ovoid (now much compressed) with rounded longitudinal ribs, five-loculed, probably five-valved, the valves, two of which have come away exposing the locules, being nearly as long as the fruit and extending almost the whole length of the locules (Pl. 20, fig. 27; Text-fig. 19). Two other locules are clearly seen in transverse section and one more obscurely. The locules are arranged radially but there is no indication of a central axis and the specimen has undergone flattening and distortion. The locule lining is not preserved except at the edges of the locules where fine oblique striations are visible. Endocarp formed superficially of cells with marked transverse alignment, many of the cells appear to be digitate or sinuous. They are black and shining. Walls in section formed of polygonal cells, about

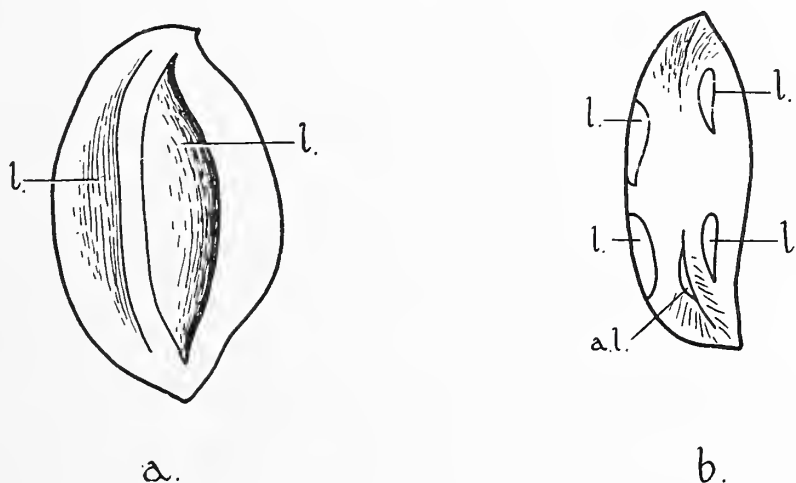


Fig. 19. Cornaceae? Genus?

- (a) Endocarp showing two locules from which valves have disappeared, side.
 (b) Transverse section of the crushed endocarp showing five locules, one abortive. Two on the left have lost their valves. *l.*, locules; *a.l.*, abortive locule.

0.012 mm. in diameter, arranged radially especially near the external surface. Exterior rough in places but the outer surface is usually worn. Length of endocarp, 6.4 mm.; breadth, 2.8 mm.; length of valve, 5 mm.

REMARKS AND AFFINITIES. One specimen (V.41994) which has lost two of its valves, it is otherwise perfect but has broken transversely since it was photographed. The most probable relationship appears to be with Cornaceae in which the genus *Davidia* most resembles the fossil. It is longitudinally ribbed, many-loculed, with locules radially arranged, germinating by the removal of dorsal valves almost as long as the fruit, and equal in length to the locules. The walls of the endocarp are formed of fibres with clear transverse alignment.

The evidence of one somewhat battered specimen is insufficient to do more than indicate the possible relationship. The character of the locule lining, mode of placentation, number and character of the seeds is not known. From Lake.

Family SAPOTACEAE

Genus SAPOTICARPUM Reid & Chandler, 1933: 467

?*Sapoticarpum* sp.

Plate 21, figs. 6-9; Text-fig. 20

DESCRIPTION. *Fruit*: Broadly turbinate, circular in outline, apex slightly concave, five-loculed, splitting loculicidally. Surface (as preserved) rugose below, shining and longitudinally ribbed above the broadest diameter, the ribs apparently formed by secreting canals (latex or resin?) scattered abundantly among the tissues and made conspicuous by abrasion (Pl. 21, fig. 8). The long narrow canals of varying breadth have a beaded appearance internally perhaps owing to uneven contraction of the dried contents (possibly, however, due to thin partitions subdividing the attenuated-fusiform vessels into separate compartments). As seen in section

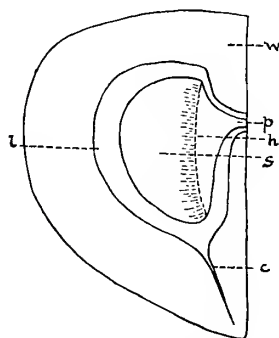


Fig. 20. ? *Sapoticarpum* sp.

Diagrammatic longitudinal section of locule. Axis of fruit on right. *w*, wall of fruit; *p*, placenta and funicle; *h*, line of long hilar scar; *l*, locule; *c*, canal leading from locule to base of fruit; *s*, seed.

the wall is about 2 mm. thick. It is a tissue of digitate sinuous cells throughout which the secreting vessels are distributed, the vessels lying parallel with the surface of the fruit and the dorsal outline of the locules. An inner compact layer of the fruit-wall (endocarp?) surrounds the locules. It is about 0.228 to 0.285 mm. thick and is close-textured and obliquely columnar in transverse section. A well-defined canal gives access from the base of the fruit to the base of the locule. It is seen in longitudinal sections of the fruit (Pl. 21, fig. 9; Text-fig. 20). The attachment of the solitary seed seems to be axile just above the centre of the flattened pear-shaped locules. Locule lined by fine angular equiaxial cells more or less transversely arranged. Length of fruit, 5 mm.; maximum diameter, 9.5 mm.

Seed: Flattened, semicircular in outline, attached by the whole of the ventral margin. Testa formed of equiaxial rounded cells about 0.013 mm. in diameter. Length of seed, 1.7 mm.; breadth, 1.4 mm.

REMARKS. One specimen (V.40875), intact when found, but on drying it dehisced longitudinally as described. It then showed the small and probably immature seeds. The form of the fruit, structure of the walls with secreting canals parallel with the circumference and the locule outline, also the mode of attachment of the solitary seeds suggest relationship with Sapotaceae. The fruit is much smaller than any known living or fossil genus and the seeds are extremely small. It seems probable, therefore, that the specimen is an immature fruit in which splitting simulating germination has occurred consequent on prolonged maceration in fossilization and subsequent drying. In the circumstances, as only one specimen has been found, it appears best to refer it doubtfully to the form-genus *Sapotocarpum* without specific definition until more information is available. From Arne.

Family EBENACEAE

Genus DIOSPYROS Linnaeus

Diospyros headonensis Chandler

Plate 20, figs. 28, 29; Pl. 21, figs. 1-5

1926 *Diospyros antiqua* Chandler, p. 38, pl. 7, fig. 2; text-figs. 21, 22.

1961b *Diospyros headonensis* Chandler, p. 147.

DIAGNOSIS. A leathery four-partite imbricate or convolute calyx formed of flat longitudinally aligned cells at the margins, elsewhere of radiating groups of cells. Length of calyx about 6.5 mm.; breadth, 5.5 mm.

HOLOTYPE. V.20086 from Lower Headon of Hordle.

DESCRIPTION. *Calyx*: Leathery, formed of four sepals united at the base, aestivation imbricate; sepals oval, rounded at the apex, somewhat puckered superficially especially below, epidermis shining, longitudinally striate at the margins, the striae about 0.008 mm. to 0.01 mm. apart, elsewhere of radiating groups of cells now obscured by abrasion. Inner surface of sepals shining formed of polygonal cells 0.016 mm. in diameter. Margins of sepals thin, semi-translucent. Length of calyx about 6.5 mm.; breadth, 5.5 mm.

Fruit: Subglobular (now flattened in fossilization), surface shining, evenly pitted, pits (cells?) 0.012 to 0.016 mm. in diameter. Length of immature compressed fruit, 3 mm.; breadth, 4 mm.

REMARKS AND AFFINITIES. One calyx enclosing an immature fruit (V.41995). The texture and arrangement of the parts indicate *Diospyros*. The breadth and texture of the sepals and the aestivation recall *D. montana* in which both convolute and imbricate aestivation occurs. The specimen agrees with *D. headonensis* Chandler from Hordle (1926: 38, pl. 7, fig. 2; text-figs. 21-23. Length, 4.5 to 5.75 mm.; breadth, 3.5 to 5 mm.) where a fine flower with staminodes still preserved and immature gynoecium was taken as the type. The Lake specimen is somewhat larger and appears to represent a more mature stage since its petals and staminodes have fallen. The fruit is more developed despite the fact that the compressed condition does not

lend itself to dissection. The Hordle calices are convolute or imbricate (cf. Pl. 21, figs. 2-5), but in living material, as stated, convolute and imbricate sepals may occur in a single species. The surface of the Hordle specimens is beautifully preserved and formed of convex cells frequently arranged in radiating groups, individual cells being about 0.012 mm. broad. In the Lake calyx the cells are so corroded that they are usually obscure except at the margins of the sepals where they are longitudinally aligned. In places, however, remains of the convex radiating cell-groups can be seen. The evidence therefore unites the Lake and Hordle calices as a single species.

The genus *Diospyros* is widespread in the tropics and sub-tropics of the world. *D. montana* is found in the Himalayas and Peninsular India, and extends through Further India and the East Indies to North Australia. From Lake.

Family SYMPLOCACEAE

Genus SYMPLOCOS Jacquin

Symplocos lakensis n. sp.

Plate 21, figs. 10-18

DIAGNOSIS. Fruit elongate-ovoid or subovoid, with domed apex, often with pointed base, accrescent calyx terminating just below the apex in a ring of small segments. Three-loculed but often one only develops. External surface more or less smooth with longitudinal furrows corresponding with the divisions between the apical segments. Apical aperture about 0.45 mm. in diameter. Length of fruit, 5.45 to 6.75 mm.; breadth, 1.25 to 3.5 mm. (crushed).

HOLOTYPE. V.41996.

DESCRIPTION. *Fruit*: Syncarpous, inferior, elongate-ovoid or subovoid, with accrescent calyx terminating below the apex in a ring of small segments surrounding the smooth domed apex of the fruit. Three-loculed, but usually with only one locule fully developed. Some specimens show clearly one or two abortive locules. Base often pointed with indented scar of attachment. External surface smooth (now much cracked) with longitudinal furrows corresponding with the divisions between the perianth segments at the apex (Pl. 21, fig. 10). Exocarp black, 0.1 to 0.15 mm. thick, formed superficially of longitudinally aligned quadrate or oblong cells 0.02 to 0.03 mm. in diameter. The exocarp tends to peel off in strips, it is not continued into the septa as seen in section. Its structure is much obscured by carbonization or by some shining secretion; in section it is formed of equiaxial angular cells 0.016 mm. (or less) in diameter. Dimensions of four typical fruits are as follows: 1) Length, 6 mm.; diameter, 3.5 by 1.5 mm. 2) Length, 6.75 mm.; diameter, 2.75 by 1.25 mm. 3) Length, 6.75 mm.; diameter, 3 by 1.5 mm. 4) Length, 5.45 mm.; diameter, 3 mm.

Endocarp: About 0.15 to 0.9 mm. thick according to the degree and direction of compression; formed of light-brown, close, hard and often brittle parenchyma, frequently forming a dome-shaped apical projection beyond the exocarp, with locules opening into a large apical foramen 0.45 mm. in diameter (Pl. 21, fig. 11). Formed of irregular angular cells about 0.025 mm. to 0.05 mm. in diameter as seen in section, except for the innermost layers which are formed of transversely elongate cells or fibres. Locules elongate, septa about 0.05 mm. thick. Surface of

locule often showing superposed sets of cells giving a criss-cross pattern, but more usually a transverse alignment of cells producing transverse striae about 0.012 mm. apart. The cells are often arranged in parallel groups. In the lower part of the locule the groups of cells are approximately longitudinally or obliquely oriented. There is much complication owing to the superposition of cells or cell impressions. Several pendulous seeds occur in the locule.

Seed: Elongate, flattened, or sub-cylindric, no organs seen. Testa smooth and shining, formed of irregular elongate cells, sometimes arranged in sinuous longitudinal rows; sometimes the cells are lobed and have protuberances interlocking with concavities on contiguous cells. Length of cells up to 0.1 mm.; breadth, 0.009 to 0.01 mm. Inner integument rough, formed of equiaxial cells about 0.025 mm. in diameter.

REMARKS AND AFFINITIES. Numerous fruits usually much compressed so that the number and structure of the locules is frequently obscured. The specimens are typical examples of a thin-walled *Symplocos*. This genus is the only representative of the family which is distributed throughout the tropics and sub-tropics of the world and is frequently a mountain plant. It is very rich in endemic species. *S. lakensis* differs from *S. anglica* from Bovey Tracey in its usually narrow form, its domed apex and the tendency to be narrowed towards the two extremities, also in the marked longitudinal furrows on the exterior of the fruit which correspond with the apical perianth segments.

V.41996 Holotype, figured Pl. 21, fig. 10. A fruit showing the apical depression.

V.41997-98, V.42000 Figured Pl. 21, figs. 11, 12, 15. Two fruits more or less complete and a third (V.42000) with part of the wall removed so as to expose the locule and seed.

V.41999 Figured Pl. 21, figs. 13, 14. A fruit with calyx, exocarp and part of the endocarp chipped away so as to expose the locules.

V.42001 A fruit with endocarp worn away below. The apical aperture is well shown.

V.42002-06 Numerous fruits and endocarps showing variation of size and form. V.42004 from fallen block from top of section. (Poole end). V.42005 from basal beds by ironstones. V.42006 *E. St. John Burton Coll.*
All the above from Lake.

V.42007-09 Figured Pl. 21, figs. 16-18. Three typical relatively uncrushed endocarps.

V.42010 Six more specimens.

All the above from Arne.

Symplocos headonensis Chandler

Plate 21, fig. 19

1926 *Symplocos headonensis* Chandler, p. 40, pl. 7, fig. 3a-c; text-fig. 24.

1957 *Symplocos headonensis* Chandler: Chandler, p. 117, pl. 17, figs. 187, 188.

1960 ?*Symplocos headonensis* Chandler: Chandler, p. 215, pl. 31, figs. 58, 59.

1961b *Symplocos headonensis* Chandler: Chandler, p. 148, pl. 30, figs. 139, 140.

DESCRIPTION. *Endocarp*: Truncate subglobular, syncarpous, three-loculed with three large rounded apertures each leading into one of the locules and sunk in an apical depression. Basal scar of attachment small slightly sunk. Styler plug missing. Surface smooth formed of more or less equiaxial cells aligned in longitudinal rows, septa with median planes of weakness which meet to form the central canal. Locule surface and seeds not seen. Length of endocarp, 5.75 mm.; breadth (slightly increased by compression), 5 mm.

REMARKS. One endocarp (V.42011) which has been compared with specimens of *S. headonensis* from the Lower Headon of Hordle with which it agrees in form and cell structure.

It differs from *S. headonensis* as hitherto defined in having three locules instead of four but as a five-loculed endocarp has been found at Hordle exceptions to the usual four-loculed type must be included in the species. From Arne.

Symplocos sp. (? *S. headonensis*)

Plate 21, fig. 20

DESCRIPTION. A second specimen from Arne closely resembles the above in its broad urceolate form and slightly sunk apical depression. The accrescent perianth still closely invests the endocarp with which it appears to be fused. Its surface is smooth and formed of variously oriented elongate cells which produce a fine tortuous pattern. In section it is black and shining about 0.057 mm. thick and readily distinguishable from the lighter brown endocarp. Length of fruit, 4.75 mm.; maximum diameter, 5 mm.

The endocarp appears to have only two locules each communicating by a round aperture with the small apical depression. Median planes of weakness are clearly present in the septum. The wall is compact, formed of fine parenchyma, 0.17 mm. thick in section. Locule lining of elongate cells on the whole longitudinally aligned similar in appearance to the surface of the testa described below and perhaps showing merely the impressions of the testa cells. There are several seeds in each locule, only one appears to be fully developed. The locule shows slight depressions or pockets into which the smaller seeds fit.

Seed: Irregular in shape when abortive some being thin and flat; they are sub-cylindrical and curved when mature. Testa of elongate cells having a general longitudinal but somewhat sinuous alignment. Length of largest seed about 3.5 mm.; breadth, 0.5 mm.

This specimen (V.42013) is slightly imperfect at the apex, and has cracked transversely below the middle so that two well developed seeds, one in each locule are exposed. Subsequently the base of the fruit became detached showing the transverse section across the two crushed locules. There seems reason to think that this and the Arne specimen (V.42011) described above are specifically identical but details of the descriptions are kept separate. From Arne.

Symplocos sp.

Plate 21, figs. 21, 22

1926 *Symplocos* sp. 2, Chandler, p. 40, pl. 7, fig. 4; text-fig. 25.

1961b *Symplocos* sp., Chandler, p. 148.

DESCRIPTION. *Endocarp*: Broadly urceolate, much compressed in fossilization with three locules and small, scarcely sunk, apical depression and perianth scar. The locules communicate with the apical depression by small apertures. The apex of the endocarp is slightly furrowed between the locules and somewhat rounded between the furrows. The furrows are continued to the base where the small sunk attachment scar can be seen. Surface smooth, cells obscure. There are slight indications of median planes of weakness on the septa between the locule openings. Length of endocarp, 4.75 mm.; breadth (maximum, exaggerated by crushing), 4.75 mm.

REMARKS. This specimen (V.42012) closely resembles an endocarp described from the Lower Headon of Hordle as *Symplocos* sp. 2 in its size, and in the three locules with incon-

spicuous small perianth scar. Preservation of both specimens is poor, and there is insufficient evidence for specific diagnosis. From Lake.

Family SYMPLOCACEAE? (or CORNACEAE?)

Genus ?

Plate 21, fig. 23

A circular plug or perianth disc from an inferior fruit, lenticular in section. Its inner face is flat and has a smooth clearly defined central circular scar, about 0.6 by 0.65 mm. in diameter, surrounded by a second concentric smooth area about 0.8 by 0.9 mm. in diameter. Its outer surface is formed of radially directed cells. Margin of plug thick, rough, formed of coarser cells the edges of which project unevenly giving a fringed effect, cells near the margin measuring about 0.05 mm. in length and 0.025 mm. in breadth. The outer face is convex with a central thick knob-like projection (style base) from which the coarse cells diverge to the circumference. Diameter of plug about 1.2 mm.; thickness, 0.35 mm.

REMARKS AND AFFINITIES. Two specimens comparable with the plugs which close the apical aperture in species of *Corokia* (Cornaceae) and in *Symplocos*. Three species of *Symplocos* are recorded from Lake, so that the plugs may have belonged to one of them rather than to Cornaceae. The relationship remains uncertain until a similar plug is found actually attached to its fruit.

V.42014 Figured Pl. 21, fig. 23. A plug or apical perianth disc.

V.42015 A second specimen.

Both the above from Lake.

Family STYRACACEAE

Genus STYRAX (Tourn.) L.

Styrax elegans Chandler

Plate 21, figs. 24-28

1926 *Styrax elegans* Chandler, p. 41, pl. 7, fig. 6a-f.

1961b *Styrax elegans* Chandler: Chandler, p. 148.

DIAGNOSIS. Endocarp ovoid or obovoid, attachment scar large, sunk. Surface of equiaxial or polygonal pits, 0.03 to about 0.05 mm. in diameter. Length of endocarp, 8.5 to 9.5 mm.; breadth, 3.5 to 5.5 mm.

HOLOTYPE. V.20091 from Lower Headon of Hordle.

DESCRIPTION. *Endocarp*: More or less obovoid, obscurely mucronate at the apex, obliquely truncated at the base by an oval sunk attachment scar about 2.5 by 1.75 mm. in diameter. Funicular aperture conspicuous, entering at the margin of the scar where it abuts against the shorter side of the endocarp. Surface obscurely three-angled longitudinally (angles masked by compression) with one narrow conspicuous longitudinal lobe arising from the attachment and

associated with the funicle; this lobe at its broadest near the apex measures 1.75 mm. transversely, it lies on the shortest side of the endocarp. Surface of attachment scar formed of fine equiaxial convex cells, 0.01 mm. in diameter, giving a smooth appearance. Surface of endocarp formed of polygonal pits about 0.03 to 0.05 mm. in diameter (obliterated by abrasion in most parts of the Lake specimen). Maximum length of endocarp from Lake, 9.5 mm.; breadth, 5.25 mm. (length and breadth both exaggerated by distortion and compression). Length of Hordle specimens, 8.5 to 9.5 mm.; breadth, 3.5 to 5 mm.

REMARKS AND AFFINITIES. One somewhat obliquely crushed endocarp (V.40876) which in size, appearance and structure is comparable with *S. elegans* Chandler from Hordle (Pl. 21, figs. 25-28). The species was compared with the living *S. japonicum* Sieb. which has somewhat smaller more ovate endocarps. Comparison with Hordle specimens establishes the specific identity of the Lake endocarp beyond doubt in spite of its abraded condition. From Lake.

Family APOCYNACEAE

Section ?PLUMIEROIDEAE Schumann

Genus APOCYNOSPERMUM Reid & Chandler emend. Chandler, 1961: 82

Apocynospermum lakense Chandler

Plate 21, figs. 29, 30; Pl. 22, fig. 1

1961 *Apocynospermum lakense* Chandler, p. 82, pl. 8, figs. 14, 15.

DESCRIPTION. *Fruit*: Unknown. Probably several- or many-seeded.

Seed: Much flattened, elongate-oval or ovate, without rimmed margin, with longitudinal median hilar-raphe scar along which splitting for germination occurred. Sometimes distortion of the seed in growth has caused the hilar-raphe scar to lie in part along the edge of the seed, or asymmetrically instead of medianly on the ventral surface. The distortion suggests the pressure of other seeds in a fruit. Testa glistening, surface ornamented all over with deep pits or depressions often narrow (0.02 to 0.025 mm. broad) and elongate (0.062 mm. long). Along and near the raphe scar the elongate cells produce longitudinal striae which gradually diverge at the broader end of the seed until they merge in the general honeycomb structure of the surface. The cells or pits are irregular, deep and about 0.037 to 0.1 mm. in diameter. At the narrower end of the ventral face they become more regular. They average about 0.037 mm. in diameter at the broad end; on the dorsal face the depressions may be longitudinally aligned or irregular and confused in their arrangement, but at the broad end they appear to form a more or less regular honeycomb pattern. All over the pits and their separating ridges there is a fine network with meshes about 0.025 mm. in diameter. The meshes are due to small more or less uniform rectangular cells. Thickness of testa, 0.23 mm, the inner part, 0.17 mm. is compact and formed of the small rectangular cells described above, the outer part, 0.057 mm. is formed by the deep surface pits and ridges. There is no evidence of a rimmed depression at either end of the seed such as occurs in pappus-bearing seeds of this family. Dimensions: 1) Length of seed, 3.75 mm.; breadth, 1.75 mm. 2) Length, 3.5 mm.; breadth, 1.2 mm. 3) Length, 4.5 mm.; breadth, 3.25 mm. 4) Length, 3.5 mm.; breadth, 1.5 mm.

REMARKS AND AFFINITIES. Four perfect and two imperfect seeds. One shows a marked median split along the hilar-raphé scar extending from the narrow end for 2.3 mm. The characters described relate the seeds to Apocynaceae. Flat unrimmed seeds with linear median raphe along which splitting (germination) occurs are highly characteristic of the family; the absence of a pappus suggests the section Plumieroideae, an essentially tropical group with extremely limited extension into more temperate regions in the case of *Vinca* and *Amsonia*. There is a marked resemblance to the Old World genus *Ervatamia* Stapf., but in this large family it is by no means easy to be sure of generic relationship without a more intensive study of the seeds than it has been possible to make. The specimens are referred to the form-genus *Apocynospermum* with the specific name *Apocynospermum lakense*.

V.34674 Holotype, figured Pl. 21, figs. 29, 30. A seed.

V.40877 Figured Pl. 22, fig. 1. A seed splitting ventrally along the hilar scar.

V.40878-79 Two perfect seeds, five incomplete specimens. V.40879 *E. St. John Burton Coll.*
All the above from Lake.

Section ?

Apocynospermum acutiforme n. sp.

Plate 22, fig. 2

DIAGNOSIS. Seed elongate-oval sharply pointed at one end. Pappus born at the truncate opposite end. Hilar-raphé ridge median longitudinal. Tegmen longitudinally striate externally with finely sinuous cells. Length of seed (without pappus), 7.6 mm.; breadth, 2.5 mm.; thickness, 1 mm.

HOLOTYPE. V.40880.

DESCRIPTION. *Seed*: Elongate-oval sharply pointed at one end, truncated by a shallow depression at the other, much compressed, without marginal rim. Hilum and raphe represented by a narrow median longitudinal ridge on one broad face which extends from the pointed base almost to the apical depression. There is a tendency for the seed to split along this ridge. Testa much vitrified, about 0.5 mm. thick, surface structure obscured by cracking. Interior of testa finely striate longitudinally, the striae, about 0.01 mm. apart. Tegmen showing a long median ventral scar and a surface with finely sinuous elongate cells about 0.012 mm. long and 0.01 mm. broad with thickened lateral walls which produce longitudinal striations. Lining of tegmen showing cells about 0.012 to 0.016 mm. in diameter with a tendency to transverse alignment. Length of seed, 7.6 mm.; breadth, 2.5 mm.; thickness, 1 mm.

REMARKS AND AFFINITIES. One seed (V.40880) (now cracked transversely) with part of the ventral surface dissected to show the tegmen within. The rim which surrounds the shallow apical depression evidently bore a pappus (not preserved). The form of the seed without marginal rim, the linear median hilar-raphé scar and the pappiferous disc at one end point to relationship with Apocynaceae, Asclepiadaceae being excluded by the absence of any trace of rim around the sides or distal end of the seed. The nearest affinity may be with the section Echitoideae in which the seeds normally bear a pappus, or with one of the rare pappus-bearing genera of the Plumieroideae such as *Holarrhena*. The testa surface (as preserved) lacks the regularly arranged rounded or quadrangular cells of this genus and the specimen has been referred to the form-genus *Apocynospermum* as *Apocynospermum acutiforme*. From Lake.

Family BORAGINACEAE

Section EHRETIOIDEAE Gürke

Genus EHRETIA Linnaeus

Ehretia lakensis n. sp.

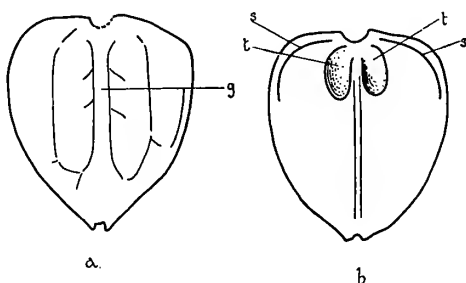
Plate 22, figs. 3-11; Text fig. 21

DIAGNOSIS. Berry subglobular with two rounded-triangular or obovate two-loculed pyrenes. Pyrenes ornamented on the dorsal surface with about four shallow angular depressions and having a median furrow. Ventral surface flat or slightly concave with a pear-shaped swelling at the apex on each side of the median line. Locules opening by sub-marginal ventral sutures in the upper half of the pyrene. Length of pyrenes, 1.2 to 2.25 mm.; breadth, 1.2 to 1.75 mm. Dimensions of a small fruit, 1.55 by 1.35 mm.

HOLOTYPE. V.40882.

DESCRIPTION. *Fruit*: A subglobular berry (usually distorted in fossilization). Epicarp formed of small convex equiaxial cells about 0.012 mm. in diameter, separated from one another by narrow grooves. The berry encloses two pyrenes.

Pyrene: Two-loculed, bisymmetric about a median dorsiventral plane through the septum, rounded-triangular or obovate in outline, cleft or narrowly emarginate at the base, convex on the dorsal surface, flat or very slightly concave on the ventral surface, thin dorsiventrally. Dorsal surface with a conspicuous median groove which broadens towards the base, flanked on each side by two long, narrow, shallow, unequal angular depressions. Ventral surface smooth with two pear-shaped inflated areas lying side by side at the apex flanking the median line and extending for almost one-quarter of the length of the pyrene. Germination by two large ventral

Fig. 21. *Ehretia lakensis* n. sp.

- (a) Pyrene, dorsal surface showing median groove *g*, flanked by angular depressed areas.
 (b) Same, ventral face showing submarginal slits for germination *s*; and subapical thickenings *t*.

sub-marginal arcuate apertures in the upper half of each pyrene each leading into one of the locules. Wall in section formed of compact regular cells tending to be arranged in a columnar manner. The 'columns' are about 0.002 mm. broad and the wall is about 0.057 to 0.085 mm. thick. Lining of locule shining, finely striate longitudinally, the striae being slightly sinuous

and about 0.005 mm. apart. Seed not seen. Dimensions of a small fruit: 1.55 by 1.35 mm. Length of pyrenes, 1.2 to 2.25 mm; breadth, 1.2 to 1.75 mm.

REMARKS AND AFFINITIES. One fruit and about a dozen pyrenes still extant. Two of the pyrenes are now dissected to show the locules and cell structure. The arrangement of the two two-loculed pyrenes points to relationship with the section Ehretioideae of the family Boraginaceae. In the tropical genus of small trees, *Ehretia*, similar small fruits and pyrenes occur. The sculpture of the dorsal surface of the fossil pyrenes is simpler than any species of *Ehretia* examined, but this suggests a specific distinction only. There can be little doubt that the fossil should be referred to *Ehretia* itself. The specific name *Ehretia lakensis* indicates the type locality. The occurrence in fine silty beds associated with Cyperaceae and Lythraceae suggests a small tree overhanging a quiet lagoon or backwater into which its fruits dropped.

The genus was recorded from the Pliocene beds of Cantal by E. M. Reid (1923: 346, pl. 9, figs. 18-21. *E. europaea* and *E. cantalensis*, species with smaller depressions). A species, now regarded as *Ehretia*, was recorded from the London Clay of Harefield under the name *Davisella* (Reid & Chandler, 1933: 483, pl. 28, figs. 6-9). The ascription has now been corrected (Chandler, 1961: 112). The pits of its dorsal surface are more numerous than in the pyrenes from Lake and more even in size. *E. clausentia* came from Nursling (London Clay).

V.40882 Holotype, figured Pl. 22, fig. 6. A typical pyrene.

V.42018 Figured Pl. 22, figs. 3, 4. A somewhat distorted fruit with two pyrenes.

V.40881, 83 Figured Pl. 22, figs. 5, 8. Two pyrenes.

V.40884 Figured Pl. 22, fig. 10. Apical part of a pyrene, ventral side, showing particularly clearly the inflated areas.

V.40885 Figured Pl. 22, fig. 11. A somewhat distorted pyrene.

V.40886 Five pyrenes and two sectioned specimens.

All the above from fine silt, base of section, western end, Lake.

Family SOLANACEAE

Genus SOLANUM (Tourn.) L.

Solanum arnense n. sp.

Plate 22, figs. 12, 13; Text-fig. 22

DIAGNOSIS. Hilum gaping not deeply rimmed, surface smooth formed of conspicuously digitate cells, about 0.085 mm. in diameter, with raised double outlines. Digitations about five or seven to one cell. Maximum diameter, 2.5 to 3 mm.

HOLOTYPE. V.40898.

DESCRIPTION. *Seed*: Obliquely oboval in outline, somewhat laterally compressed so as to be narrower at the micropylar than at the opposite end, lenticular in cross-section, bisymmetric about a plane passing through hilum and micropyle, curved. The outline of the seed suggests that it had a curved embryo, but the cavity is undivided there being no partition between the radicular and cotyledonary limbs. Hilum large, gaping between the limbs, not deeply rimmed, leading into a small cavity separated from the main seed-cavity by a small curved partition. This arises from the testa near the micropylar end of the hilum and dies out near the chalaza as is well seen in *Capsicum* (cf. Text-fig. 22). Micropyle terminal on the narrower limb. Surface smooth, shining, black (as preserved) formed of conspicuously digitate cells about 0.085 mm.

in diameter. The outlines of these cells are double and often slightly raised (text-fig. 22). The digitations may be long and are sometimes curved or slightly bifid; there may be about five to seven around one cell. In section the testa (about 0.057 mm. thick) is formed of fluted columns the flutings corresponding with the digitations of the cells. An inner coat (tegmen) is formed of angular cells about 0.028 mm. in diameter. Maximum diameter of holotype, 2.5 mm. Diameter at right angles to this, 2.25 mm. Maximum diameter of a second seed, 3 mm. Diameter at right angles to this incomplete.

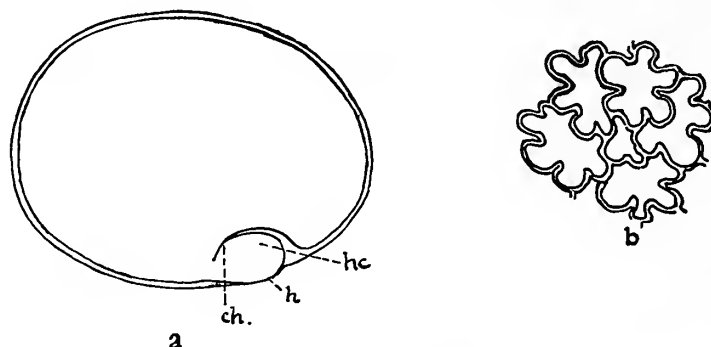


Fig. 22. *Solanum arnense* n. sp.

- (a) Diagram of seed in longitudinal section to show structure of hilar region in *Capsicum*, *Solanum* and *Solanispermum*. *h*, hilum; *hc*, hilar cavity separated by small curved partition from seed-cavity; *ch*, position of chalaza in hilar cavity.
- (b) Diagram to show cells of testa with raised walls in *Solanum arnense*.

REMARKS AND AFFINITIES. The seeds are usually broken owing to the brittle nature of the testa. They agree with Solanaceae in the curved form, hilar cavity as described, and digitate cells of the testa with raised cell walls. Closely comparable characters have been found in the living *Solanum marginatum* L., one of the few among numerous species seen with similar smooth testa. In most species the testa is rough, much of the roughness being due to the upstanding cell walls. In *S. marginatum* the cells are larger than those of the fossil, about 0.142 mm. in diameter, the seed diameter is 2 to 3 mm.

- V.40898 Holotype, figured Pl. 22, fig. 12. Seed showing hilar opening and well-preserved testa cells.
- V.40899 Figured Pl. 22, fig. 13. A longer narrower seed, slightly imperfect and collapsed on one side.
- V.40900 Valve of a seed showing the hilar cavity on the inner side.
- V.40901-02 Several fragmentary seeds, one collapsed and three imperfect specimens.
All the above from Arne.

Genus SOLANISPERMUM Chandler, 1957: 118

Solanispermum reniforme Chandler

Plate 22, figs. 14-22

1957 *Solanispermum reniforme* Chandler, p. 118, pl. 17, figs. 189-191.

The species was described from Bovey by Chandler (1957) and was based largely on material from the Bournemouth Beds and Cliff End Beds at Mudeford. The seeds showing many of the

characters described are now figured. Specimens have recently been obtained from the Lower Bagshot Beds at Arne which although somewhat larger than the average either belong to this species or may be a variety of it.

A bisymmetric, flattened or slightly inflated seed, transversely oval in outline is shown from Sandbanks (Bournemouth Freshwater Beds) in Pl. 22, fig. 14. A reniform seed from Cliff End, Mudeford appears in Pl. 22, fig. 17. A rarer hooked form from Branksome Dene, Bournemouth Freshwater Beds is seen in Pl. 22, fig. 19. The variation of the position of the hilum owing to distortion in growth is obvious on comparing the normal seed (Pl. 22, figs. 15, 17-19) with the one shown in Pl. 22, fig. 16 where the hilum appears as a gaping aperture on one of the broad surfaces. It leads into a small cavity separated from the main seed-cavity by a thin curved partition (Pl. 22, fig. 15) as shown on the inner surface of one valve of a seed which has split marginally. Text-fig. 22 is a diagram showing this structure and would equally well represent this fossil and the Recent genus *Capsicum*. In the living *Capsicum* the funicle lay close to this partition and the chalaza near the inner end of it. The marginal micropyle of the fossil is most apparent in hooked seeds where it occupies the extremity of the hook. Normally the testa is abraded and the surface appears to be ornamented with interrupted sinuous rugosities (Pl. 22, figs. 14, 19). These diverge from the hilum and frequently produce a pitted effect, the sinuous pits being about 0.05 to 0.1 mm. in diameter. The rugose coat is about 0.1 mm. thick and appears striate, the striae crossing the tubercles at right angles and near the margin lying parallel with it. Along the striae splitting occurs as the result of drying and abrasion giving a fibrous appearance (Pl. 22, figs. 17, 18, 20). In actual fact the 'fibres' are formed of equiaxial cells, about 0.012 mm. in diameter, of which there are several layers. Inside the 'fibres' is a spongy coat, 0.4 mm. thick, formed of compact parenchyma. Lining of seed-cavity striate, the striae diverging from the hilar-chalazal region. Maximum diameter of seeds, 4.8 mm.; commonly 3.5 mm. Diameter in plane of symmetry (undistorted seeds) at right angles to the above, 2.25 to 3.6 mm. One seed from Arne is exceptionally large owing to bursting on drying. Another abraded and crushed seed from Arne measures 4 by 3.5 mm.

REMARKS AND AFFINITIES. Four seeds have now been found at Arne, one much decayed and burst (Pl. 22, fig. 21), the other two much abraded so that the 'fibres' are clearly shown (Pl. 22, figs. 20, 22). Two of them are considerably larger than the seeds from elsewhere. As previously stated (Chandler, 1957: 119) the form of the seed, character of gaping hilum, and small hilar-chalazal cavity strongly suggest relationship with Solanaceae. Seeds of *Capsicum* and allied genera show a marked resemblance in form and frequent distortion in growth but do not display the same succession of coats. Striate and fibrous testas, or testas with fibrous outgrowths occur within the family e.g. in *Lycopersicum* and *Cyphomandra*. No living genus with identical testa structure has yet been found but the connexion with the family Solanaceae appears extremely probable. It may eventually be necessary to establish a distinct variety or even species for the Lower Bagshot material but in the absence of more perfect specimens this cannot at present be done.

- V.40887 Figured Pl. 22, fig. 20. A large seed.
 V.40888 Figured Pl. 22, fig. 21. A large distorted, broken and sand-pitted seed.
 V.40889 Figured Pl. 22, fig. 22. A small distorted seed, much abraded and sand-pitted.
 V.40890 A seed.
 All the above from Arne.

Family CAPRIFOLIACEAE

Genus SAMBUCUS (Tourn.) L.

Sambucus parvula Chandler

Plate 23, figs. 1-10

1926 *Sambucus parvulus* Chandler, p. 43, pl. 7, fig. 9a-c.1961b *Sambucus parvulus* Chandler: Chandler, p. 150.

A single seed (V.40903) shows the typical obovate form, terminal micropyle and hilum on the ventral face, and the sinuous transverse ridges of *Sambucus*. The ridges are about 0.008 mm. apart. The seed is splitting marginally. Length, 1.4 mm.; breadth, 0.8 mm. It has been compared with specimens of *Sambucus parvula* from the type locality, Hordle (cf. Pl. 23, figs. 3-10), and is indistinguishable from them. The surface of the Lake specimen is better preserved than that of similar seeds from Colwell awaiting description and the whole seed is scarcely pyritized unlike the Colwell specimens which are heavily impregnated with pyrites throughout. From finer beds towards base of section exposed in foreshore. Lake.

Family CUCURBITACEAE

Genus CUCURBITOSPERMUM Chesters, 1957: 57

Cucurbitospermum lakense n. sp.

Plate 23, figs. 11-14

DIAGNOSIS. Seed obovate in outline, more or less flattened, smooth superficially without sharply defined marginal rim. Length of seed, 5.5 to 6.5 mm.; breadth, 4.25 to 4.75 mm. Wall about 0.05 mm. thick at the marginal suture.

HOLOTYPE. V.40904.

DESCRIPTION. *Seed*: Obovate in outline, more or less flattened, bisymmetric, splitting marginally in the plane of symmetry into equal valves, smooth superficially without sharply defined marginal rim or other ornamentation. Surface shining formed of equiaxial cells 0.012 to 0.016 mm. in diameter. Anatropous, hilar scar a small oval depression truncating the pointed end slightly obliquely, raphe marginal continued almost completely around the circumference, chalaza marked by a thickening of the raphe at the rounded apex of the seed. Micropyle a conspicuous canal adjacent to the hilum, opening into the hilar depression. Testa woody, wall about 0.15 mm. thick at the marginal suture and 0.05 mm. thick at the middle of the flat surface, formed of equiaxial cells arranged in several rows giving an ill-defined columnar appearance in section. Tegmen formed of polygonal more or less equiaxial cells. Over the raphe these become rectangular and are aligned in longitudinal rows, individual cells varying from 0.016 to 0.025 mm. in diameter. Dimensions: 1) Length of seed, 6.5 mm.; breadth, 4.75 mm. 2) Length of seed, 5.5 mm.; breadth, 4.25 mm.

REMARKS AND AFFINITIES. Twenty-two seeds, some split into symmetric valves showing the internal structures which leave no doubt as to the relationship with Cucurbitaceae. An unornamented, unrimmed form of seed is relatively rare. It occurs in *Escallonia* and *Citrullus* but neither of these genera agree in form or size with the fossil. *Bryonia* has seeds similar in size but they are rimmed. *Cucurbitospermum sheppeyense* from the London Clay (Chandler, 1961: 295, pl. 29, figs. 24–26) is closely comparable in size and smoothness but has a smooth marginal flange; its seeds tend to be plano-convex and are considerably more inflated with finer cell structure.

- V.40904 Holotype, figured Pl. 23, fig. 12. A seed with one valve partially removed to show the raphe and micropyle.
 V.40905 Figured Pl. 23, fig. 11. A seed, figured to show the external surface and form.
 V.40906 Figured Pl. 23, figs. 13, 14. A seed split so as to show the interior of the valves, hilum, raphe, chalaza and micropyle.
 V.40907 Eighteen seeds from the coarser seams at various points low in the section.
 V.40908 A seed from a seam at the top of the section, easternmost end nearest Poole.
 All the above from Lake.

Cucurbitospermum obliquum n. sp.

Plate 23, figs. 15–17

DIAGNOSIS. Seed roundly elongate sub-quadrangular, somewhat inflated, without ornamentation or marginal rim. Testa about 0.5 to 0.6 mm. thick in the plane of symmetry. Length of seed, 5.25 mm.; breadth, 2.1 mm.; thickness, 1.5 mm.

HOLOTYPE. V.40909.

DESCRIPTION. *Seed*: Bisymmetric, rounded elongate sub-quadrangular slightly curved (but whether this is merely an individual variation is not known) so that one margin is almost straight, the other convex; splitting in the plane of symmetry into equal valves, somewhat inflated, without the marginal rim. Anotropous, hilum terminal at the junction of the curved and straight margins, chalaza at the opposite extremity, raphe marginal in the plane of symmetry. Surface formed of equiaxial cells about 0.016 mm. in diameter. Testa thick, from about 0.5 to 0.6 mm. as measured in the plane of dehiscence, the outer layers, 0.1 to 0.2 mm. thick, break rather irregularly, but the inner layers break along a finished suture plane (Pl. 23, fig. 17). Testa cells, radially arranged as seen in transverse sections of the wall, about 0.025 mm. long and 0.012 mm. broad. Cells of tegmen equiaxial 0.012 mm. in diameter. Tegmen thickened around the raphe. Length of seed, 5.25 mm.; breadth, 2.1 mm.; thickness, 1.5 mm.

REMARKS AND AFFINITIES. One seed (V.40909) belonging to the Cucurbitaceae, distinguished by the narrow sub-quadrangular form and thick testa. It does not appear to be closely related to any genus yet seen. From Lake.

INCERTAE SEDIS

Genus RHAMNOSPERMUM Chandler, 1925: 30

The genus *Rhamnospermum* was founded on material from the Lower Headon of Hordle. This was compared with seeds of *Rhamnus* and referred doubtfully to the family Rhamnaceae.

The grounds for such relationship have already been discussed (Chandler, 1925: 31; Reid & Chandler, 1926: 118) but the systematic position has always been regarded as doubtful. On further consideration this suggested relationship now appears to be without adequate foundation, and it seems better to regard *Rhamnospermum* as of unknown affinity.

The genus *Bridelia* (Euphorbiaceae) has bilobed seeds similar in form and testa structure to the fossil. Although in this genus the raphe lies between the lobes, the chalaza lies at the opposite end of the seed to the hilum not in the middle of the groove between the lobes so that in *Bridelia* the seed is fully anatropous.

'Seeds' of *Rhamnospermum* have been found at the following horizons and localities: Lake and Arne (Cuisian?), Bournemouth Freshwater Beds including Sandbanks and Branksome Dene and other sites nearer Bournemouth itself (Lutetian?), the Bournemouth Marine Beds of Southbourne, the Highcliff Sands of Cliff End near Mudeford, Hengistbury and Barton Beds, Lower and Upper Headon Beds of Hordle and Colwell Bay respectively, the Oligocene Bembridge marls of Thorness Bay and the Hamstead Beds of Bouldnor and Hamstead, the last four named in the Isle of Wight.

The 'seeds' usually occur in great abundance, and are associated with numerous seeds of *Brasenia* at some horizons and sometimes with little else. This suggests that they belong to a water plant or to one growing by the water side and bearing abundant fruits perhaps growing in thick clusters.

Although specimens from different horizons (Pl. 23, figs. 18-20, 26-38; Pl. 24, figs. 1-9) frequently show distinctions in size, or form (cf. Pl. 24, figs. 5, 6), or occasionally in the coarseness of the surface cells, these distinctions are not constant, so that diagnosis of more than one species does not seem possible at present. It may actually be the case that different species or varieties may be represented in some of the localities, but, on the other hand, the differences noticed may result from environment and preservation. Without knowledge of the true relationship of this plant the value of these distinctions cannot be satisfactorily assessed.

One specimen (Pl. 24, figs. 8, 9) from the Upper Headon of Colwell appears to be attached to a peduncle. A ring of small rounded objects with irregular margins at the junction of the fruit with the 'peduncle' suggests calyx lobes or bracts. Unfortunately the specimen is much crushed and obscure so that the precise relationship of these parts cannot be determined with certainty.

One or two 'seeds' from Arne show what appears to be remains of a close-fitting outer coat still adhering over the chalaza scar between the lobes (Pl. 23, figs. 24, 25). But without more evidence from better specimens it cannot be assumed with certainty that this adherent layer really belongs to the specimens. When present, it is compact, black and shining, coarsely columnar in section and formed externally of equiaxial cells.

Rhamnospermum bilobatum Chandler

Plate 23, figs. 18-38; Pl. 24, figs. 1-9

1925 *Rhamnospermum bilobatum* Chandler, p. 30, text-fig. 13.

1926 *Rhamnospermum bilobatum* Chandler, pl. 5, fig. 1 a-e.

1926 *Rhamnospermum bilobatum* Chandler; Reid & Chandler, p. 117, pl. 8, figs. 1, 2.

1960 *Rhamnospermum bilobatum* Chandler: Chandler, pp. 216, 236, pl. 32, figs. 60, 61; pl. 35, figs. 155, 156.

1961b *Rhamnospermum bilobatum* Chandler: Chandler, p. 152.

The species was fully described from Hordle and the Bembridge Beds. The outstanding characters are the subglobular seed deeply bilobed having a large circular aperture at one end closed by a plug (Pl. 23, figs. 19, 20, 27; Pl. 24, figs. 2, 3), and a large circular chalaza in the middle of the deep groove between the lobes (Pl. 23, figs. 18, 28; Pl. 24, fig. 6). Surface ornamented with polygonal cells with beaded walls which are aligned transversely across the two lobes. Tegmen translucent fused with the testa around the chalaza.

Numerous crushed seeds occur especially in the coarser seams of vegetable debris. The best preserved were found at Sandbanks and Hordle. In all localities there are specimens so much abraded that the outer opaque coat has gone leaving only the yellowish semi-translucent tegmen (Pl. 23, figs. 22, 30, 32, 34-36; Pl. 24, fig. 2). Most of the Lake specimens are flattened and are much smaller than the Sandbanks seeds typical examples measuring 2.25 to 2.5 mm. in length and 1.75 to 2.25 mm. in breadth (Sandbanks seeds 2.5 to 3.1 mm. in length). The polygonal cells of the testa are about 0.016 to 0.025 mm. in diameter (Sandbanks seeds 0.025 to 0.03 mm. in diameter). They are, however, too variable to permit of clear specific distinction.

V.40910-12 Figured Pl. 23, figs. 21-23. Three seeds, two with outer coat preserved, one with tegmen only.

V.40913 Numerous flattened seeds with outer coat preserved.

V.40914 Numerous flattened seeds with tegmen only.
The above from Lake.

V.40915-16 Figured Pl. 23, figs. 24, 25. Two seeds, one (fig. 25) with the appearance of a thick stalk and remains of an outer coat (fruit wall?).

V.40917 Three seeds, two showing what may be the adherent remains of an outer coat (fruit?) between the lobes.

V.40918 Five seeds from laminated silty beds with rootlets.

V.40919 Twenty seeds.
All the above from Arne.

Genus CARPOLITHUS Linnaeus

Carpolithus arnensis n. sp.

Plate 24, figs. 10-13

DIAGNOSIS. Fruit one-loculed, one-seeded, ovoid, with slight basal constriction and with accrescent perianth? External surface with stout sunk fibres forking above the basal constriction or giving off alternating branches. Fruit wall inside perianth columnar in section. Length incomplete. Diameter (crushed), 22 by 15 mm. Seed with large basal chalaza adjacent to base of fruit.

HOLOTYPE. V.40941.

DESCRIPTION. *Fruit*: One-loculed, one-seeded, with accrescent perianth?, probably originally ovoid (broken at the apex in fossilization which has split and curled inwards), having a large constricted area internally and externally at the base which suggests a basal chalaza (Pl. 24, figs. 10, 11). A small median basal scar about 5 mm. in diameter appears to mark the attachment (Pl. 24, fig. 12). From its margin strong straight simple fibres, sunk in conspicuous deep narrow grooves, diverge upwards. They are usually unbranched to the limit of the basal constriction, only very rarely forking in this part of their course (Pl. 24, fig. 11). At the level of the constriction they may divide into two, or more commonly they give off several alternating branches all of which are continued towards the apex as narrow sunk

nerves lying upon close-set parallel or sub-parallel ridges. Occasionally adjacent branches unite. At the extreme apex there remains slight evidence of further forking with a tendency for adjacent branches to anastomose. In sections of the fruit wall, in places only, two distinctly differentiated but closely fused coats can be seen. The outer coat is compact, 0.6 to 0.8 mm. thick, in which the nerves described above are embedded. It is formed of equiaxial cells, about 0.027 mm. in diameter, which in certain aspects show immensely thick walls and minute lumen. This coat appears to represent the perianth. The inner coat, when visible, about 0.114 mm. thick, is coarsely columnar, the rectangular cells which compose it being somewhat longer than broad and aligned at right angles to the surface. Breadth of cells about 0.038 mm. Locule lining of round angled rectangular cells variously oriented. Length of fruit preserved (incomplete at apex) about 20 mm. Diameter as crushed, 22 by 15 mm. Maximum diameter of large basal scar, 15 mm. The scar extends for about 5 mm. along the long axis of the fruit.

REMARKS. A broken fruit (V.40941) and its internal cast in coarse sand. Similar fibres may occur in the fruits of Olacaceae but they occupy the inner part of the fruit wall. Somewhat similar fibres also occur in Myrsinaceae, but there is no accrescent perianth in this family, nor a large basal scar. The specimen is distinguished as *Carpolithus arnensis* until such time as its true relationship is discovered. From Arne.

Carpolithus sp.

Plate 24, fig. 14

DESCRIPTION. *Fruit*: Bisymmetric, one-loculed, ovate, conspicuously pointed at the narrow (stylar?) end, flattened, surface ornamented with a network of fine sharp ridges giving rise to oblong or elongate meshes over most of the surface, the longitudinal ridges being more conspicuous than the transverse; at the basal rounded end of the fruit the ridges are more prominent and form smaller equiaxial meshes. Wall about 0.5 mm. thick, formed superficially of rectangular cells, 0.02 by 0.025 mm. in diameter, aligned longitudinally; in section formed of coarse cells at right angles to the surface, about 0.025 mm. broad. Lining of wall formed of conspicuous elongate cells, 0.016 mm. broad, arranged in parallel groups usually longitudinally aligned but occasionally with obliquely oriented groups interspersed among them. Length of fruit, 3 mm.; breadth, 2.75 mm.

Seed: Agreeing in shape with the locule, hence ovate, flattened, pointed at the micropylar end which passes into the stylar canal, having a sub-apical placenta on the locule wall, about 0.15 by 0.075 mm. in diameter. Testa formed of fine elongate cells about 0.01 mm. broad; surface with irregular unevenly scattered protuberances.

REMARKS. One somewhat decayed specimen (V.40942). The form and placentation, and the net-veined surface suggest relationship with Moraceae or Urticaceae. No satisfactory determination has been possible. From Lake.

Carpolithus sp.

Plate 24, figs. 15, 16

Without further detailed information, or some clue as to their relationship, these specimens are difficult to understand and to describe clearly and concisely. They are oboval or obovate

(or possibly transversely oval), usually flat, but sometimes very slightly inflated in the middle, crenulate or irregularly jagged at the margin, bisymmetric, splitting around the margin into equal valves showing on the internal surface a marginal flange or flat suture plane delimited by a very slight ridge from the general surface of the flat cavity. The surface of the integument is formed of small convex cells, conspicuously inflated and separated from one another by deep grooves. The cells may be rectangular or more or less rounded with straight or very slightly sinuous outlines. They measure about 0·018 to 0·027 mm. in diameter, or sometimes as little as 0·012 mm. There is a network of ridges which arises on one margin towards the narrower end of the organism; when slightly abraded it can be seen that the network is due to a series of nerves which pass to the centre of the 'seed' branching and anastomosing. Some of the branches extend to the margin. Possibly the point on the margin from which the network arises is the hilum. The appearance of the specimen suggests a flat winged seed, of which the central part only, where the fibres form a definite network, is occupied by the body. Thickness of testa 0·09 mm. over the middle of the seed, hard and close-textured. It is formed internally of cells about 0·012 mm. in diameter which produce two sets of striations at right angles to one another, one set parallel with the longest axis of the 'seed', this being the most marked. Within the hard testa there are ragged remains of a semi-translucent light-coloured coat which shows similar longitudinally aligned cells. The convergence of these cells towards the narrower end of the seed suggests that one organ is situated here. Length of seed, 3 to 4 mm.; breadth, 2·7 to 3 mm.

REMARKS AND AFFINITIES. The external appearance of the seeds is highly characteristic, although knowledge of their internal structure is incomplete. The systematic position still awaits discovery.

V.40943 Figured Pl. 24, fig. 15. A seed with beautifully preserved testa and veins.

V.40944 Figured Pl. 24, fig. 16. Another more sand-pitted specimen.

V.40945 Seven specimens or parts thereof. One is a single valve, imperfect at the two extremities. All the above from Lake.

Carpolithus sp.

Plate 24, fig. 17

A whorl of small rounded bracts, or carpels, or sporangia. Four appear to be complete and to have gaped longitudinally. They are conspicuously thickened along one margin, but the cell structure of the walls is obscure. Remains of several others persist on the opposite side of the axis to these four and along their broken transverse edges appear to show protruding remains of hairs formed of several cells arranged end to end. The nature and relationship of the specimen is obscure. Maximum diameter of group, 0·912 mm.; least diameter, 0·684 mm. Maximum breadth of burst fruits or sporangia, 0·228 to 0·285 mm. V.40946 from basal beds in foreshore, Lake.

Carpolithus sp.

Plate 24, figs. 18, 19

A small flat stalked pod with one margin slightly convex, the other markedly so. The greatest breadth is 2·5 mm. from the distal end of the stalk, i.e. below the middle of the pod. The

curvature is sharpest towards the lower end the breadth gradually tapering towards the apex (slightly imperfect). There is a marginal rim enclosing marginal bundles on each side which taper towards the apex. The rim is somewhat flattened on the more convex margin, rounded and thicker on the other margin. A few low rounded tubercles or warts (about 0.057 mm. in diameter) can be seen on the surface especially near the margins. Cell structure obscure but in places fine pits can be seen. On the stalk there are longitudinally aligned rows of rectangular cells about 0.013 mm. broad. Length including stalk, 5 mm.; breadth, 2 mm.; length of stalk, 1 mm.

The pod (V.40947) superficially resembles a *Clematis* fruit with long style (=stalk). This relationship is nevertheless excluded by the tapering of the marginal bundles towards the broken tip. Had the pod really been *Clematis* the bundles would have entered from the attachment at this end where they would have been stouter. Further the fine surface pitting is unlike the surface structure of *Clematis*. From fine silt, base of section, western end, Lake.

Carpolithus sp.

Plate 24, fig. 20

DESCRIPTION. *Seed*: Inflated (now collapsed laterally), rounded dorsally, angled along the ventral margin on which lies the hilum the angle being rounded on one side of the hilum and acute on the other; hilum marginal, 0.8 mm. from the more inflated end of the seed, projecting and now gaping; raphe probably ventral on the angular margin of the less inflated end of the seed; testa hard, of two coats, the outer preserved only in the collapsed lateral hollows with indications of transverse striations and of surface pittings, some due to weathering, some, no doubt, original. Inner coat smooth, hard, formed of equiaxial cells apparently 0.01 mm. in diameter. Seed pendulous or erect. Length, 2.4 mm.; breadth, 1.3 mm.

REMARKS. One specimen (V.40948), perfect, except that it has collapsed, the two lateral faces being concave instead of convex, the outer coat of the testa is worn away from the dorsal side. Definite diagnostic characters are lacking but the species might be recognizable again. No determination can be made. From Lake. *E. St. John Burton Coll.*

Carpolithus sp.

Plate 25, figs. 1, 2

A small group of fruits or seeds attached to a placenta. They appear to be represented by an inner integument only as the coat preserved is thin and translucent. Individual fruits are more or less elongate-oval in outline, originally ovoid?, having an organ at each end indicated by a darkening and thickening of the thin integument. At the distal end there is also a slight truncation. A few thin-walled relatively large cells diverge from the dark area at the distal end. Elsewhere cell structure is obscure. Length of individual fruits about 0.44 mm.; breadth about 0.247 mm. The nature and relationship of this specimen (V.40949) is unknown. From basal beds by ironstones, east end of section, Lake.

Carpolithus spp.

Plate 25, figs. 3-10

A number of broken fragments of capsules have been found with certain characters in common. All have a wrinkled and puckered external surface in which the puckerings tend, on the whole, to have a longitudinal trend, and an inner surface which is more or less smooth and transversely striate. One fragment, about 14 mm. long, 6 mm. broad as crushed, (cf. Pl. 25, figs. 3, 4) appears to be a valve broken slightly at the basal end. It is much flattened, but one surface shows the rugose external puckering (Pl. 25, fig. 3) and part of what may be a septoidal plane of fracture, whereas the opposite surface appears to show a flattened locule with numerous transverse grooves near the outer edge. These perhaps indicate impressions of closely adpressed seeds. A second fragment (Pl. 25, figs. 7, 8) shows the proximal end of a valve with a pocket on the inner side (Pl. 25, fig. 8). Fibres parallel with the finished margin of the pocket (seed-cavity?) can be seen. They curve and sweep transversely over the surface of the septum. There are several other even more obscure fragments (Pl. 25, figs. 5, 6, 9, 10).

While there is some resemblance in structure and in the external puckered coat to the capsules of *Lagerstroemia* the available evidence is insufficient to place these fragments definitely in the family Lythraceae. It may however be noted that Lythraceae seeds named *Alatospermum lakense* n. sp. are found in the Lower Bagshot at Lake (see p. 119) Differences of form in the capsule fragments suggest that more than one species and genus may be represented. There is no certainty that all belong to one family.

- V.40950 Figured Pl. 25, figs. 3, 4. A crushed valve of a capsule broken at the proximal end. It shows the puckerings and rugosities of the external surface and the transverse furrowings of the locule surface.
 V.40954 Figured Pl. 25, figs. 9, 10. A broken fragment showing the puckered external surface clearly.
 V.40952 Figured Pl. 25, fig. 6. Another fragment showing longitudinally oriented external puckerings and transverse striations of the septa and locule surfaces.
 V.40951 Figured Pl. 25, fig. 5. A fragment with coarser rugosities externally.
 V.40953 Figured Pl. 25, figs. 7, 8. A fragment with rugose external surface and a hollow (seed-cavity?) on the internal surface outlined by fibres of the wall. These fibres change their direction and become transverse over the surface of the locule wall or septum.
 All the above from Lake.

Carpolithus sp.

Plate 25, fig. 11

DESCRIPTION. *Fruit*: Obovoid (now much crushed) with a single cavity, and wall about 0.55 mm. thick. Attachment scar a conspicuous oval hollow at the narrower end. Stylar scar? at the opposite end perhaps indicated by a slight emargination. Wall in section woody with cells or fibres aligned at right angles to the surface. Internal surface showing fine transverse striae obscured by sand-pitting. Length of fruit about 18.5 mm.; breadth, 14 mm. The data are insufficient for satisfactory determination. V.40955 from Lake.

Carpolithus sp.

Plate 25, figs. 12-14

A small probably immature superior fruit of unknown relationship, pedunculate with a thick longitudinally wrinkled stalk broadest at the lower end where there appears to have

been a joint. The ovary or unripe fruit is enclosed by five persistent imbricate leathery perianth segments of which three form an outer whorl and two opposite ones an inner whorl. Each segment has an inconspicuous sub-apical umbo beyond which and forming the entire marginal area is a smooth shining region of convex cells about 0.038 mm. in diameter. Except around the margin the surface of the segment is finely puckered, the puckers being aligned longitudinally on the whole. Surface cells slightly convex, rectangular, longitudinally aligned. Ovary ovoid with short thick style ending in four bifid stigmas. Surface of fruit longitudinally puckered. Length of fruit including stalk, 5 mm.; length of stalk, 1.75 mm. Breadth of fruit, 4.5 mm. Diameter of stalk at its thicker lower end, 1.75 mm. V.40956 from fine silty bed with roots at base of section, Arne.

Carpolithus sp.

Plate 25, figs. 15, 16

A large smooth ovoid (or possibly obovoid) fruit, now much flattened in fossilization, has opened longitudinally down one side showing a locule with transversely striate surface and a few transverse depressions which perhaps represent pockets caused by the pressure of seeds, now fallen (Pl. 25, fig. 16). Number of carpels and locules obscure. Length of fruit, 12 mm.; maximum breadth as flattened, 8.5 mm. The specimen is too crushed and sand-pitted to show surface cell structure satisfactorily. V.40957 from Lake.

Carpolithus sp.

Plate 26, figs. 1, 2

The specimen appears to be a two-loculed pyrene, probably one of a pair of pyrenes if the fruit had been complete. It is lanceolate in outline, sharply pointed at the upper end, rounded at the lower where there is a small prominent scar of attachment. The dorsal surface is convex, the other (ventral) concave. In transverse section two locules are seen apparently extending the whole length of the fruit and separated by a short dorsiventral septum so that they lie side by side along the broadest diameter. The locules open by a sub-marginal split extending around the circumference on the ventral side from the apex to the base. The convex surface shows fine longitudinal cells and striations with some criss-cross striae athwart them. The concave surface has a median longitudinal band of fibres over the septum from which fine elongate cells and a few stout branching fibres diverge downwards. In places there are patches of cells arranged in a complicated finger-print or criss-cross pattern. At the extreme margin on this surface there are fine parallel cells which diverge passing upwards. Length of fruit, 2.5 mm.; breadth, 0.7 mm.; thickness about 0.137 mm.

The two-loculed pyrene (V.40958) which may have been one of a pair suggests comparison with Boraginaceae but no comparable genus has been found. The fossil should be readily recognizable if further material is discovered. From fine silt, base of section, western end, Lake.

Carpolithus sp.

Plate 26, figs. 3-7

DESCRIPTION. *Fruit*: Superior, having a persistent calyx of five separate ovate sepals with sharply pointed apices (Pl. 26, fig. 6). When complete the fruit is oboval with a tendency to be

somewhat truncate at the apex and gradually narrowed to the base, bisymmetric, flat or almost flat, splitting in the plane of symmetry into two valves. Styles terminal, patent, two, persistent, lying side by side in the plane of symmetry. Locules probably two as indicated by a slight median longitudinal external ridge along which a tendency to split can be detected suggesting two locules side by side in the plane of maximum diameter and symmetry. Surface with remains of a felt of yellow-brown hairs (usually worn away) beneath which is a smooth coat of equiaxial cells about 0.01 mm. in diameter. There are also traces of fine longitudinal striae. Within the outer semi-decayed epidermal layer are coarse contiguous fibre-like structures (sclerenchyma?) tapering at their ends. They have no obvious connexion with fibro-vascular tissue but may be secreting ducts. As the result of maceration in fossilization these 'fibres' are exposed as separated strands into which the specimens tend to shred especially at the apical or stylar end. The great majority of specimens are represented only by separate more or less shredded curled and distorted valves having the appearance of fibrous bracts. Length of two perfect fruits, 5 and 6 mm. respectively; breadth, 3 and 3.25 mm. The specimens are abundant in the basal beds by the ironstones at the east end of the Lake section.

- V.40959 Figured Pl. 26, figs. 3, 4. A fruit with two valves beginning to shred longitudinally into the component fibres.
 V.40960 Figured Pl. 26, figs. 5, 6. Another specimen showing the calyx and the persistent style bases.
 V.40961 Figured Pl. 26, fig. 7. Half of a smaller fruit shredding into fibres.
 V.40962-65 Numerous specimens represented by detached much shredded valves. Two mounted in Canada Balsam after slight maceration with nitric acid. V.40965 *E. St. John Burton Coll.*
 All the above from basal beds, by ironstones, east end of section, Lake.

Carpolithus sp.

Plate 26, fig. 8

Remains of a few compressed several- (five-?) segmented fruits, more or less obovoid or conical originally, pointed below, flat or slightly convex above. On account of the crushed condition the exact form and structure are difficult to determine. The surface is black owing to a thin outer coat of equiaxial cells, about 0.01 mm. in diameter, producing a somewhat uneven surface. This coat overlies a layer of coarse longitudinal fibres, each uneven in thickness, yellow in colour, fused to form a coat which readily disintegrates into its component fibres on weathering; these fibres frequently show nodular thickenings which alternate with those on adjacent fibres. The locule lining is black, shining, finely striate transversely or obliquely according to the position in the fruit. There is evidence in one specimen that there were thin septa, one such being seen with structure like that of the rest of the locule lining, its striations being oblique. The number of locules and septa could not be seen, but is probably five to correspond with the exterior of the specimen. There is no evidence whether dehiscence was septicial or loculicial. The relationship remains obscure. Length of fruits about 4 mm.; diameter, 3.5 mm.

- V.40966 Figured Pl. 26, fig. 8. A fruit showing the multi- (five-?) partite apex.
 V.40967 A second specimen laterally flattened so that the apex is shown on one side but it is somewhat obscure.
 Both the above from Lake.

Carpolithus sp.

Plate 26, figs. 9, 10

One valve of a bisymmetric seed incomplete at the distal end, probably originally more or less obovate in outline and compressed, having an organ (micropyle?) at the proximal end from which the cells diverge. The cavity appears to be straight, not curved or campylotropous. A fragment of the other valve adheres along one margin. External surface covered with circular inflated cells (air-cells?) often about 0.027 mm. in diameter, with complicated interlocking outlines due to long digitations. The broken end of the seed shows that the testa readily cracks along these digitate outlines. In section the testa shows a columnar coat, 0.05 mm. thick. Lining of seed-cavity semi-translucent and thin, formed of transversely elongate and aligned cells with a tendency to be grouped in short longitudinal rows. The main columnar coat of the testa tends to shred longitudinally on weathering giving a somewhat fibrous appearance. Along one margin of the seed, as preserved, there is a crested ridge which may indicate a raphe or be merely a marginal crest emphasized by crushing of the seed. The surface cells are highly reminiscent of a seed from the Lower Headon of Hordle (Chandler, 1925: 25, pl. 3, fig. 10a, b) redescribed under the name *Hantsia* (Chandler, 1961b: 114, pl. 25, fig. 40; text-fig. 2) and recently found at a number of somewhat older horizons in the Hampshire Basin. There is however nothing in the broken seed to suggest that it ever possessed the curved form of *Centrospermae*. Length of fragment, 2 mm.; breadth, 1.3 mm. V.40970 from Lake.

Carpolithus sp.

Plate 26, figs. 11, 12

Two two-valved fruits, flattened, cordate at the apex, gradually attenuated to the base. They split medianly into symmetric valves with the plane of dehiscence at right angles to the flattened surfaces, the incurved inner edges of the valves breaking away from a median septum. The surface is rugose, of elongate longitudinally aligned cells and equiaxial depressions about 0.036 mm. in diameter. There appears to be a small scar (persistent perianth?) at the broad end. Length of fruit, 2.5 mm.; breadth, 1 mm. No seeds have been seen and the fruits remain undetermined. There is some resemblance to *Cruciferae*.

V.40968 Figured Pl. 26, fig. 11. A fruit now mounted on a slide (broken).

V.40969 Figured Pl. 26, fig. 12. A dehiscing fruit.

Both the above from fine silt, base of section, western end, Lake.

Carpolithus sp.

Plate 26, figs. 13, 14

DESCRIPTION. *Fruit*: Pointed ovoid, originally inflated but now much flattened, formed of elongate, thick, slightly sinuous longitudinal fibres (about 0.05 mm. thick). One end (apex?) is always intact and pointed, the other is always gaping and frayed into component fibres, the walls having a marked tendency to shred. Remains of a dark outer coat can be seen, but the coat itself is mostly worn away. The dimensions are: 1) Length, 2 mm.; breadth, 1.5 mm.

2) Length, 2.5 mm.; breadth, 1.5 mm. 3) Length, 2.25 mm.; breadth, 1.5 mm. 4) Length, 2.25 mm.; breadth, 1 mm. (folded). The true nature and relationship of these specimens has not been found.

V.40971-72 Figured Pl. 26, figs. 13, 14. Two fruits.

V.40973 Two others. V.40974 a fruit from the base of the cliff section.
The above from Lake.

Carpolithus sp.

Plate 26, figs. 15-18

DESCRIPTION. *Fruit?*: Sub-obovoid or ovoid, now much flattened, woody, with eight conspicuous ridges extending from the truncate base to within about 0.5 mm. of the apex of the conspicuous two-partite (?) patent style where they form a shoulder; five ridges are better developed than the other three. On dissection the specimen in Pl. 26, fig. 15 shattered, no evidence of a locule was seen, but the walls at the base are formed of hard woody parenchyma. Length, 2.5 mm.; breadth, 1.9 mm.; length of style, 0.3 mm.; breadth, 0.4 mm.; breadth of base, 0.6 mm. From Lake.

V.40975-78 Figured Pl. 26, figs. 15-18. A number of ribbed or angled bodies. Nature unknown. Pl. 26, fig. 15 shattered. All from Lake.

V.40979 Another specimen. Lake.

Carpolithus sp.

Plate 26, figs. 19, 20

Seven small wedge-shaped bodies recall by their shape the seeds of *Ruta*. The dorsal surface is curved and broader at one end than at the other, the lateral faces are flat and meet at a sharp angle, the ventral margin thus formed is either convex or prominently angled; the junctions of the dorsal and lateral faces are produced so as to form conspicuous ridges bordering the narrow dorsal face which is concave transversely. Surface shining, formed of equiaxial cells with a tendency to be hexagonal. They measure about 0.05 mm. in diameter. When sectioned the specimens appear solid, formed throughout of these cells without locule or seed-cavity. Length of bodies, 2.4 mm.; breadth, 1.4 mm.; greatest breadth of dorsal face, 0.5 mm.

The true nature of these specimens is a problem. The rather large cells of which they are formed throughout suggest pulp or albumen. No organs or cavity could be found. No corresponding living material is known. Whatever their nature may be, their constant form, size, and character indicate that they are structural entities.

V.40980 Figured Pl. 26, fig. 19. A seed-like body. A second specimen (now decayed) is figured on Pl. 26, fig. 20.

V.40981 Five specimens.

The above from Lake.

Carpolithus sp.

Plate 26, figs. 21, 22

A subovoid pentagonal body pointed at the base and slightly flattened at the more sharply pointed apex. The five angles form rounded ridges which extend from base to apex where they merge in the median prominence. Length, 2 mm.; breadth, 1.1 mm.

After treatment with nitric acid the specimen (V.40982) began to crack all over and readily split longitudinally with the result seen in Pl. 26, fig. 22. The half figured shows a pair of curved longitudinal lines of nodules which fit into corresponding curved lines of depressions on the other half. The elevations and depressions are all quadrate except the apical ones which are subglobular, the walls exposed around them are smooth and polished, the substance is close, hard and woody with a general radial direction of the cells. When one half was broken transversely it appeared to be solid.

The specimen may be a placenta. Its structure is difficult to understand. No comparable living material has been seen. A similar object has been found at Hordle. From Lake.

Unknown Organisms

Plate 27, figs. 1-22

Small hollow originally ovoid bodies (usually much flattened in fossilization) are fairly common at Lake where they lie embedded among the carbonaceous fruits and woody fragments. Hitherto all attempts to determine them have failed. They are flexible, composed of stout shining branching fibres (Pl. 27, fig. 8) of chitinous appearance. The coarse fibres overlie an inner coat of much finer silky fibres which form a compact wall. The size is about 7.5 to 8.5 mm. in length and 5.5 mm. in breadth. They were at first thought to be sponges and were kindly examined from this point of view by Dr. K. P. Oakley who reported as follows: 'Disc-like sacs with walls composed of protein-fibres of two sizes forming an open meshwork. *Spicules are absent*, so that these bodies could scarcely be freshwater sponges which are spiculate. Their structure strongly recalls that of many *Euceratosa* (Horny sponges). One would scarcely hesitate to identify these organisms as *Euceratosa* were it not for the fact that this group is entirely marine.' Later, Dr. Oakley stated that the iodine content had been determined, the yield being 0.02% of iodine compared with 0.0006% in associated plant remains. Recent *Keratosa* sponges have an iodine content averaging about 0.3% while a similar fossil from the Cromer Forest Bed, Pakefield, Suffolk yielded 0.1%. Dr. Oakley pointed out that certain algae concentrate iodine.

Similar bodies have now been isolated from Lignitic beds at Southbourne, Hampshire (cf. Pl. 27, figs. 7-13). One such shows the fine inner meshwork enclosed between two tightly appressed thick woody fragments (Pl. 27, figs. 11-13). If these fragments represent opposite surfaces of a fruit, they show no distinctive pattern or cell structure and are apparently indeterminable. That the fine meshwork was probably connected with the woody fragments is suggested by their smooth inner surfaces showing impressions of the fine fibres. A stout net-like skeleton is seen in some fruits, for example in Cucurbitaceae, but the texture is not chitinous as in these fossils. An imperfect specimen from Southbourne (Pl. 27, fig. 10) shows the coarse and fine fibres associated as in the Lake material. There are net-like fragments from Hengistbury (Pl. 27, fig. 14) and Bovey Tracey, Devon (Pl. 27, fig. 15). A somewhat similar object (Pl. 27, fig. 16) was also found at Reuver (C. & E.M. Reid, 1915, pl. 20, fig. 1) and was named *Carpolithus* sp. 41. A comparable specimen is V.44770 from Reuver. There is also an imperfect example in derived Tertiary material from Broxbourne (Chandler, 1961: 92, pl. 4, fig. 14).

It may be noted that the chitinous texture of the fibres is unlike most plant structures. For convenience of comparison the somewhat similar bodies from the Cromer Forest Bed, Pakefield are figured in Pl. 27, figs. 17-22.*

- V.40990 Figured Pl. 27, figs. 1, 2. A compressed body.
 V.40991 Figured Pl. 27, fig. 3. A similar specimen.
 V.40992 Figured Pl. 27, figs. 4, 5. A body opened to show the imperfect coarse outer network (fig. 4) and the finer softer meshes which form the inner wall (fig. 5).
 V.43516 Figured Pl. 27, fig. 6. Fragment showing the branching of the coarse outer fibres. From fine silt, base of section, western end.
 V.44790-92 Specimens and fragments. V.44793 from coarse lignitic seam, V.44794 from base of section by iron-stones in foreshore.
 All the above from Lake.

Plate 27, fig. 23

A skeletonized fragment (V.42031) from Lake with fibres arranged in small approximately equal radial groups is so distinctive in its appearance that it seems worth while to draw attention to it by a figure. Its nature is unknown. A similar fragment was found in the Bournemouth Freshwater Beds by the late Dr. Bandulska between Alum and Durley Chines, and at Branksome Dene by the author.

Tuber?

Plate 27, figs. 24-26

A number of subglobular hollow bodies which have burst at one end. The surface is somewhat scaly and in some specimens it shows circular areas delimited by concentric cracks. In places these areas are punctured by small circular openings (Pl. 27, fig. 25) or they may carry small projecting mucros. Similar specimens (to be described) were found in slightly newer beds at Sandbanks. Their nature is obscure. They may represent tubers, or insect eggs. A specimen has also been found lately at Hordle and many in the London Clay of Bognor. Some, but not all, show a thin translucent inner skin. The outer coat is very variable in thickness, often less than 0.05 mm. but it may be thicker in the coarse scaly specimens. The diameter of the bodies is normally about 2 to 2.75 mm.

- V.40983 Figured Pl. 27, figs. 24, 25. Part of a thick-walled highly ornamented specimen.
 V.40984 Figured Pl. 27, fig. 26. A small, thin-skinned, somewhat crumpled specimen.
 V.40985-86 Numerous specimens, some as described above; others yellow-brown, horny and opaque.
 The above from Lake.
 V.40987-89 Numerous specimens. Arne.

* Chitinous sac-like structures (seen while this monograph was in the press) some of which appear to be identical with these fossils have been found by Professor T. M. Harris in Middle Jurassic beds of Yorkshire. They suggest that the Tertiary specimens may be derivative, an actual possibility in view of the fact that Carboniferous spores occur not infrequently in a number of Tertiary horizons both freshwater (Lake, Bournemouth) and marine (London Clay, Highcliff Sands Mundeford, etc.). Their true nature still awaits discovery,

C. PLANT IMPRESSIONS FROM PIPE-CLAY BASINS OF THE PIPE-CLAY SERIES

The following specimens are preserved as impressions in fine white pipe-clay. A few are known to come from Corfe, Dorset. The majority were labelled 'Gardner collection presumed to come from Bournemouth' and many were registered as V.1156 from 'Bournemouth and Alum Bay'. The matrix cannot be distinguished from that of the known Corfe material. The specimens may therefore have been derived from the Dorset pipe-clays of Corfe or Poole where Gardner collected as he did at Bournemouth. Such impressions were at one time abundant in the Dorset clay (cf. p.5). In this case they would probably be Lower Bagshot in age. On the other hand they may have come from Bournemouth Freshwater Beds from the Poole end of the section where pipe-clay patches were commoner than further east but less conspicuous than in the Lower Bagshot Beds. Most are not of great importance for beautiful as these specimens sometimes appear, few show sufficiently distinctive characters to determine them with safety. Such ill-defined impressions could be compared with a number of living forms. A few have been figured and briefly described but no attempt has been made to name most of them.

Angiospermae

MONOCOTYLEDONES

Family PALMAE

Genus TRACHYCARPUS H.Wendland

Trachycarpus raphifolia (Sternberg) Takhtajan

Plate 28, figs. 1-3; Text-fig. 23

1821 *Flabellaria raphifolia* Sternberg, p. 32, pl. 21.

1853 *Flabellaria raphifolia* Sternberg: Ettingshausen, p. 30, pl. 1, figs. 1-9; pl. 2, figs. 1-6; pl. 3, figs. 1, 2.

1958 *Trachycarpus raphifolia* (Sternberg) Takhtajan, p. 1670, pl. 4, figs. 1-5.

DESCRIPTION. *Leaf*: Incomplete, large, palmate, petiole not spiny but with slight sinu-
osities occurring irregularly along the margin. Leaf-blade with more than thirty-eight pinnae,
multiplicate for a radius of about 30 cm. from the point of insertion on the rachis or petiole, the
folding being such that the upper surface of each pinna is bent along the midrib to form an
angle opening upwards, while an angle opening downwards is formed on the lower surface of
the leaf along the margins of adjacent pinnae where they are still united. Thirty pinnae lie
to the left of the petiole and rachis, eight only to the right (the right side being much more
incomplete). There is no evidence whether few or many pinnules were borne on the petiole
and missing lower part of the leaf on the right side. On the left the basal pinnae are reflexed
towards the petiole. Towards the margin the leaf becomes multifid, the separated pinnae
tapering towards their extremities, but in no case is the extreme tip preserved. There is no
evidence of further subdivision or shredding of the tapering extremities. The part of the leaf
which is extant covers an angle of about 225°, but the spread of the perfect leaf must have
greatly exceeded this. The separated pinnae show firm, but not conspicuously thickened,

margins. The midribs are stout and conspicuous throughout their length, about 1 mm. broad, forming the most marked features of the multiplicate part of the blade; they are convex on the dorsal (under) surface, sunk on the ventral (upper) surface. Each midrib is flanked by a series

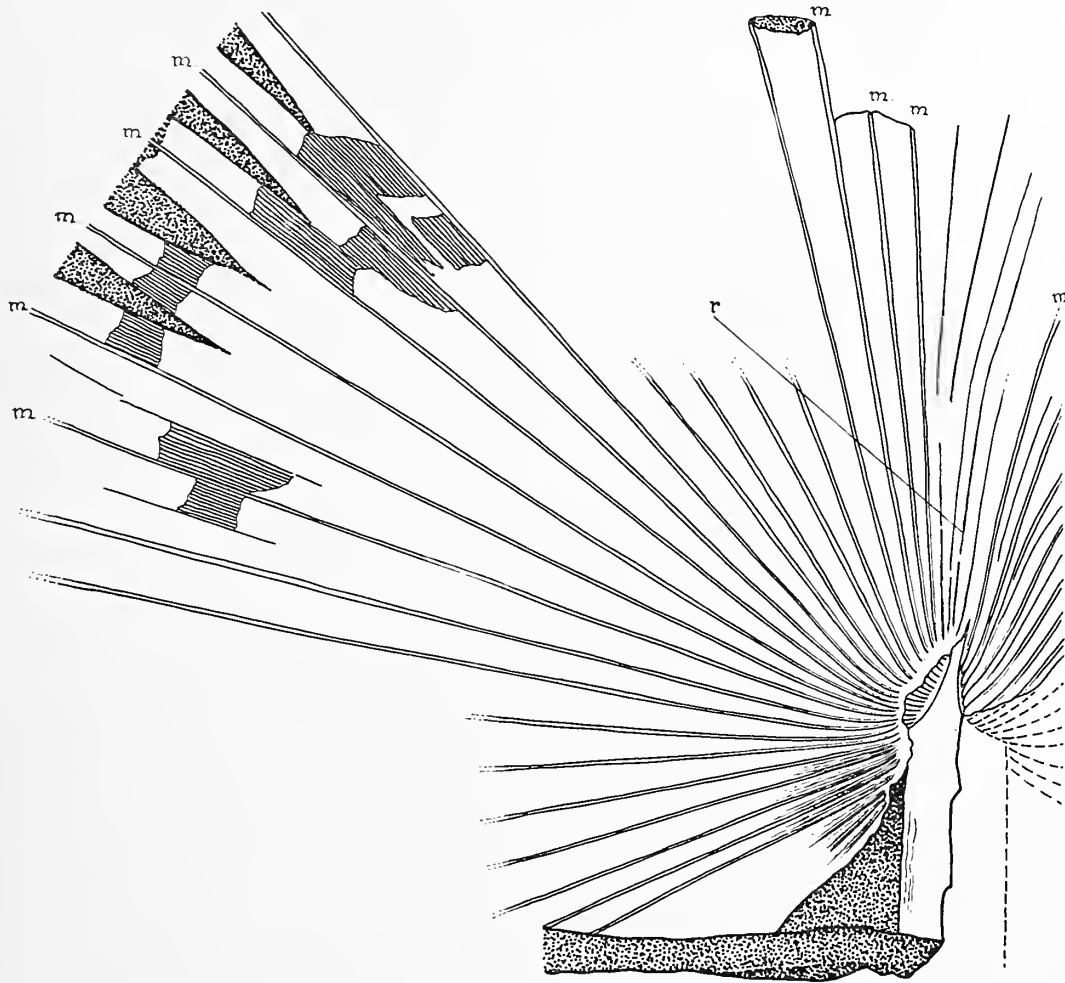


Fig. 23. *Trachycarpus raphifolia* (Sternberg)

Diagrammatic drawing about one-sixth nat. size. Only centre and part of margin on left are completed as the rest shows no significant features. Stippling matrix. Shaded parts of leaves on left indicate actual leaf remains. Much leaf substance also preserved on the upper part of the rachis but is not shaded. *m*, midribs of pinnae; *r*, rachis. *Shipp Collection*, Dorset County Museum, Dorchester.

of inconspicuous parallel nerves about 0.5 mm. or less apart. No transverse nervules are apparent.

Lower surface of leaf: Apex of petiole, subtriangular, the sides of the triangle somewhat concave, the apex prolonged to form a thin, but well-defined and probably long rachis. Its full length cannot be determined owing to masking of the impression of this lower side of the leaf by adherent leaf-substance, about 3 to 4 cm. of rachis bearing close-set pinnae are exposed where the leaf-substance has flaked away. Surface smooth, finely striate longitudinally,

possibly slightly corrugated in parts, but this may be an effect of preservation rather than an original character.

Upper surface of leaf: Represented by actual remains over the rachis and by patches towards the distal ends of the pinnae. Unfortunately the leaf-substance has completely decayed at the centre so that there is no evidence as to the form and character of the ligule if any. The surface is smooth, the rachis narrow and obscure but its position is indicated by the giving off of a few pinnules. It can be traced for at least 22 cm.

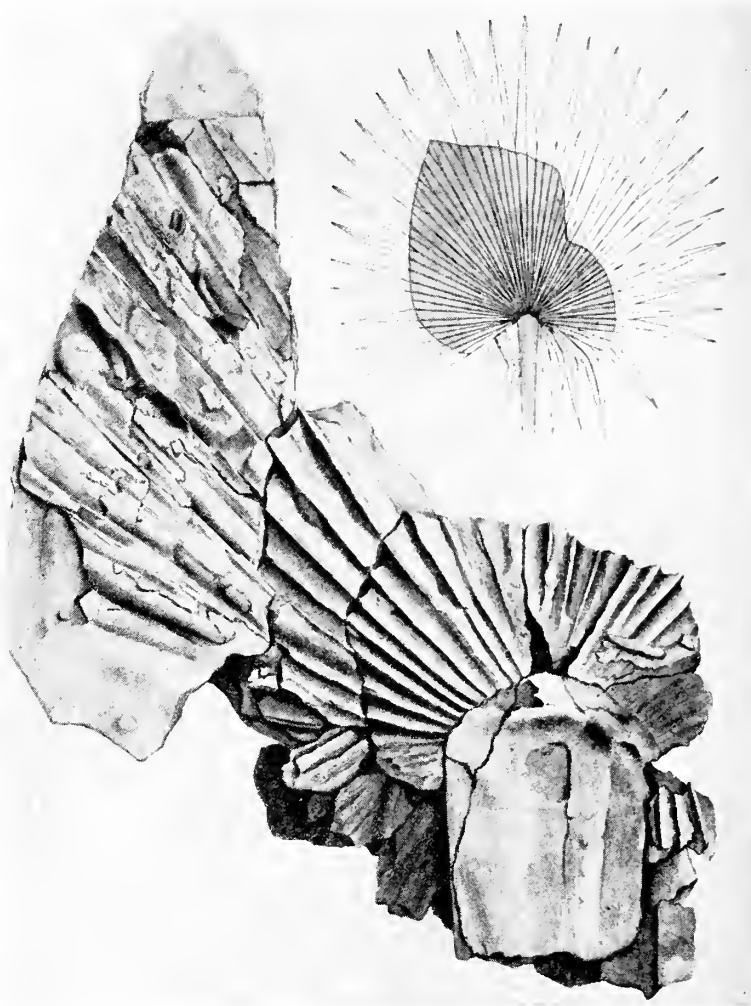


Figure 24 Unpublished figure after Gardner. Opposite sides of palm leaf. From Studland.

Petiole: Longitudinally and finely striate, the striae curving slightly near the margin and in conformity with the slight irregularities of the edge. The upper surface has not been seen. The lower surface was evidently slightly convex. Largest diameter of the leaf about 90 cm. (estimated). Actual diameter of block bearing the leaf asymmetrically placed about 35 by 56 cm. Greatest length of leaf blade preserved (measured along the axis from the point where the petiole narrows abruptly at its apex), 25 mm. Maximum breadth of leaf preserved, 48 cm. of which 38 lie to the left of the rachis and 10 to the right. Length of petiole preserved (measured

from same point), 7.5 mm. Greatest length of any pinna preserved (measured from its insertion on the axis), 38.5 cm.; maximum breadth of a pinna, 3 cm.

REMARKS AND AFFINITIES. One large block representing the impression of the lower surface of about half of a large leaf with rachis and a part of the petiole. Compressed remains of

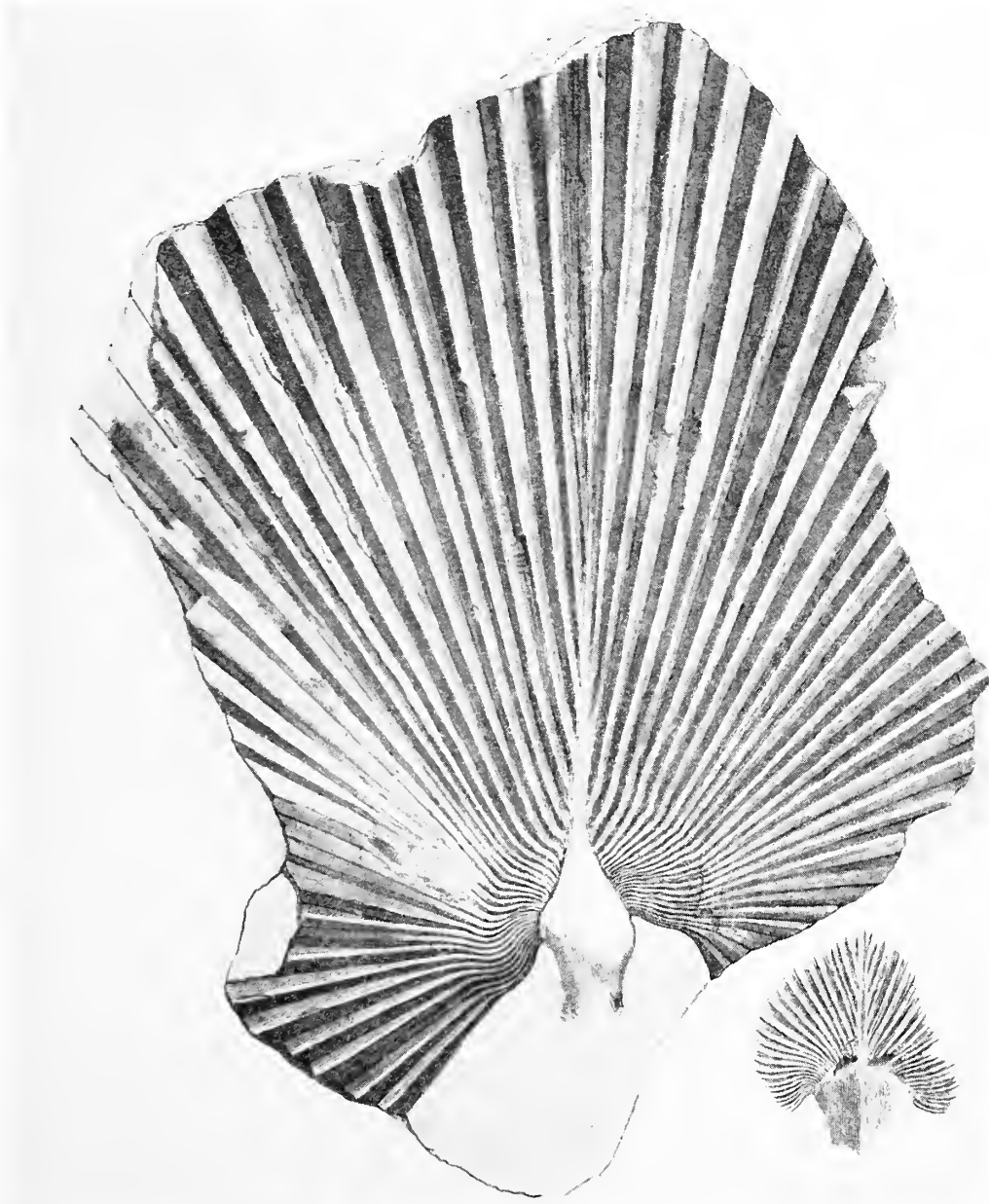


Figure 25 Unpublished figure after Gardner. Opposite side of palm leaf. From Alum Bay.
V.10879. $\times 0.5$.

the actual leaf-substance were evidently preserved originally over much or all of the specimen, so that the upper surface must at one time have been visible. Now, however, the substance has largely cracked and fallen away, although it could still be seen in 1944 over the upper part of

the rachis, and in scattered patches around the centre of the leaf on the left, as well as in outlying parts of the leaf-blade. The matrix is whitish-grey pipe-clay, iron-stained where the leaf-substance has lain and decayed. Two smaller fragments in a similar matrix show a few pinnules only. All three are labelled 'Plastic Clays, Corfe Castle, Shipp Collection', and are preserved in the Dorset County Museum, Dorchester. The large leaf may be the specimen referred to by La Harpe & Bristow (1826: 111) as 'a fine specimen in the Dorchester Museum' said to come from Creech Barrow, but their note on this specimen states that 'the petiole . . . is greatly swelled at its junction with the lamina of the leaf'; a statement which does not agree with more recent observation of the specimen at Dorchester. A specimen (V.10879) in an unpublished figure by Gardner (reproduced in Text-fig. 25) agrees with this description, but comes from Alum Bay. A second specimen, less perfect, is preserved in the Geological Survey Museum. Yet another specimen in Dorchester Museum in a hard slab of bright red ironstone shows a matted mass of similar pinnae irregularly disposed. Its precise origin is unknown. It was sent to the Dorset County Museum in 1935 by Mrs. Turner of Steeple Rectory near Corfe. The study of the specimens at Dorchester was made possible by the kindness of the Dorset Natural History and Archeological Society who also allowed photographs of the largest and most perfect leaf to be taken.

Other extant specimens of palm leaves from the Dorset Pipe-clay Series are mentioned on p. 5.

In 1958 Takhtajan made a study of fossil fan-palms giving a key to the identification of four genera which in his opinion are met with in the Tertiary of Europe and the U.S.S.R. viz. *Chamaerops*, *Sabal*, *Trachycarpus* and *Livistona*. It must, however, be remembered that more than this number of genera can be distinguished by their seeds in the London Clay alone. A number of fossil leaves considered by Takhtajan were referred to *Trachycarpus raphifolia* and listed as synonyms under this heading. It appears highly probable that the large fan-palms from Corfe should be referred to the genus *Trachycarpus* and to this species. Takhtajan defines *Trachycarpus* in the following terms (as translated from the Russian): Stalk without thorns, margins finely granulated or smooth, slightly convex from above or flat, 5 to 20 mm. wide where leaf-blade is affixed on the ventral side, the 'comb' [ligule] is inconspicuous, blunt or seldom more or less pointed usually more or less asymmetric. On the dorsal side the 'comb' [rachis?] is lacking or weakly represented, triangular. Leaf-blade fan-shaped, nearly circular in outline or somewhat ovate and broadly wedge-shaped at the base, divided up into thirty to forty segments for one-third to one-half of its length distally.

Among the leaves referred by Takhtajan to *Trachycarpus* are those from the Bembridge Beds name *Palaeoithrinax mantelli* by Reid & Chandler (1926: 80, pl. 5, figs. 1-5) in which, however, the margins of the pinnules are thickened and there is no marked midrib.

Takhtajan states that the genus *Trachycarpus* belongs to one of the most frost resistant palms which extends far to the north and endures frost up to -14°C . He regards it as indicating that the contemporary climate was sub-tropical.

DICOTYLEDONES

Family HAMAMELIDACEAE

Genus PROTOALTINGIA Reid & Chandler, 1933: 247

Protoaltingia hantonensis Chandler

Plate 28, figs. 6-8

See p. 69

DESCRIPTION. *Fruiting Heads*: Borne on a branched inflorescence, ovoid. Surface with rounded or polygonal areoles in which remains of capsular fruits can be seen, the whole forming a compact capitulum. Where best preserved the capsules are four-partite and probably two-loculed, the distal ends of the dehisced segments being crescent-shaped and without awn-like prolongations. Peduncle stiff, longitudinally striate. Length of largest fruiting head, 20 mm.; breadth, 15 mm. Length of a second head (without striate peduncle), 13 mm.; breadth, 12 mm.

REMARKS AND AFFINITIES. Three specimens, two mature, and one immature still attached to the branched inflorescence (Pl. 28, fig. 8). They are preserved as impressions in a fine pipe-clay matrix with much decayed partially embedded carbonaceous remains. One of the mature specimens retains a short length of its stiff striate peduncle. The other and larger specimen is associated with, but not in organic connexion with, a stout twig or stalk which may, or may not, have originally been connected with it. There is no evidence on this point. Both the mature specimens show areoles for the fruitlets some of which are preserved although rather obscure. Hints of two locules can be detected and the four-partite character of the capsules can be seen in places. Their distal ends are crescent-shaped and there is no evidence of original prolongation into awns which would almost certainly have remained in so fine a matrix. As the species is highly characteristic of a number of horizons in the Tertiary Beds of the Hampshire Basin it has been named *Protoaltingia hantonensis*. The heads are apparently smaller, and the fruitlets smaller and more numerous than in *P. europaea* Reid & Chandler.

- V.40294 Holotype, figured Pl. 28, fig. 6. A large fruiting head. The associated impression of a stout peduncle may, or may not, belong to it.
- V.40295 Figured Pl. 28, fig. 7. Another but smaller mature head showing the curved segments of the small capsules rather clearly.
- V.40296 Figured Pl. 28, fig. 8. An immature head still attached to a stiff branched inflorescence.
All the above *f. S. Gardner Coll.* from Bournemouth area, perhaps from the Dorset pipe-clays.

Family SAPINDACEAE?

Genus CUPANOIDES Bowerbank emend. Reid & Chandler, 1933: 364

? *Cupanoides* sp.

Plate 28, figs. 9, 10

DESCRIPTION. *Capsule*: Syncarpous, deeply three-lobed, somewhat depressed at the apex, lobes compressed dehiscing loculicidally from the style for about one-half of the length, valves gaping apart with the divided axis adhering to their inner angles. Gaping margins of

valves rimmed by thick strand of fibres which arise from the axis, walls thin. External surface finely crumpled, perhaps indicating a leathery texture, inner surface with remains of a network of fine nerves directed from the axis overlying a series of similarly directed striations or crumples. The manner of dehiscence and shape of the capsule strongly recall the section *Cupanieae* of the family Sapindaceae, but the evidence is insufficient for closer determination. Hence it has been referred provisionally to the form-genus *Cupanooides*. The interpretation of the specimen given above was arrived at by making models to show what original form would produce corresponding impressions. Diameter as preserved (opened partially) about 12 mm.

V.40292 Figured Pl. 28, figs. 9, 10. Counterpart impressions of a capsule. *f. S. Gardner Coll.*, presumed to come from Bournemouth; perhaps from the Dorset pipe-clays.

INCERTAE SEDIS

Genus?

Plate 28, figs. 4, 5

A stiffly winged fruit or seed (V.40281) with one margin straight, the other smoothly convex. The fruit-(or seed-) body is at one end and appears to be embraced by the wing. This body is ovate, shortly stalked below, pointed above, slightly inflated. Its surface is rather rough but perhaps the roughness is not original, as parts of the wing and body are marked by circular scars and holes (possibly caused by insects). The wing appears to have had a stiff margin, due perhaps to a thickening or to a strand of fibres. Although its distal part is perfect in form, its cell structure is obscure but fine striations diverging from the straight margin may indicate the orientation of cells, and there are obscure hints of fine branching transverse fibres. Length of whole specimen, 17.5 mm.; length of body about 9 mm.; breadth of wing, 4.5 mm.

The form suggests a winged fruit rather than a seed, the body being seated upon or probably embedded within the winged fruit at one end. The straight sharply defined margin on one side suggests that there were originally a pair of such fruits or carpels united along this margin as in Sapindaceae, but the characters are not sufficiently distinctive to permit of determination. *W. R. Brodie Coll.* from Corfe clays, near Corfe with counterpart.

Genus?

Plate 29, fig. 24

DESCRIPTION. A flattened stiff-winged fruit or seed, wing broadening towards the apex which is slightly imperfect. Base narrow rounded, ventral margin straight, dorsal margin curved. The wing arises obliquely from the body. It was originally smooth and shining but its substance is now much decayed. Its surface is obliquely striate, the striae diverging from the body of the seed and from the straight margin of the wing. A narrow rim of wing embraces the base of the seed-body. Body semi-oval, surface, as preserved, slightly rugose and there is evidence of striations parallel with the curved inner edge from which the wing arises. Length of whole fruit as preserved, 15 mm.; length of straight margin, 11.5 mm.; length of body on straight margin, 6.5 mm.; greatest breadth of body, 4 mm.; greatest breadth of wing, 5 mm.

REMARKS. The shape of the wing and body and the direction of the striations and especially the straight margin of the wing suggest that the specimen is a fruit rather than a winged seed. It may be one of a pair of fruits attached to one another along the straight margin as in certain Sapindaceae e.g. *Thouinia* or *Toulicia*. The available data are insufficient for convincing determination. The specimen (V.40280) appears to be distinct from that described above. The body is semi-oval not ovate. The margin of the wing is less sharply defined and appears not to have been thickened, while the striations of the wing are more oblique and the surface is more puckered as if it were of thinner texture than that of the species in Pl. 28, figs. 4, 5. *W. R. Brodie Coll.*, from Corfe clays.

Undetermined Genera

- V.40285** Figured Pl. 29, figs. 1, 2. An impression with counterpart of a small stalked superior fruit with three pointed erect perianth segments visible (probably five in the complete whorl). The fruit appears to lie in a cup formed by the united lower part of the perianth, it may have been a subglobular berry, but the evidence is somewhat obscure. Length of fruit and calyx excluding stalk, 5 mm.; breadth, 2.75 mm. Length of stalk about 2 mm. On the same slabs closely adjacent to the fruit are the counterpart halves of a long lanceolate leaf thick textured with entire but very slightly and irregularly sinuous margin.
- V.40279** An impression of a fruit similar to the one above.
- V.40278** Figured Pl. 29, fig. 3. An impression of a fruit showing three superior persistent perianth segments. The specimen is seen from the side and shows the narrow triangular fruit below contracting towards the base. Fruit body with a few longitudinal ridges (furrows in impression). The perianth or wings show no nervation. The segments are erect and not spreading, united for about half their length, free above, narrow and pointed, probably at least five in the complete whorl. Length of specimen, 6.5 mm.; maximum breadth, 4.75 mm. Length of fruit below wings, 2 mm.; breadth at junction with wings, 1 mm.
- V.40282-83** Figured Pl. 29, figs. 4, 5. Two detached obovate or spatulate petals or wings of a fruit with fine nervation diverging from the narrow base and bifurcating and sometimes anastomosing above to form long narrow meshes. Several closely adjacent fine strands appear to form the midrib. Margin entire. Length of one specimen, 11 mm.; maximum breadth, 5.5 mm. Length of the second, 9 mm.; maximum breadth, 5 mm. These organs somewhat resemble the wings of *Loxostylis* (Anacardiaceae) or of *Abelia quadrialata* Reid & Chandler from the Bembridge Beds (1926: 133, pl. 8, figs. 29-31) but they may equally well be petals of a flower. The evidence is insufficient for determination.
- V.40293** Figured Pl. 29, fig. 6. A gamopetalous five-partite perianth, calyx or bract with spreading segments. Centre with small but deep depression. No nervation or structure can be detected owing to the poor condition of the surface. One specimen and incomplete counterpart. Greatest diameter slightly incomplete, 50 mm.; maximum breadth of segments, 6 to 9 mm.
- V.40288** Figured Pl. 29, fig. 7. A flower or fruit with four pointed rather narrow reflexed perianth segments each having several approximately parallel nerves. Centre of specimen obscure. Diameter of specimen about 10 mm. Length of one segment, 6 mm. Breadth of a narrow segment, 1.5 mm.
- V.40287** Figured Pl. 29, figs. 8, 9. A gamopetalous somewhat funnel-shaped perianth, five-partite above with pointed segments having convex sides and rather wide concavities between them. Nervation obscure but a midrib can be seen in each segment. There is a long curved style projecting well beyond the perianth (cf. fig. 8). Small square cells longitudinally aligned, about 0.02 mm. in diameter, can be seen on the surface of the perianth. Diameter about 7 mm.
- V.40291** Figured Pl. 29, figs. 10, 11. The counterpart impressions of a five-lobed perianth or five-partite gaping capsule. Segments curved and twisted each deeply bilobed at the distal end. Two lobes are distinctly larger than the other three. The condition of the specimen is poor, but traces of midrib and of sub-parallel longitudinal nerves can be seen. Maximum diameter about 27 mm.; breadth of segment about 6 mm.
- V.40290** Figured Pl. 29, fig. 13. A regular five-lobed gamosepalous flattened calyx (or corolla) with rounded lobes, entire margins and obscure nervation. The rim of the lobes is slightly thickened or stiffened. At the centre there is a circular scar about 3 mm. in diameter with indented margin, possibly the impression of stiff appendages. Two specimens, one imperfect, the other (V.40289) very obscure, may belong to the same species. Diameter across the most perfect specimen, 16 mm.; breadth of one of its segments, 4 mm.

- V.11862** Figured Pl. 29, fig. 12. Another similar calyx.
- V.40286** Figured Pl. 29, figs. 14, 15. A small obscure pod, convex along one margin straight along the other contracted to form a long tapering point at one end, concealed at the other by the calyx described below (fig. 15), flattened. It has a thin smooth semi-translucent rim almost 0.5 mm. broad, along the convex edge. Length (as exposed), 9 mm.; breadth, 2.5 mm.
- V.40286** Figured Pl. 29, figs. 14, 15. A specimen somewhat similar to that in figs. 8, 9 but seen from the side. It appears to represent a gamopetalous perianth having a somewhat contracted denser cup-like base and thick short stalk. There are free pointed segments above, the margin between the segments being rounded. Three segments only are seen, each has several parallel longitudinal nerves, the tip of one is broken. The form of the base suggests that a superior fruit lay within it the lobed bract forming a frill around it as in *Holmskioldia* (Verbenaceae) or *Grielum* (Rosaceae). Length of whole fruit including stalk, 6.5 mm. Length of stalk, 1.5 mm. Diameter, incomplete owing to broken free tip, 5.5 mm. (estimated complete diameter about 8 mm.). At first sight it is tempting to regard this specimen as a three-lobed bract like that of *Carpinus*, but the nervation definitely excludes this relationship.
- V.40284** Figured Pl. 29, fig. 23. A small elongate obovoid, more or less symmetrical, flattened fruit with rounded apex and obscure longitudinal ribs. It contracts to the long stalk but projects slightly beyond the stalk at its extreme base. Length including stalk, 11 mm.; breadth, 3.25 mm. near the apex. Length of stalk, 3.5 mm.

Valve of an unknown capsule

Plate 29, figs. 16–22

Seventeen concavo-convex coarsely striate organs, suboval in outline, lenticular in transverse section, five of which are figured. Seven have counterparts so that the external and internal impressions are seen, ten are represented by one impression only, seven being internal (convex) casts, and three external impressions. One (Pl. 29, fig. 16) may still be attached to a peduncle. The rounded furrows and ridges diverge from the ventral margin and sweep more or less transversely across the surface to the rounded dorsal margin. A few ridges fork, more rarely two may unite. They are occasionally very finely sinuous (Pl. 29, figs. 16, 22). At the upper margin of the valve a few ridges run parallel with the edge of the specimen giving a clear definition to its outline. Remains of an outer coat with convex cells (pits on the cast) about 0.03 mm. in diameter may be seen around the dorsal margin in one specimen, and near the point of attachment in another. Irregularities of the surface near the ventral margin may indicate the former position of a seed.

These puzzling objects appear to be casts of one valve of a dehisced carpel which has split marginally. They probably belong to some genus in which a more or less horny or papery lining detached from the outer coat shows the impression of a system of fibres between the two coats. Although these fibres which diverged from the ventral margin form ridges owing to the horny character of the inner coat no actual fibre structure is impressed through. Most of the specimens appear to be impressions of the inner surface of the horny detachable coat only. A structure producing this effect is seen in the carpels of Ochnaceae e.g. *Ochna* and *Gomphia*, and in Staphyleaceae (*Euscaphis*), and perhaps in some Rubiaceae. The genera examined show a somewhat coarser system of fibres more widely spaced than those of the fossil. The characters of the fossil do not seem to be sufficiently defined for satisfactory determination, nor should the attempt be made without very full knowledge of the internal structures of pods and capsules in many families. The plant nature of the specimens cannot now be doubted in spite of the temptation at a first glance to regard them as peculiar lamellibranchs or as gastropods with large outer whorl and minute spire. Length of two typical valves (approximately at right angles to the ridges), 7.5 mm.; breadth (parallel to the ridges), 5 mm.

- V.40307 Figured Pl. 29, fig. 16. A carpel, internal cast possibly still attached to an impression of a peduncle with remains of carbonaceous material. A pitted area around the dorsal edge may be the impression of part of the outer coat.
- V.40312 Figured Pl. 29, fig. 17. An obscure impression of another carpel. Also counterpart.
- V.40308 Figured Pl. 29, fig. 18. Another internal cast with ventral margin on the left. Also the counterpart external impression.
- V.40309 Figured Pl. 29, fig. 19. An internal cast. The irregularity of the surface near the ventral margin may indicate the former position of a seed.
- V.40311 Figured Pl. 29, fig. 20. An external cast again showing rugosities which may indicate the former position of a seed.
- V.40310 Figured Pl. 29, figs. 21, 22. Two counterpart impressions of a carpel showing the external and internal surfaces.
- V.40301, V.40304-06 Four carpels, represented by counterpart impressions.
- V.42022, V.40289, V.40298-V.40300, V40302-03 Seven impressions without counterparts, some show the internal surface, and some the external.
- All the above except V.40280-81 (pp. 163-166) *ŷ. S. Gardner Coll.*, from Bournemouth area. Probably from the Corfe or Poole pipe-clays.

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INDEX

New taxonomic names and the page numbers of principal references are printed in **Clarendon** type.

An asterisk * indicates a figure.

- Abelia quadrialata*, 165
Acacia, 5
Acalypha, 89
Acer, 10
Acorus, 57
Acrostichum, 4, 7-9, 19, 39
 lanzaeanum, 3, 4, 7, 14, **19**, **39**; Pl. 5, figs. 4, 5
Actinidia, 8, **111**, **113**
 crassisperma, **112**, **113**
 sp., 17, **111**; Pl. 16, fig. 1
Agyneia, 88
Alatospermum, 8, **119**
 lakense, 17, **119**, 120, 151; Pl. 16, figs. 20-25;
 Pl. 17, figs. 1-6
Alchornea, 87, 88
 Altenburg, Thuringia, 125
Altingia, 70-72
 Alum Bay, I.O.W., 10
Ammannia, 8, **118**, **119**
 japonica, 119
 lakensis, 17, **118**; Pl. 16, figs. 17-19
Ansonia, 139
 Anacardiaceae, 7, 16, 90, 91, 165
Andrachne, 83
 lakensis, **80**, 83; Pl. 11, figs. 1-6
Anemia, 8, 11, 40
 poolensis, 6-8, 14, 40, **41**, 123; Pl. 4, figs. 43-46;
 Pl. 5, figs. 1, 2
 subcretacea, 7, 10, 14, **40**, **41**; Pl. 5, fig. 3
 Anemieae, 40
 Angiospermae, 36, 50, 158
Anneslea, 113
 Apocynaceae, 7, 18, 138, 139
Apocynospermum, 138, 139
 acutiforme, 18, **139**; Pl. 22, fig. 2
 lakense, 18, **138**; Pl. 21, figs. 29, 30; Pl. 22, fig. 1
Aquilaria, 116
 Araceae, 15, 56, 57
Aracispermum, 56, 57
 arnense, 15, **56**, 57*; Pl. 7, figs. 9-12
Aralia, 4, 10, 11
Araucarites, 21, 23
 ARKELL, W. J., 2
 Arne, 3, 5, **6**, 7
 Asclepiadaceae, 139
Asplenium subcretaceum, 40
Asterinella, 32

Baccites rugosus, 124
 BANDULSKA, H., 157
Beta, 37
Blysmus, 51
 Boraginaceae, 7, 18, 140, 141, 152
 Bovey Tracey, Devon, 30, 135
Brasenia, 61, 146
Breynia, 84
Bridelia, 146
 BRODIE, P. B., 5
 BRODIE, W. R., 5
Bryonia, 145
Buracavia, 88
 BURTON, E. St. J., viii, 5
Burtonella, 4, **36**, 37, 66
 emarginata, 4, 15, **37**, **66**; Pl. 4, figs. 34, 35;
 Pl. 8, figs. 16-26
Bursera, 78, 79
 palmeri, 78
 Burseraceae, 7, 8, 15, 77-79

 Calameae, 15, 55, 56
Calamus, 8, 55
 daemonorops, 15, **55**; Pl. 7, fig. 6
Canarium, 78, 79
 Cantal, France, 141
 Capparidaceae, 4, 6-8, 15, **36**, 37, 66, 68, 69
Capparidispermum, 68
 eocenicum, 15, **68**; Pl. 9, figs. 16, 17
 Caprifoliaceae, 7, 8, 18, 144
Capsicum, 141, 143
Cardita planicosta, 3

- Caricoidea*, 52
arnei, 14, 53; Pl. 6, figs. 34, 35
minima, 14, 54; Pl. 7, fig. 1
obscura, 11, 14, 52, 53*, 54; Pl. 6, figs. 20-33
- Caricoideae, 14, 51, 52, 54, 55
 Genus?, 14, 55; Pl. 7, figs. 2-5
- Carpolithes* sp. 4, 130
- Carpolithus*, 147
arnensis, 18, 147, 148; Pl. 24, figs. 10-13
 spp., 18, 38, 119, 148-155; Pl. 24, figs. 14-20;
 Pl. 25, figs. 1-16; Pl. 26, figs. 1-22
 sp. 41, 156
- Cassia*, 5
- Cayratia*, 108
- Centrospermae, 37, 154
- Chaerospondias*, 91
axillaris, 91
- Chamaerops*, 162
- CHESTERS, K. I. M., viii
- Chrysodium lanzaeanum*, 19
- Cinnamomum*, 65, 66
- Cissus elongata*, 104
- Citrullus*, 145
- Cladium minimum*, 54
- Clematis*, 150
- Cleome*, 68, 69
gigantea, 68
violacea, 68
- Cleomella*, 37
angustifolia, 37
machrideana, 37
- Cleyera*, 8, 111-113
obliqua, 17, 111, 112; Pl. 17, fig. 7
- Cliff End, Mudeford, 3, 32, 34
- Cocculae, 62, 65
- Cocculinae, 62
- Cocculus*, 65
- COLENTT, G. W., 35
- Colwell Bay, I.o.W., 35
- Commiphora*, 78, 79
- Coniferales, 10, 20, 42
- Corfe, 4, 5
- Cornaceae, 7, 17, 18, 121, 122, 127, 130, 131
 Genus?, 131*, 137; Pl. 20, fig. 27; Pl. 21, fig. 23
- Cornoideae, 8, 18, 122, 129
- Cornus*, 8, 122, 130
quadrilocularis, 18, 130; Pl. 20, figs. 23-26
- Corokia*, 137
- Corylopsis*, 72
- COUPER, R. A., 20
- Crataeva*, 68
- Creech Barrow, 5
- Cruciferae, 154
- Cryptocarpa*, 91
- Cucurbitaceae, 7, 18, 144, 145, 156
- Cucurbitospermum*, 144
lakense, 18, 144; Pl. 23, figs. 11-14
- Cucurbitospermum*—continued
obliquum, 18, 145; Pl. 23, figs. 15-17
sheppeyense, 145
- Cupaniae, 164
- Cupanooides*, 5, 163, 164
 sp., 16, 163; Pl. 28, figs. 9, 10
- Cupressaceae, 49
- CURRY, D., 51
- Cyperaceae, 8, 9, 14, 50, 51, 54, 55, 141
 Genus?, 55; Pl. 7, figs. 2-5
- Cyphomandra*, 143
- Cyrtospermum*, 57
- Dactylaena*, 37
glazioviane, 37
pohliana, 37
- Daphne*, 116
gnidium, 116
laureola, 116
- Davidia*, 131
- DAVIS, A. G., 51
- Davisella*, 141
- Decodon*, 119, 120
- Dichidocarya*, 119, 120
- Dicotyledones, 15, 36, 58, 163
- Dilleniaceae, 7, 17, 111
- Diospyros*, 8, 133, 134
antiqua, 133
headonensis, 12, 18, 133; Pl. 20, figs. 28, 29;
 Pl. 21, figs. 1-5
montana, 133, 134
- Dorchester Museum, 3, 5, 159, 162
- Dracontocarya**, 8, 90, 91
glandulosa, 16, 90, 91; Pl. 12, figs. 10-21
- Dracontomelon*, 91
- Drupa rhabdosperma*, 74
- Dunstanian*, 8, 122, 129, 130
lakensis, 18, 129*; Pl. 20, fig. 22
multilocularis, 129
- Ebenaceae, 7, 18, 133
- Echitoideae, 139
- EDWARDS, W. N., 32
- Ehretia*, 8, 140, 141
cantalensis, 141
clausentia, 141
europaea, 141
lakensis, 6, 18, 140*; Pl. 22, figs. 3-11
- Ehretioideae, 140, 141
- Eleocharis acicularis*, 51
- Eomastixia*, 8, 122, 124, 125, 127, 128
bilocularis, 124, 125
rugosa, 12, 17, 124, 125, 127; Pl. 18, figs. 4-41;
 Pl. 19, figs. 1-7
urceolata, 17, 126, 127*; Pl. 19, figs. 8-13
- Epipremnum*, 57

- Ervatamia*, 139
Escallonia, 145
Euceratosa, 156
Euphorbia, 7
 Euphorbiaceae, 6-8, 16, 80, 83, 85, 87, 89, 146
Euphorbiospermum, 89
 punctatum, 16, 89; Pl. 12, fig. 5
 sp., 89; Pl. 12, fig. 6
Euphorbiotheca, 8, 80, 83, 84, 88
 digitata, 16, 80, 81, 84, 86, 87*, 88; Pl. 11,
 figs. 7-19
 lakensis, 16, 80-82*, 83; Pl. 11, figs. 1-6
 platysperma, 16, 80, 81, 83, 84; Pl. 11, figs.
 20-23
 spp., 16, 88; Pl. 11, figs. 24, 25
 tuberculata, 16, 80, 81, 85; Pl. 12, figs. 1-4
Eurya, 113
Euscaphis, 166
- Ficus*, 4, 5, 8, 10, 36, 58
 lucidus, 15, 58*; Pl. 7, figs. 13-18
 sp., 4, 15, 36; Pl. 4, fig. 33
 Filicales, 19, 39
Fimbristylis dichotoma, 51
 diphylla, 51
 vahlîi, 51
Flabellaria raphifolia, 158
 Flacourtiaceae, 7, 17, 114
Fortisia lanzaeana, 19
 Furzeybrook Clay Pit, Corfe, 3, 5
- GARDNER, J. S., vii, 1, 2, 5
 Geological Survey & Museum, 5
Gnidia
Gomphia, 166
Gordonia, 17, 114; Pl. 16, figs. 2-4
Grielum, 166
 Gymnospermae, 14, 20, 42
- Hamamelidaceae, 7, 15, 69-71, 163
 Hamamelidoideae, 72
 Genus?, 15, 72; Pl. 8, figs. 27, 28
Hamamelis, 72
 Hamstead, I.O.W., 35
Hantsia, 154
 HARRIS, T. M., 157
 Hengistbury, 34, 104
Holarrhena, 139
Holmskioldia, 166
 Hordle, vii, 34
Hordwellia, 8, 112, 113
 crassisperma, 12, 17, 112; Pl. 17, figs. 8-61
Hypserpa, 65
- Icacinaceae, 7, 8, 16, 95, 98, 99
Icacinicarya, 6, 98, 99
 inornata, 6, 7, 16, 98*, 99; Pl. 13, figs. 20-24;
 Pl. 14, figs. 1, 2
 platycarpa, 99
Iodes, 8, 95-97
 acutiformis, 16, 95; Pl. 13, figs. 1-5
 corniculata, 95
 multireticulata, 97
- Juglans*, 10
- Kydia*, 4
- Lauraceae, 7, 10, 15, 65
Laurocarpum, 10, 65
 spp., 15, 65; Pl. 8, figs. 12-15
Laurus, 10
Lagerstroemia, 151
 Lake, nr. Hamworthy, 5-7
Lanfrancia, 127
Lansea, 8, 92
 caffra, 92
 sp., 16, 92; Pl. 12, fig. 22
 Leguminosae, 4, 10, 15, 72
 Genus?, 15, 72; Pl. 9, fig. 25
 Lepidocaryinae, 55, 56
Leucosmia, 116
Liquidambar, 4, 11, 70-72
Livistona, 162
 Lower Swanwick, 51
Loxostylis, 165
Lycopersicum, 143
 Lygodiaceae, 20, 40
Lygodium, 4, 8, 20, 40
 kaulfussi, 4, 14, 20
 poolensis, 6, 14, 40
 reticulatum, 14
 scandens, 14
 Lytchett, nr. Poole, 3
 Lythraceae, 7, 8, 17, 118, 119, 141, 151
Lythrum japonicum, 119
- Marattia hookeri*, 11
Mastixia, 8, 122, 123, 125-129
 cantiensis, 8, 17, 122, 123; Pl. 18, figs. 1-3
 euonymoides, 129
Mastixicarpum, 8, 122, 127, 129
 compactum, 125, 129
 crassum, 12, 17, 123, 128, 129; Pl. 19, figs.
 14-23; Pl. 20, figs. 1-4
 Mastixioideae, 6-8, 17, 121, 122, 127

- Meliosma*, 8, 100
sheppeyensis, 8, 16, 100, 123; Pl. 14, figs. 3, 4
 sp., 16, 100; Pl. 14, figs. 3, 4
 Menispermaceae, 6-8, 15, 61, 65, 123
Menispermum, 65
Metasequoia, 21
 Monocotyledones, 14, 50, 158
 Moraceae, 7, 15, 36, 58, 59, 148
 Myrsinaceae, 148
- Natsiatum*, 8, 96, 97
eocenicum, 8, 10, 12, 16, 96, 97; Pl. 13, figs. 6-16
sinense, 97
Nipa, vii, 9
Nummulites prestwichianus, 3
Nymphaea, 60, 61
 Nymphaeaceae, 8, 15, 60, 61
Nyssa, 121
 Nyssaceae, 8, 17, 120, 121
 Nyssoidae, 8, 120
 eocenica, 12, 17, 120, 121; Pl. 20, figs. 5-21
- OAKLEY, K. P., 156
Ochna, 166
 Ochnaceae, 166
 Olacaceae, 148
Oncoba, 8, 114, 115
 echinata, 115
 rugosa, 12, 17, 114, 115*; Pl. 16, figs. 5-10
 Ovicarpium reticulatum. 52
- Palaeobursera*, 8, 77
 bognorensis, 78
 lakensis, 15, 77, 79; Pl. 10, figs. 20-26
 sp., 77
Palaeocleome, 6, 67-69
 lakensis, 8, 15, 67; Pl. 9, figs. 1-15
Palaeococculus, 8, 63, 65
 lakensis, 15, 63, 64*, 123; Pl. 7, figs. 23-29;
 Pl. 8, figs. 1-3
Palaeonymphaea, 60, 61
 eocenica, 11, 15, 60; Pl. 7, figs. 19, 20
Palaeophytocrene, 8, 97
 foveolata, 8, 16, 97, 98, 123; Pl. 13, figs. 17-19
Palaeospatha daemonorops, 55
Palaeothrinax mantelli, 162
Palmacites daemonorops, 55
 Palmae, 7, 14, 55, 158, 160*, 161*
Peddica, 116
Pemphis, 120
Petalostigma, 87, 88
Phellodendron, 8, 73, 75
 costatum, 15, 73; Pl. 10, fig. 1
 Phyllanthoideae, 16, 80, 83, 85
 Phytocreneae, 97, 98
Pimelea, 116
 Pipe-clay Series, 5, 39
- Plexiplica*, 125
 reidii, 124, 125
 rugosa, 124, 125
 Plumierioideae, 18, 138, 139
Podocarpus, 11
 elegans, 11
 Polypodiaceae, 8, 14, 19, 39
Porana, 10
 oeningensis, 10
 Proteaceae, 10
Protium, 78, 79
Protoaltingia, 69, 70, 163
 eocenica, 71, 163
 hantonensis, 5, 10, 12, 15, 69-71, 163; Pl. 9,
 figs. 18-24; Pl. 28, figs. 6-8
Protocommiphora, 78, 79
 Pteridophyta, 14, 19, 39
- Quercus*, 10
- Reading Beds, viii
 Redend Sandstone, 4, 19
 Resedaceae, 37
 Reuver, 156
 Rhamnaceae, 145
Rhamnospermum, 145, 146
 bilobatum, 7, 8, 13, 18, 123, 146; Pl. 23, figs.
 18-38; Pl. 24, figs. 1-9
Rhamnus, 145
 Rhodales, 36, 37, 66
 Rhoideae, 16, 92
Rhus, 8, 92, 93
 lakensis, 16, 93, 94; Pl. 12, figs. 23-26
 spp., 16, 93, 94; Pl. 12, figs. 27-29
- RICHARDS, P. W., 2
 RIDLEY, H. N., 3
 Rosaceae, 8, 15, 38, 166
 Rubiaceae, 166
Rubus, 8, 38
 acutiformis, 4, 11, 15, 38; Pl. 4, figs. 36-40
Ruta, 155
 Rutaceae, 7, 8, 15, 73-76
Rutaspermum, 8, 73, 74, 76
 excavatum, 12, 15, 73, 74, 77; Pl. 10, figs. 2-13
 glabrum, 15, 75; Pl. 10, figs. 16-18
 magnificum, 15, 76, 77; Pl. 10, fig. 19
 striatum, 15, 75, 76, 77; Pl. 10, figs. 14, 15
- Sabal*, 56, 162
 sp., 15, 56; Pl. 7, figs. 7, 8,
 Sabiaceae, 7, 16, 100
 Salicineae, 5
Sambucus, 8, 144
 parvula, 13, 18, 144; Pl. 23, figs. 1-10
 Sandrock, 4, 19

- Sapindaceae, 10, 16, 163-165
 Sapotaceae, 7, 18, 132
Sapotocarpum, 132, 133
 sp., 18, 132*; Pl. 21, figs. 6-9
 Saxony, 125, 129
 Schizaeaceae, 7, 14, 20, 40
 Scirpoideae, 50, 51
Scirpus, 8, 50, 51, 52, 68
lakensis, 6, 11, 14, 50, 51; Pl. 6, figs. 7-18
setaceus, 51
 sp., 14, 52; Pl. 6, fig. 19
Securinega, 83
 Sedgwick Museum, Cambridge, vii, 5, 10
 Selsey, Sussex, 1
Sequoia, 8, 20, 21
couttsiae, 4, 8, 11, 14, 20-22*, 23, 25*, 27*, 28*,
 29*, 31*, 33, 34; Pls. 1-3; Pl. 4, figs. 1-32
Sinomenium, 65
Sinowilsonia, 72
 Solanaceae, 7, 18, 141-143
Solanispermum, 142
reniforme, 12, 18, 142; Pl. 22, figs. 14-22
Solanum, 8, 141
arnense, 18, 141, 142*; Pl. 22, figs. 12, 13
marginatum, 142
 Southbourne, 32, 33
Spathiphyllum, 57
 Spondieae, 7, 8, 16, 90, 91
 Staphyleaceae, 166
Stillingia, 88, 89
 Studland, 3, 4, 19, 30
 Styracaceae, 7, 8, 18, 137
Styrax, 8, 137
elegans, 12, 18, 137, 138; Pl. 21, figs. 24-28
japonicum, 138
 Symplocaceae, 7, 18, 134, 137
 Genus?, 137; Pl. 21, fig. 23
Symplocos, 7, 8, 134, 135, 137
anglica, 135
headonensis, 18, 135, 136; Pl. 21, figs. 19, 20
lakensis, 18, 134, 135; Pl. 21, figs. 10-18
 spp., 18, 136; Pl. 21, figs. 20-22
 Taonabeae, 17, 111-113
 Taxodiaceae, 49
 Taxodineae, 7, 14, 20, 42
Taxodium, 8, 42, 49
europaeum, 49
lakense, 14, 42, 43*-47*, 49; Pl. 5, figs. 6-16;
 Pl. 6, figs. 1-6
 Teredo-bored wood, 3, 7
Tetrastigma, 8, 110, 111
acuminata, 17, 110, 111; Pl. 15, figs. 39, 40
lobata, 17, 110, 111; Pl. 15, figs. 35-38
 Theaceae, 7, 8, 17, 111, 113, 114
 Genus?, 114; Pl. 16, figs. 2-4
Thouinia, 165
Thymelaea, 116
 Thymelaeaceae, 7, 8, 17, 115, 116, 118
Thymelaeaspermum, 116
lakense, 17, 116, 117; Pl. 16, figs. 11-15
sulcatum, 17, 117; Pl. 16, fig. 16
Tiliacora, 65
Tinospora, 7, 8, 61
arnensis, 15, 61, 62; Pl. 8, figs. 4-10
excavata, 8, 61, 62, 123; Pl. 8, fig. 11
wilkinsoni, 61, 62
 Tinosporeae, 61
Toulicia, 165
Tovaria, 69
Trachycarpus, 8, 158, 162
raphifolia, 14, 158, 159*, 162; Pl. 28, figs. 1-3
Tricarpellites, 78, 79
 Tuber, 157
 Turów, Poland, 103
 Turritellae, 3
 Urticaceae, 148
 Verbenaceae, 166
Victoria, 61
Vinca, 139
Visnea, 113
 Vitaceae, 6, 7, 16, 17, 100
Vitis, 8, 100
ambigua, 16, 108; Pl. 15, figs. 27, 28
arnensis, 16, 107, 109; Pl. 15, figs. 20-26
cuneata, 16, 102; Pl. 14, figs. 45, 46
excavata, 16, 108; Pl. 15, figs. 29, 30
glabra, 17, 103, 104, 107, 109; Pl. 14, figs.
 49-53
goodharti, 17, 101; Pl. 14, figs. 32-44
lakensis, 17, 102; Pl. 14, figs. 47, 48
lanata, 103
lusatica, 103
platysperma, 17, 104, 109; Pl. 15, figs. 1-5
poolensis, 17, 106; Pl. 15, figs. 16-19
pygmaea, 8, 10, 12, 17, 100, 101, 123; Pl. 14,
 figs. 5-31
 spp., 17, 103, 104, 106, 109; Pl. 15, figs. 14, 15,
 31-34; Pl. 26, figs. 23, 24
symmetrica, 17, 105; Pl. 15, figs. 6, 7
teutonica, 103
thunbergii, 103
triangularis, 17, 105, 106; Pl. 15, figs. 8-13
 Wardenia, 8, 62, 63
poolensis, 7, 15, 62; Pl. 7, figs. 21, 22
Wetherellia, 89, 90
variabilis, 7, 8, 16, 89, 123; Pl. 12, figs. 7-9

WHITE, E. I., viii
Whitecliff Bay, I.o.W., 1
Wikstroemia, 116
WONNACOTT, F. M., vii, viii
WOODWARD, A. S., vii

Zanthoxyleae, 74
Zanthoxylon, 74, 75
 bungei, 74
 costatum, 74
 ornatum, 77

PLATES



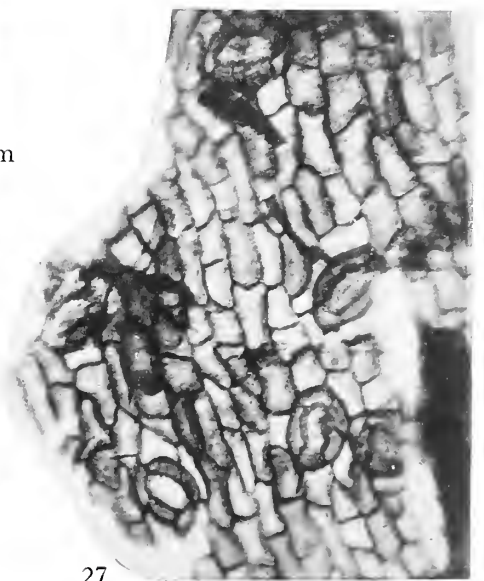
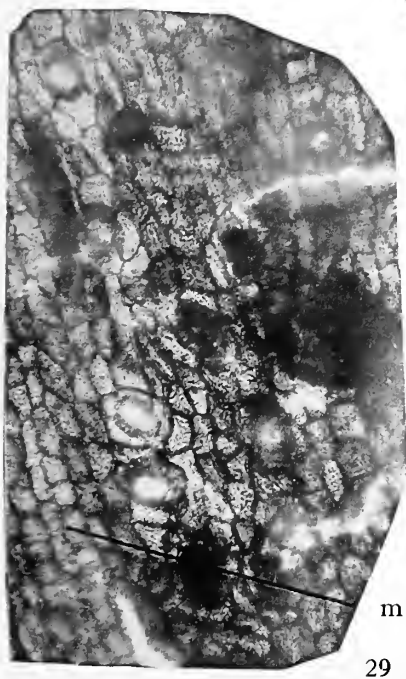
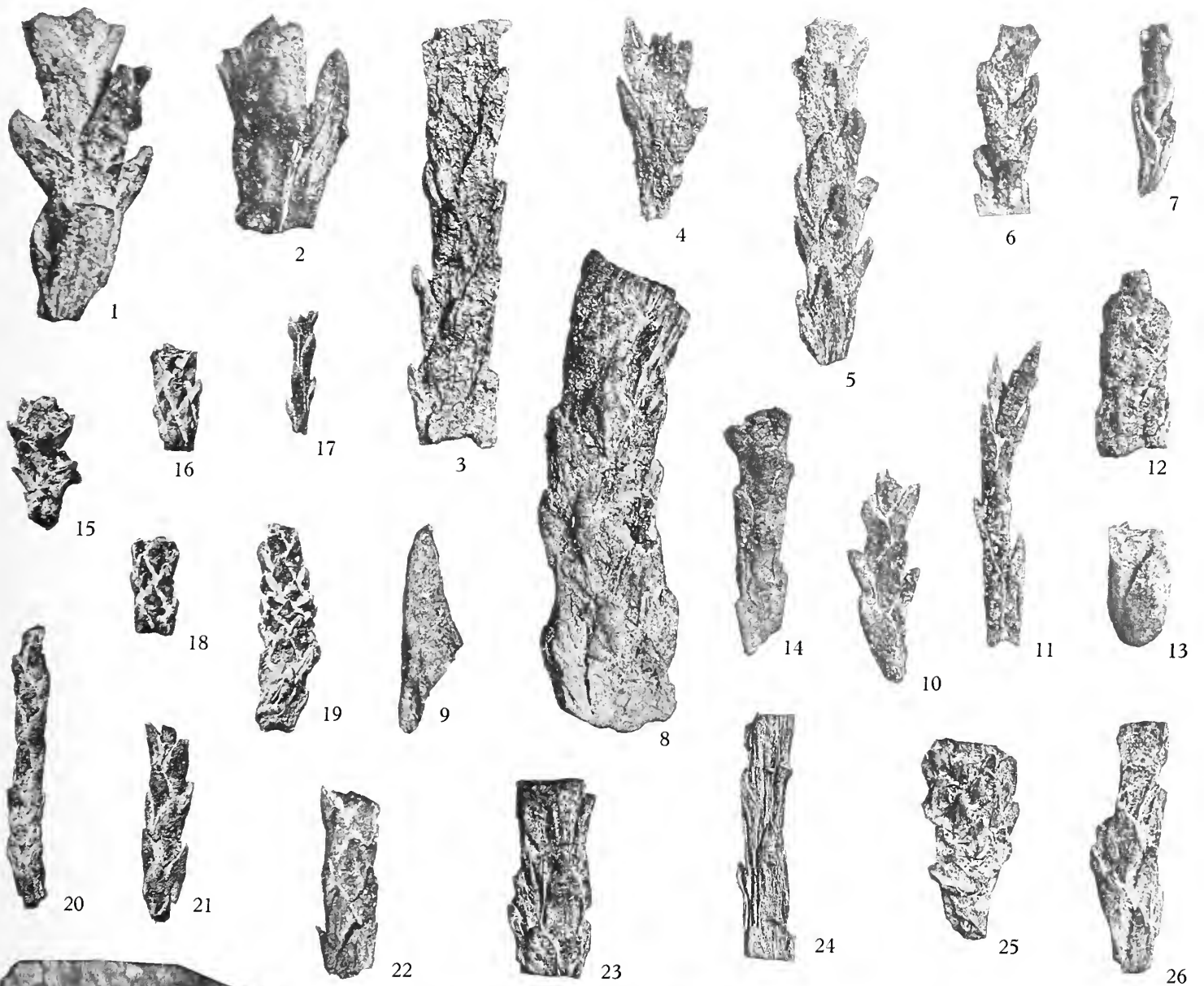


Explanation of Plate 1

- Fig. **Sequoia couttsiae** Heer p. 20
1. Small fragment of twig. $\times 15$. V.40317.
 2. Another. $\times 15$. Destroyed to yield cuticle in Pl. 1, fig. 27.
 - 3, 4. Two fragments of twig. $\times 6.5$. V.40322, V.42350.
 - 5-7. Three small fragments of twig. $\times 6.5$. V.40325.
 8. Thicker twig. $\times 3$. V.40325.
 9. Large detached leaf probably of this species. $\times 6.5$. Destroyed.
 - 10, 11. Two twigs. $\times 6.5$. V.40331, V.42351.
 - 12, 13. Two twigs. $\times 6.5$. V.40339.
 14. Twig. $\times 6.5$. Destroyed.
 - 15-21. Seven twigs. $\times 4$. V.20015, V.40341.

- Fig.
22. Twig. $\times 6.5$. Decayed.
 - 23-26. Four twigs. $\times 5$. V.40349.
 27. Stomatal band of dorsal cuticle of a leaf. $\times 220$. V.40318a.
 28. Dorsal cuticle of a leaf showing part of a stomatal band and at *m* ordinary epidermal cells over the midrib. $\times 230$. Decayed.
 29. Dorsal cuticle showing part of a stomatal band and at *m*, a few of the ordinary epidermal cells over the midrib. $\times 213$. V.40343.

Figs. 1, 2, 27 Studland; Figs. 3-9 Southbourne, Figs. 3, 4 leafy lenticle, cliff base, Figs. 5-9 Lignite above Boscombe Sands; Figs. 10, 11 Cliff End, Mudford; Figs. 12-14 Hengistbury Head, Figs. 12, 13 marine clays between 22 and 40 ft. above basal pebble bed, south-east face, Fig. 14 dark sands, cliff base, west end; Figs. 15-21, 29 Hordle; Fig. 22 Colwell Bay; Figs. 23-26 Hamstead; Fig. 28 Lignite, Bovey Tracey.



SEQUOIA

Explanation of Plate 2

Fig.

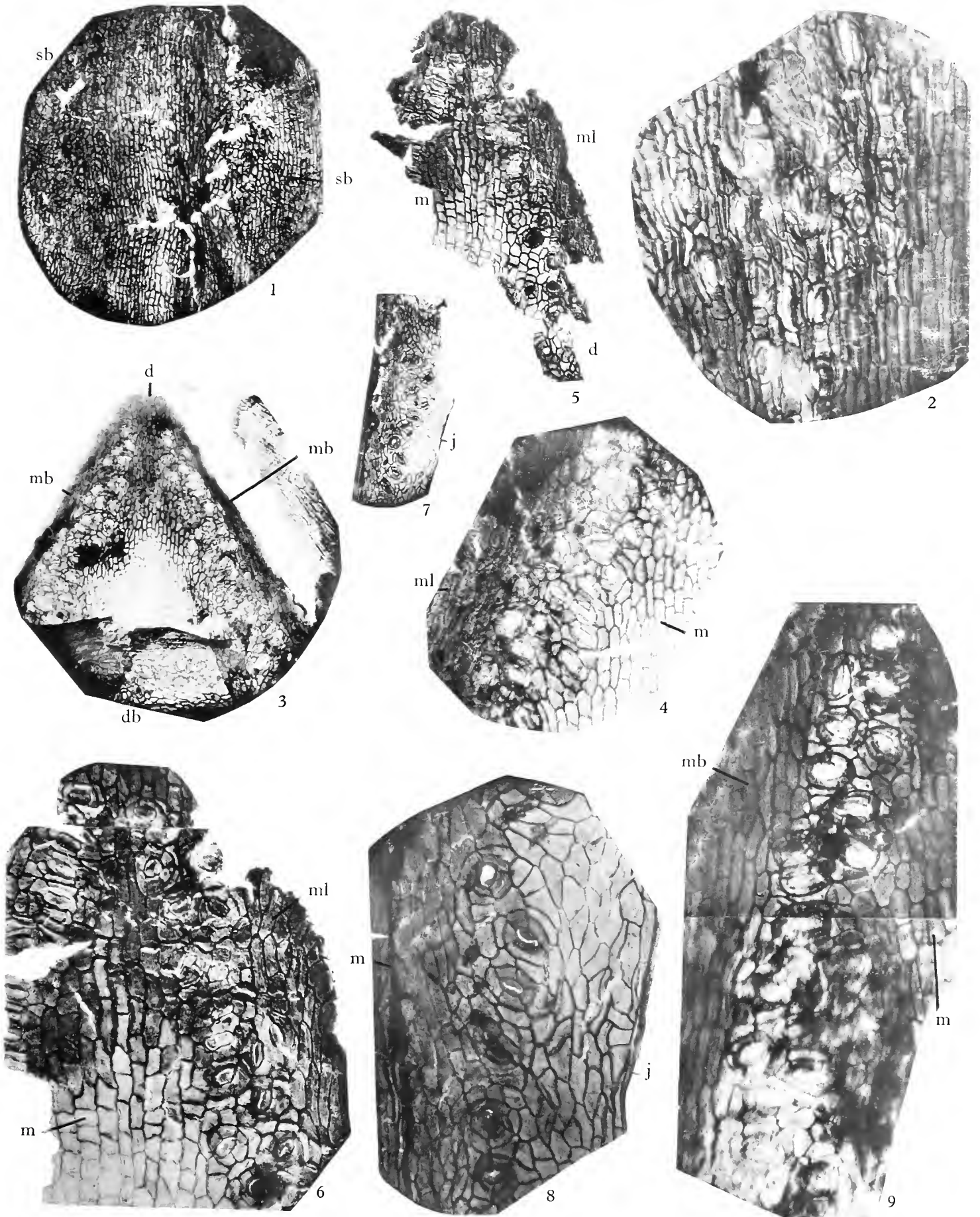
Sequoia couttsiae Heer p. 20

1. Dorsal cuticle from decurrent basal part of a leaf. The stomatal bands, *sb*, flank the band of ordinary epidermal cells over the midrib. Cuticle partly obscured by fungal hyphae especially on the left. $\times 67$ approx. V.40324.
2. Dorsal cuticle. A stomatal band is conspicuous. $\times 220$. This fragment was attached to that shown in Pl. 2, figs. 7, 8, being from the same leaf. V.40334.
3. Ventral cuticle of the free upper part of a broad leaf. The ventral decurrent basal part of one side of another leaf lies across it at the base of the figure at *db*. The upper edge of this fragment adjoined the dorsal cuticle at the leaf margin. The lower edge was joined to the twig. The free leaf tip shows the two stomatal bands separated by the median band of ordinary epidermal cells over the midrib. The marginal bands of ordinary epidermal cells, seen at *mb*, are opaque. At *d* part of the stomata free leaf tip is seen. $\times 57$. V.40319.
4. Ventral cuticle of another leaf showing part of one stomatal band. Guard cells and slits between them are clearly shown. *m* is the band of ordinary epidermal cells over the midrib and *ml* one marginal band. $\times 150$. V.40319.
5. A large part of the ventral cuticle of a young leaf showing the right-hand stomatal band and the upper end of the left-hand stomatal band. Ordinary epidermal cells of the marginal band are at *ml* and of the middle over the midrib at *m*. This middle band almost disappears near the apex where the two stomatal bands nearly meet. Part of the right decurrent flange is preserved at *d*. $\times 96$. V.40333.

Fig.

6. Part of the same showing auxiliary and guard cells of the stomata and the slightly sinuous character of the median epidermal cells in this young leaf. *ml* and *m* as in Fig. 5. $\times 230$.
7. Part of the ventral cuticle of a decurrent leaf base. Leaf margin to left, junction with twig, *j*, to right. $\times 59$. V.40334.
8. Part of the same ventral decurrent flange. The dark line at *m* marks the leaf margin beyond which is a fragment of dorsal cuticle. The finished margin at *j* marks the junction of the decurrent flange with the twig. $\times 204$.
9. Part of a ventral cuticle showing the left stomatal band, marginal, *mb*, and median, *m*, bands of ordinary epidermal cells. $\times 290$ approx. V.40318a.

Fig. 1 leafy lenticle, cliff base, Southbourne; Figs. 2, 5-8 Cliff End, Mudeford; Figs. 3, 4 Lignite, Bovey Tracey; Fig. 9 Studland.



SEQUOIA

Explanation of Plate 3

Fig.

Sequoia couttsiae Heer p. 20

1. Ventral (left of dotted line) and dorsal (right of line) cuticle of a leaf tip. The ventral side is almost complete except for the decurrent flanges but has split longitudinally along the right stomatal band, *s*. *m*, the median band of ordinary epidermal cells; *ml*, the leaf margin between the ventral and dorsal cuticles. The dorsal cuticle shows the stomata free tip and the asymmetric development indicated by a dark longitudinal line at *r* which marks the dorsal angle over the midrib. $\times 58$. V.40324.
2. Another ventral cuticle somewhat contracted along the midrib, *m*. Stomatal bands, *sb*, are both visible but that on the right is torn along its outer edge and is very incomplete. Left marginal band of ordinary epidermal cells at *ml*. Right margin of dorsal cuticle showing ordinary epidermal cells is at *d*. $\times 100$ approx. V.40323.
3. Left stomatal band of the same. *m*, midrib; *ml*, marginal epidermal band. $\times 200$ approx.
4. Part of ventral cuticle of a decurrent leaf base. Margin of leaf to left, junction with twig at *j*. $\times 130$. V.40340.
5. Free tip of a very young leaf, ventral cuticle (extreme apex missing). Two stomatal bands show large stomata. The median band of ordinary epidermal cells, *m*, lies between them. Marginal band of ordinary epidermal cells is at *ml*. $\times 140$ approx. V.40340.
6. Part of the same. The stomatal bands are seen uniting at the apex. The majority of the large stomata show a single ring of auxiliary cells. $\times 222$.

Fig.

7. Right stomatal band (ventral) of an older leaf. The double ring of auxiliary cells around the stomata can be seen although all structure is much obscured by fungal hyphae. *m*, median band of ordinary epidermal cells over midrib. *ml*, marginal band of epidermal cells. $\times 208$. V.40342.
8. Another young leaf, ventral cuticle with decurrent flanges, *d*, preserved. $\times 59$. V.40343.
9. Part of a ventral cuticle showing median band, *m*, of ordinary epidermal cells (slightly imperfect below), left stomatal band and the tip of the right band, *sb*. In the latter the guard cells and pores show particularly clearly. $\times 100$ approx. V.40347.
10. Lower part of left stomatal band of the above. *m*, marginal ordinary epidermal cells. $\times 210$ approx.
11. Central part only of ventral cuticle from a free leaf tip. Parts of the two stomatal bands, *sb*, are shown and the median band of ordinary epidermal cells over the midrib is at *m*. The junction with the twig is indicated by the curved thickened edge at the base. Decurrent flanges not preserved. $\times 100$. V.40349.
12. Left stomatal band of same. $\times 209$.
13. Lowest stoma preserved from the right stomatal band shown in Fig. 11. $\times 209$.

Figs. 1-3 leafy lenticle, cliff base, Southbourne; Figs. 4-8 Hordle; Figs. 9, 10 Colwell Bay; Figs. 11-13 Hamstead.



SEQUOIA

Explanation of Plate 4

- Fig. Sequoia couttsiae** Heer p. 20
1. Carbonaceous cone embedded in an ironstone slab. $\times 1$ approx. V.42349.
 2. Detached cone-scale, outer surface, from basal end of a cone. $\times 5$ approx. V.40352.
 3. Apical cone-scale, showing stalk and (in profile) the escutcheon. $\times 5$ approx. V.40352.
 4. Another scale, upper surface. $\times 5$ approx. V.40352.
 5. Carbonaceous cone showing a few seeds, *s*, in position of growth. $\times 2$. V.20012.
 - 6, 7. Large apical scale, side (Fig. 6) and apex (Fig. 7). $\times 6.5$. Decayed.
 8. Half a scale, escutcheon, outer surface. $\times 6.5$. V.40345.
 - 9, 10. Two much corroded seeds. In Fig. 9 abrasion clearly displays the limits of body and wing. $\times 6.5$. V.40332, V.40338.
- 11–18. Eight seeds. The hilar scar, *h*, is very clearly shown in Figs. 12–14. $\times 4$. V.20014.
- 19–27. Six seeds. Those in Figs. 23–26 show the two surfaces of a single valve of seeds which have split marginally into two equal valves, Figs. 24, 26 being the inner surface so that the seed-cavity is clearly displayed flanked by wings. Wings in Figs. 23, 24 are much abraded. Figs. 20, 21 show opposite sides of an undehisced seed. In Fig. 20 the hilar scar, *h*, is clearly seen. In Fig. 19 the apical stylar mucro is conspicuous, seed little abraded but wings narrow. In Fig. 22 wings worn away and body curved. In Fig. 27 body much curved, style to the left at *m*. $\times 6.5$. V.40346.
- 28–32. Five seeds showing variations of form and size. The hilar scar, *h*, is clearly shown in Figs. 29, 30. $\times 5$. V.40351.
- Ficus** sp. p. 36
33. Endocarp. $\times 15.5$. Decayed.
- Fig. Burtonella emarginata** n. gen. & sp. p. 37
34. Holotype. Seed showing surface ornamentation and emargination between the limbs for comparison with a poorly preserved seed in Fig. 35. $\times 15.5$. V.40353.
 35. Much compressed seed with reticulate surface. $\times 15.5$. Decayed.
- Rubus acutiformis** Chandler p. 38
- 36, 37. Two much compressed and shrunken endocarps. $\times 15.5$. V.40355, V.42353.
 38. Endocarp for comparison. $\times 15.5$. V.40356.
 - 39, 40. Two well preserved specimens for comparison. $\times 15$. V.20058. Fig. 39 decayed.
- Carpolithus** sp. p. 38
41. Crumpled seed. $\times 15.5$. V.40357.
- Unknown Organ p. 38
42. Unknown organ showing resin-like exudations, *r*. $\times 15.5$. V.40358.
- Anemia poolensis** Chandler p. 41
43. Pair of fertile pinnules, upper surface showing alignment of cells over midrib. *st*, broken stipe. $\times 15$. V.31539.
 44. Single recurved fertile pinnule showing distinct segments, broken stipe behind at *st*. Note transverse alignment of cells over middle of median segment in the figure. $\times 15$. V.31490.
 45. Another fertile pinnule. *st*, broken stipe; *b*, segment with broken tip; *p*, typical toothed segment. $\times 15$. V.31544.
 46. Same, opposite side. *st*, stipe. $\times 15$.
- Figs. 1–4, 28–32 Hamstead; Figs. 5, 11–18, 39, 40 Hordle; Figs. 6, 7, 9, 10 Cliff End, Mudeford; Figs. 8, 19–27 Colwell; Figs. 33, 35–37, 41, 42 Studland; Figs. 34, 43–46 Lake; Fig. 38 Branksome Dene.



SEQUOIA, FICUS, BURTONELLA, RUBUS, CARPOLITHUS,
UNKNOWN ORGAN, ANEMIA

Explanation of Plate 5

Fig.

Anemia poolensis Chandler p. 41

1. Three attached terminal fertile pinnules, all tightly enrolled, lower surface. $\times 15$. V.40807.
2. Pair of fertile pinnules showing tips of toothed segments, lower surface, *s*, stipe. White patches are sand grains. $\times 15$. V.40869.

Anemia subcretacea (Saporta) p. 40

3. Pinnule fragment in same matrix as fronds in Figs. 4, 5. The fragment shows repeated dichotomous forking of the nerves. $\times 3$. Decayed.

Acrostichum lanzaeanum (Visiani) p. 39

- 4, 5. Matted mass of silt with embedded pinnules showing characteristic reticulate nervation. $\times 1.6$. V.40277.

Taxodium lakense n.sp. p. 42

- 6, 7. Two typical imbricate twigs. $\times 6.5$. Fig. 6 holotype. V.40359-60.
- 8-13. Six twig fragments. $\times 6.5$. V.40389, V.42358-62.

Fig.

14. Upper cuticle of the free part of an imbricate leaf of which only the lower half near the junction with the twig is preserved. It shows the thickened cell walls, transversely elongate epidermal cells over the median area, *m*, and two stomatal bands, *sb*, with scattered rounded stomata. Diverging marginal epidermal cells are seen. *j* is the junction with the lower cuticle, *d*, at the leaf margin. $\times 60$. V.40361.
15. Lower cuticle of the same leaf, tip only. It shows the median epidermal cells over the midrib and a few scattered rounded stomata in the stomatal bands which flank it on each side. $\times 60$ approx.
16. Another leaf, basal cuticle, dorsal surface. At *v* is the still attached ventral decurrent flange forming the left extremity of the figure, its junction with the dorsal cuticle at the leaf margin indicated by a dark line *m, m*. It shows numerous close-set stomata. The dorsal cuticle shows thick inflated cells and part of the left stomatal band with sparsely scattered stomata. Right stomatal band and right leaf margin are not seen. $\times 60$ approx. V.40362.

Figs. 1-5, 8-13 Arne; Figs. 6, 7, 14-16 Lake.



3



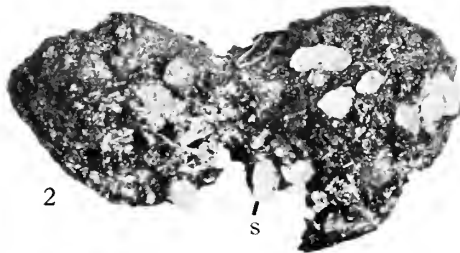
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s



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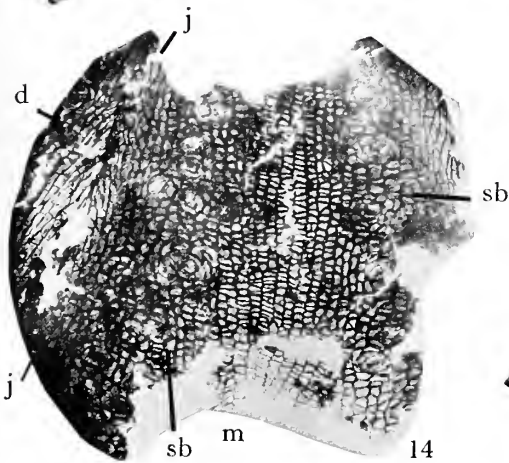
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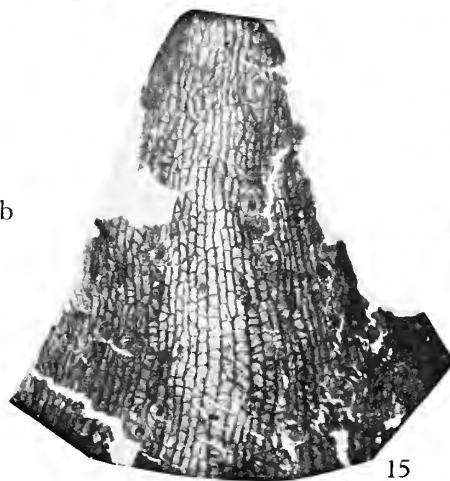
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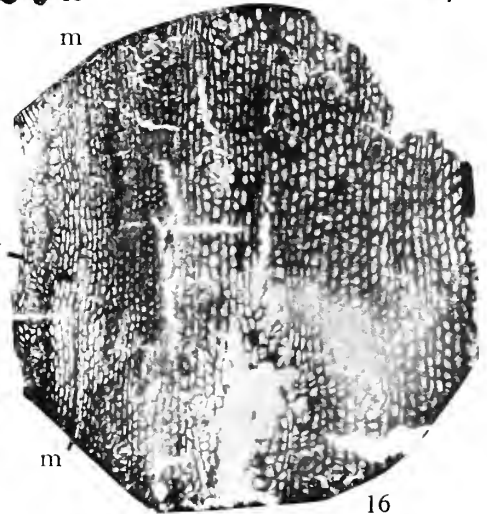
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15



16

ANEMIA, ACROSTICHUM, TAXODIUM

Explanation of Plate 6

Fig.

Taxodium lakense n.sp. p. 42

1. Lower cuticle of scale-like leaf from an imbricate twig. The left-hand margin with divergent cells is at *mv*, right-hand margin also visible. Leaf tip not preserved. The two stomatal bands with numerous stomata lie one each side of the midrib, *m*, which is overlain by a median band of ordinary epidermal cells. $\times 60$. V.40363.
2. Same, left-hand side showing thickened inflated, reticulate cell walls. Radially arranged auxiliary cells are seen around the stomata, also the pair of scales between guard cells and auxiliaries in each stomatal apparatus. Divergent marginal epidermal cells are clear. $\times 136$.
3. Stoma with seven auxiliary cells from the base of a young leaf (dorsal) with thin cell walls. The pore is obscured by thick cuticle. $\times 208$. V.40373.
4. Outline drawing to explain Fig. 3 with the auxiliary cells numbered 1-7. The stoma is more vertically orientated than in Fig. 3.
5. Male cone. $\times 10$. V.40386.
6. Same differently lighted to show scales which are obscure in Fig. 5. $\times 10$.

Scirpus lakensis Chandler p. 50

7. Holotype. Fruit with carbonaceous outer coat rarely ever preserved. $\times 20$. V.40397.
8. Same. $\times 30$.
9. Same, opposite side. $\times 20$.
10. Much abraded fruit showing the inner lining layers. $\times 20$. V.40398.
11. Typical abraded specimen showing ladder-like effect of the cell arrangement in the shining inner coat. $\times 16$. V.40399.
12. Longer narrower abraded specimen. $\times 16$. V.40400.
13. Another fruit with ragged remains of the partially abraded coat. The distinctive cell arrangement is again seen. $\times 16$. V.40401.
14. Similar specimen. $\times 16$. V.40402.
15. Abraded fruit with long style preserved and ragged remains of an outer coat. $\times 15$. V.40396.

Fig.

16. Typical abraded specimen. $\times 15$. V.41924.

17. Another partially macerated and therefore semitranslucent. $\times 25$ approx. V.41924.
18. Seed from another specimen. $\times 25$ approx. Decayed.

? **Scirpus** sp. p. 52

19. Fruit with outer layers preserved, possibly a distinct species as the contracted basal neck is not seen. Three out of five longitudinal ridges are visible in the figure. $\times 16$. V.40406.

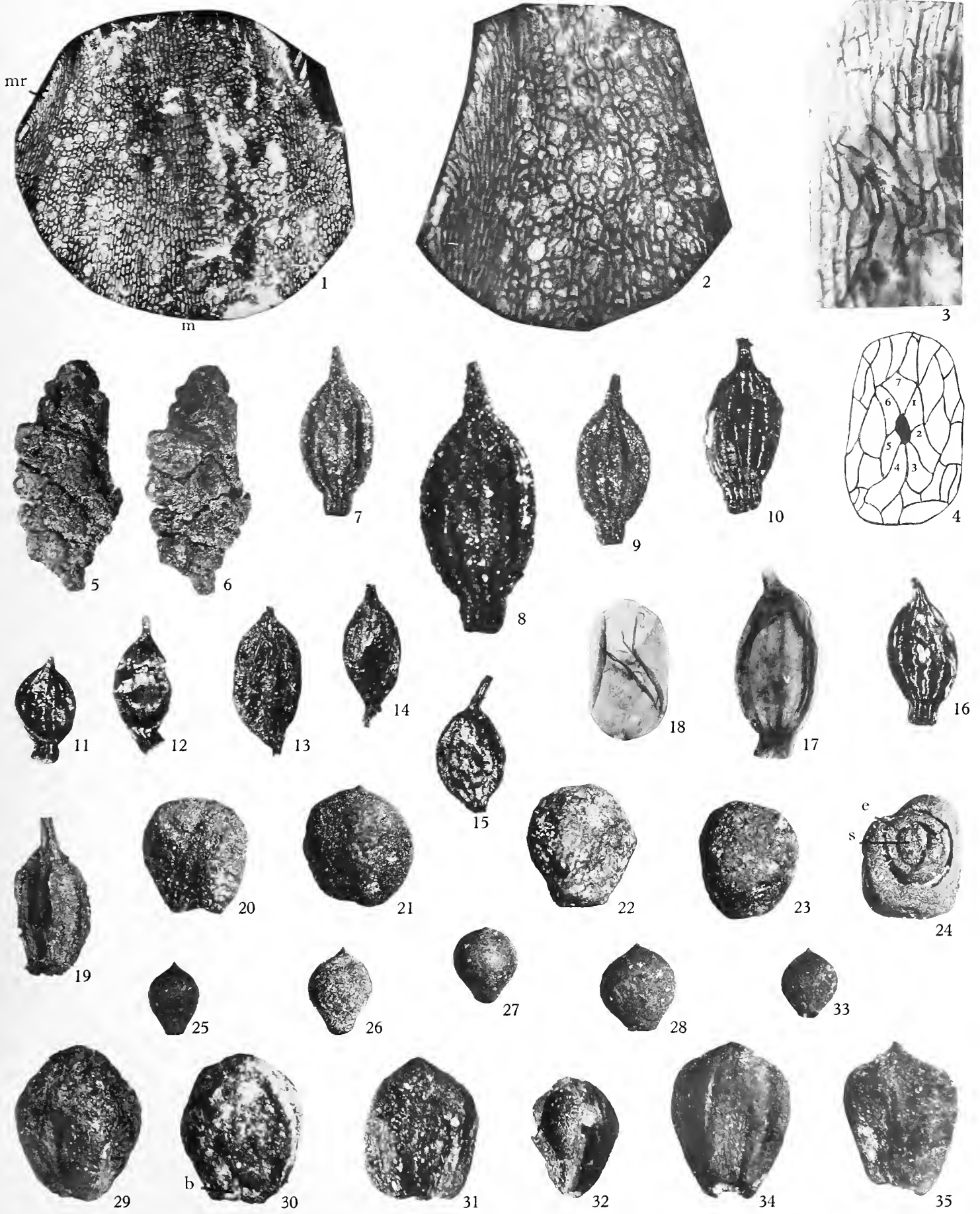
Caricoidea obscura Chandler p. 52

20. Holotype. Fruit. $\times 15$. V.40407.
21. Another, somewhat abraded at the apex so that the style of the endocarp protrudes. $\times 15$. V.40408.
- 22, 23. Two other typical fruits. $\times 15$. V.40409-10.
24. Fruit abraded on one side so that the endocarp, *e*, and seed, *s*, are exposed. $\times 15$. V.40411.
25. Slender detached endocarp with pointed apex and truncation below due to the basal aperture. $\times 15$. V.40412.
- 26-28. Three endocarps showing variations of form and size. $\times 15$. V.40413, V.43521-22.
- 29-31. Three fruits, *b*, basal aperture. $\times 15$. V.40414, V.42356-57.
32. Another fruit dissected so as to release the endocarp and show the cavity in which it lay. $\times 15$. V.40415.
33. Endocarp from the above tilted slightly to show the basal aperture. $\times 15$.

Caricoidea arnei n.sp. p. 53

- 34, 35. Two fruits. Holotype, Fig. 34 shows the compressed attachment scar at the base. $\times 15$. V.40420-21.

Figs. 1-14, 19, 29-33 Lake, Fig. 3 from base of section near ironstones in foreshore, Figs. 7-14 from fine silt, base of section, western end; Figs. 15, 34, 35 Arne; Figs. 16-18 Lower Swanwick, Southampton; Figs. 20-28 Cliff End, Mudeford.



TAXODIUM, SCIRPUS, CARICOIDEA

Explanation of Plate 7

Fig.

Caricoidea minima (Chandler) p. 54

1. Fruit, side. Basal truncation due to large attachment area. × 15. V.40423.

Cyperaceae? Genus? p. 55

- 2-5. Four fruits. Fig. 5 shows a slightly distorted specimen. *b*, basal aperture. × 16. V.40424, V.42363-65.

Calamus daemonorops (Unger) p. 55

6. Spine base with two broken spines. × 6.5. V.40430.

? **Sabal** sp. p. 56

7. Fragment of leaf, lower surface, showing pinnules diverging from left side of rachis. × 6. V.40431.

8. Same (after slight breakage), upper surface showing short ligule, *l*, and pinnules diverging behind it on the right. × 6.

Aracispermum arnense n.sp. p. 56

9. Holotype. Seed showing large hilar aperture, *a*. The micropyle is at *m* in a depression at the opposite end of the seed. × 15. V.40432.

10. Another, lettering as in Fig. 9. × 15. V.40434.

11. Another, *a*, hilar aperture. The large dark surface is a slight concavity due to contact with a second seed during growth. × 15. V.40433.

12. Another, opposite side to that with hilar aperture but showing the depression associated with the micropyle at *m*. × 15. V.40435.

Ficus lucidus n.sp. p. 58

13. Holotype. Carpel showing form and curved mucro marking the point of entrance of the fibro-vascular strands. × 15. V.40437.

14. Another somewhat crushed specimen. × 15. V.40438.

- 15, 16. Two more carpels. × 15. V.40439, V.43523.

17. An almost uncrushed specimen, mucro conspicuous as described in Fig. 13. × 15. V.43524.

Fig.

18. Carpel showing the angled margin along which splitting tends to occur. × 15. V.40440.

Palaeonymphaea eocenica n.sp. p. 60

19. Holotype. Seed with embryotega, *e*. The projecting tag is the rim of the hilum. The longitudinal ridge near the right margin indicates the raphe. *ch* is the position of the chalaza. × 15. V.40449.

20. More abraded and crushed but typical seed. *e*, embryotega; *r*, raphe; *ch*, position of chalaza. × 15. V.40450.

Wardenia poolensis n.sp. p. 62

- 21, 22. Holotype. Endocarp, opposite sides showing horse-shoe shaped ridge and wide marginal flange with radial ridges which end abruptly (see Fig. 22). *st*, stylar limb. × 6.5. V.40457.

Palaeococculus lakensis Chandler p. 63

23. Syntype. Endocarp exterior. × 15. V.40458.

24. Same, interior of the other valve. × 15.

25. Somewhat distorted endocarp. × 15. V.40459.

26. Crumpled and distorted seed removed from another distorted endocarp. *m*, micropyle; *ch*, ventral chalaza and raphe on the inner curve of the seed. × 15. V.40462.

- 27, 28. Two endocarps showing ribs on the broad marginal flange. *a*, attachment. × 6.5. V.40460, V.42352. In all the above *st*, stylar limb.

29. Much distorted endocarp. *a*, attachment between ends of limbs. The wide marginal flange with few ribs and the coarsely ribbed horse-shoe shaped area over the locule are seen. × 15. V.40466.

Figs. 1, 7-12, 21, 22, 29 Arne; Figs. 2-6, 13-18, 20, 23-28 Lake, Figs. 2-5, 15, 16 from fine silt, base of section, western end; Fig. 19 Sandbanks.



CARICOIDEA, CYPERACEAE GENUS (?), CALAMUS, SABAL, ARACISPERMIUM, FICUS, PALAEOGYMNAEA, WARDENIA, PALAEOCOCCULUS

Explanation of Plate 8

Fig.

Palaeococculus lakensis Chandler p. 63

1. Endocarp showing another variation of form. $\times 15$. V.42354.
2. Valve of endocarp, interior, showing the elongate foramen between the limbs. *st*, stylar canal. $\times 15$. V.40461.
3. Valve of an endocarp, exterior, showing foramen. *st*, stylar limb. $\times 15$. V.42355.

Tinospora arnensis n.sp. p. 61

4. Holotype. Endocarp, ventral side, showing aperture into condyle, median ridge and spines. Only slightly distorted. $\times 6.5$. V.40452.
5. Crushed endocarp (completely flattened), ventral. Aperture into condyle is occupied by a quartz pebble. Stylar scar at *a*. $\times 6.5$. V.40453.
6. Same, dorsal. $\times 6.5$.
7. Imperfect endocarp, fragment of dorsal surface showing median ridge and tubercles. $\times 9$. V.40456.
8. Same fragment, opposite side, remains of seed projecting at *s* in both Figs. $\times 6$.
9. Fragment of same after splitting in plane of symmetry, showing locule. Spines are seen in profile. $\times 15$.
10. Released fragment of seed of same showing curved dorsal surface. $\times 15$.

Fig.

Tinospora excavata Reid & Chandler p. 62

11. Neotype. Endocarp for comparison, ventral, to show different character of the tubercles in this species when relatively unworn. $\times 6.5$. V.29825.

Laurocarpum spp. p. 65

- 12-15. Crushed berries showing the basal truncation due to the large scar of attachment. Surface much crumpled and sand-pitted. $\times 6$. V.40467, V.40469, V.40470, V.40472.

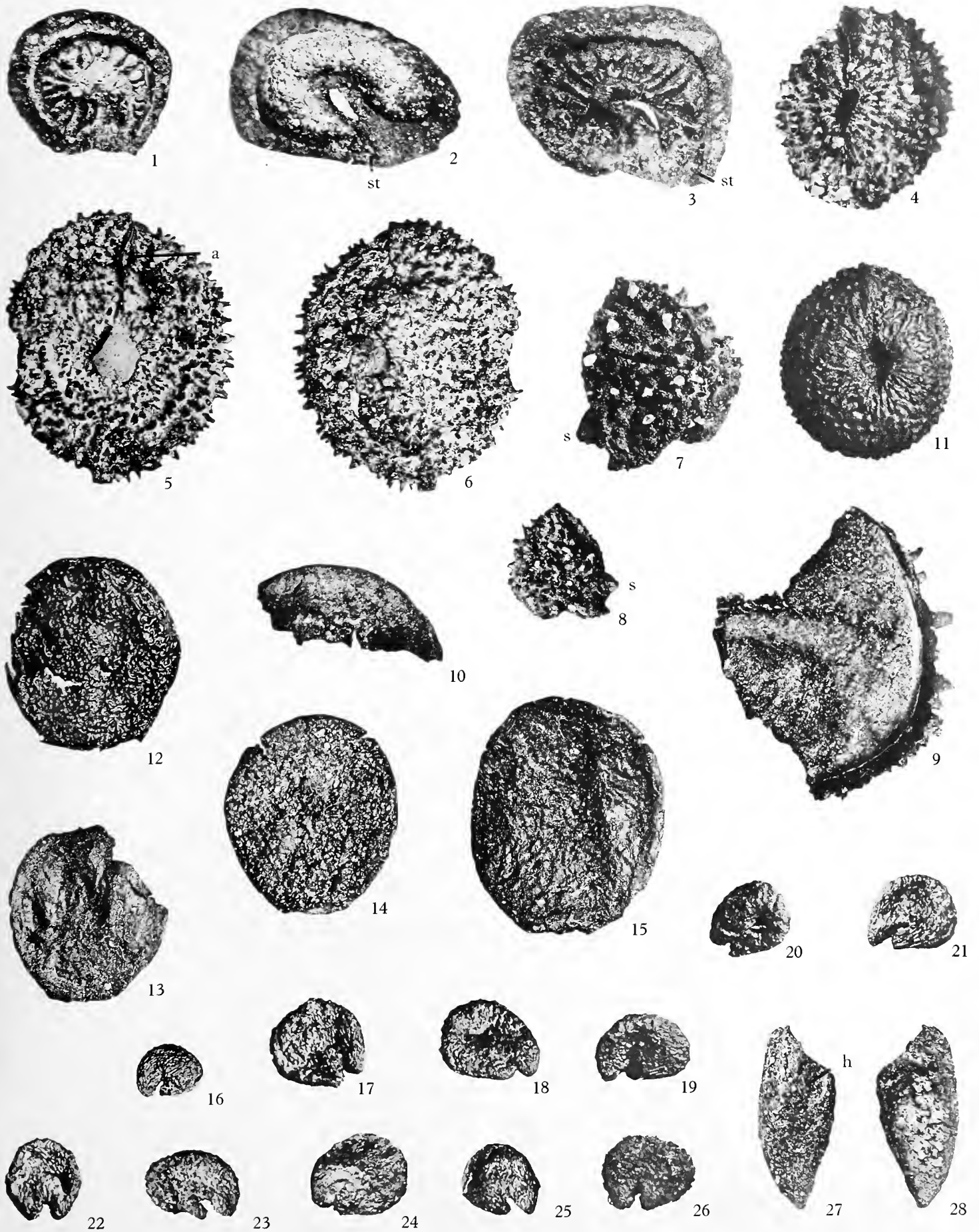
Burtonella emarginata Chandler p. 66

- 16-25. Ten seeds showing variations of form and size, also the reticulate sculpture of the surface. (See also Pl. 4, figs. 34, 35.) $\times 19$. V.40354.
26. Seed, showing deep emargination between limbs. $\times 15$. V.40479.

Hamamelidaceae Genus? p. 72

27. Valve of seed, exterior, showing large sunk hilar scar at *h*. $\times 6.5$. Decayed.
28. Same, interior. $\times 6.5$.

Figs. 1-3, 7-10, 12-25 Lake, Fig. 15 from base of section near ironstones; Figs. 4-6, 26-28 Arne; Fig. 11 Warden Point, Sheppey.



PALAEOCOCCULUS, TINOSPORA, LAUROCARPUM, BURTONELLA,
HAMAMELIDACEAE GENUS (?)

Explanation of Plate 9

Fig.

Palaeocleome lakensis n.gen. & sp. p. 67

1. Holotype. Seed showing the emargination between the limbs and tag-like excrescences of the outer coat. Form relatively short and broad. $\times 15$. V.40480.
2. Another showing hooked form and excrescences. $\times 15$. V.40481.
3. Another broadly transverse in outline. $\times 15$. V.40482.
4. Subcircular seed with clear emargination and less conspicuous excrescences. $\times 15$. V.40483.
5. Hooked seed. The outer coat is much abraded so that regular rows of coarse concentric pits are exposed. $\times 15$. V.40484.
6. Hooked seed with outer coat partly abraded; conspicuous spine-like excrescences are seen at the margin. $\times 15$. V.40485.
7. Small seed, outer surface of one valve. $\times 15$. V.40486.
8. Inner surface of the same valve. The testa shows a tendency to split parallel with the curvature of the seed-cavity. Excrescences are visible in profile at the margin. $\times 15$.
9. Unusual form of seed with conspicuous prolongations of the outer coat at the base of both limbs and large tag-like excrescences over the surface. $\times 15$. V.40487.
10. Somewhat hooked seed, outer coat partly preserved around the circumference, but elsewhere worn away so that the regular pitted coat is exposed. $\times 15$. V.40488.
11. Small somewhat distorted seed with inner pitted coat partly exposed. $\times 15$. V.40489.
12. Broad seed showing the basal emargination and superficial tag-like excrescences. $\times 15$. V.40490.
13. Small subquadrangular seed with inner pitted coat well exposed. $\times 15$. V.40491.
14. Seed with spine-like excrescences. Inner coat with pits exposed in places. $\times 15$. V.40492.

Fig.

15. Seed-cast showing the curved form and unequal limbs. The micropyle, *m*, lies at the end of the longer limb. The chalaza, *ch*, on the inner edge of the shorter limb. The hilum lay between the limbs at *h*. $\times 15$. V.40493.

Capparidispermum eocenicum n.sp. p. 68

16. Holotype. Seed showing the transversely oval form and the emargination between the limbs. Crushing has to some extent obscured the pitting of the surface. $\times 19$. V.40497.
17. Another seed with subcircular outline, with clear pits and small emargination. $\times 19$. Decayed.

Protoaltingia hantonensis n.sp. p. 69

18. Immature fruiting head showing areoles with four cusps to each. $\times 6.5$. V.40500.
19. Another with thick peduncle. $\times 6.5$. V.40501.
20. Holotype. Ripe fruiting head much abraded exposing the lower part of the endocarps still lying within the areoles. $\times 6.5$. V.40499.
21. Same, opposite side, after one or two of the less abraded projecting parts shown in Fig. 20 had broken away. *a, a*, cusps due to loculicidal and septicial splitting. $\times 6.5$.
22. Much abraded crushed ripe head showing remains of the peduncle and of the areoles from which the fruits have fallen. $\times 6.5$. V.40502.
23. Abraded, crushed and somewhat immature fruiting head showing somewhat obscurely the areoles and four-partite fruitlets. $\times 6.5$. V.40503.
24. Imperfect very small and immature head. $\times 6.5$. Decayed.

Leguminosae. Genus? p. 72

25. Crushed and imperfect seed. $\times 6.5$. V.40505.

Figs. 1-17, 22-25 Lake, Figs. 1-17 fine silt, base of section, western end; Figs. 18, 20, 21 between Branksome and Canford Chines and Fig. 19 between Durley and Alum Chines, Bourne-mouth.



PALAEOCLEOME, CAPPARIDISPERMUM, PROTOALTINGIA,
LEGUMINOSAE GENUS (?)

Explanation of Plate 10

Fig.

Phellodendron costatum Chandler p. 73

1. Seed, side, showing characteristic knob-like micropylar end and longitudinal ridges. $\times 15$. V.40506.

Rutaspermum excavatum n.sp. p. 73

2. Holotype. Seed, side, surface ridges unusually well preserved. Hilar scar on left. $\times 15$. V.41932.
3. Another, much abraded. Hilar scar on right. $\times 15$. V.41933.
4. Another, less abraded than Fig. 3. Hilar scar on right. $\times 15$. V.41934.
5. Much battered and abraded seed. Hilar scar on right. $\times 15$. V.41937.
6. Another, slightly distorted, dorsilateral view. Hilar scar on right. $\times 15$. V.40516.
7. Seed, side, hilar scar on left. $\times 15$. V.40517.
8. Seed, dorsilateral view. Hilar scar on right. $\times 15$. V.40518.
9. Seed, side, hilar scar on right. $\times 15$. V.41935.
10. Inner surface of one valve of a seed. *m*, micropyle; *r*, raphe; *ch*, chalaza. $\times 15$. V.40519.
11. Relatively unworn fragment of testa. $\times 15$. V.41938.
12. Seed, side, with outer shining coat, rarely preserved, hilum on right. $\times 15$. V.41936.
13. Another, more dorsilateral aspect, with outer shining coat, hilum on left. $\times 15$. V.40515.

Rutaspermum striatum n.sp. p. 75

14. Holotype. Seed, side, hilar scar truncating margin on right in the upper half. $\times 15$. V.40507.
15. Same, looking on to strap-shaped hilar scar. *m*, micropyle at upper end of scar; *h*, the aperture at the other end of the scar through which the fibres enter the testa to become the raphe. $\times 15$.

Fig.

Rutaspermum glabrum n.sp. p. 75

16. Holotype. Seed, side, hilar scar truncating the right-hand margin above, *m*, micropyle; *r*, opening for raphe; *ch*, position of chalaza within. $\times 15$. V.40509.
17. Another tilted to show ventral hilar facet, *h*, with median furrow. $\times 6.5$. V.40510.
18. Another seed, side, crushed, showing smooth surface. $\times 15$. V.40511.

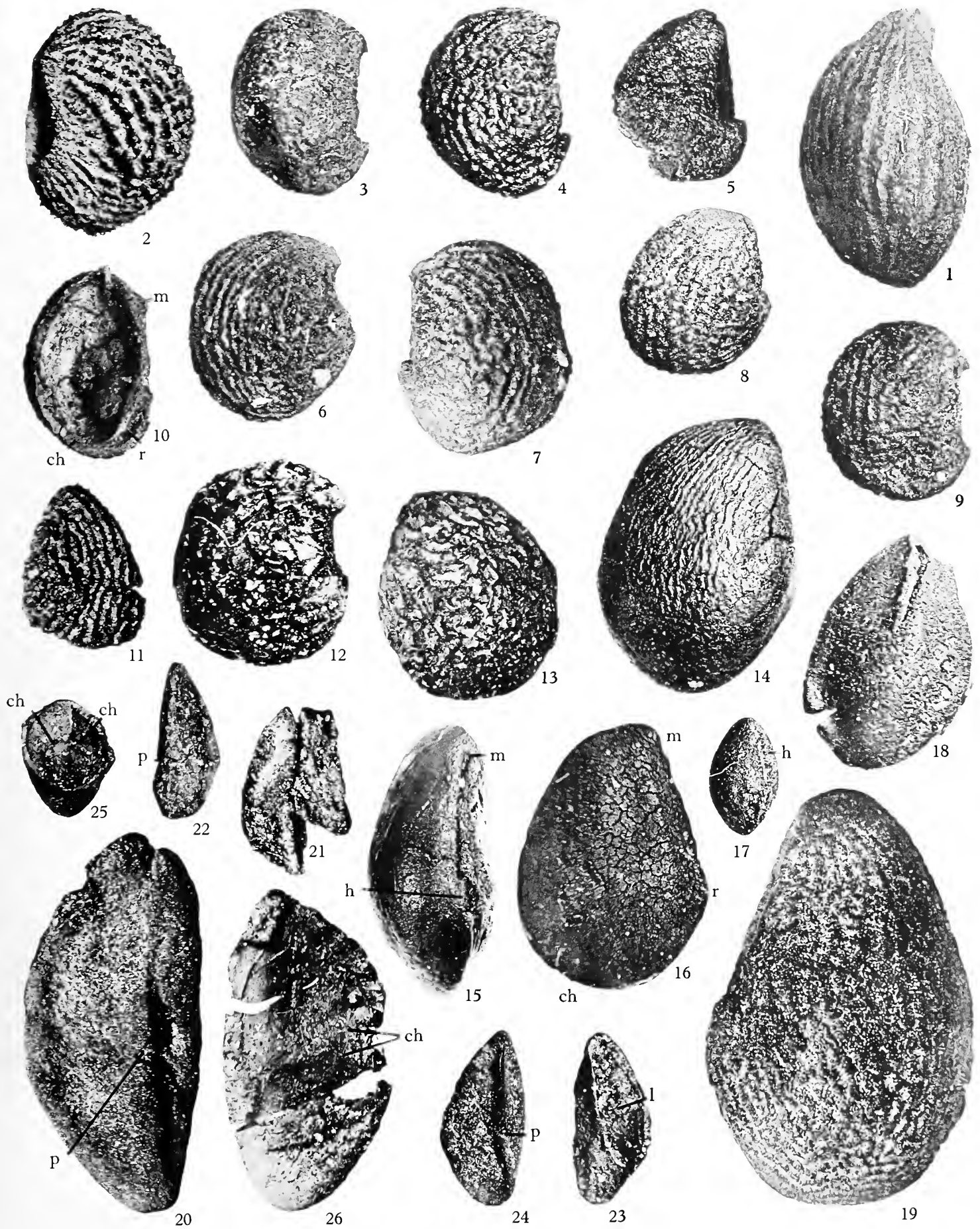
Rutaspermum magnificum n.sp. p. 76

19. Holotype. Seed, side, hilum truncating the upper part of the left-hand margin. $\times 15$. V.40521.

Palaeobursera lakensis n.sp. p. 77

20. Holotype. Detached pyrene or carpel, ventral, showing aperture, *p*, for fibres to the placenta within. $\times 15$. V.40523.
21. Carpel, ventrilateral aspect, still attached to part of the axis (right). $\times 6.5$. V.40524.
22. Another, compressed laterally so that only one of the two ventral facets is visible. Ventral angle on left; *p*, aperture to placenta. $\times 6.5$. V.40525.
23. Another, dorsilateral, with locule exposed at *l* through the loss of its germination valve. $\times 6.5$. V.40526.
24. Typical carpel, ventral, facets unequal; *p*, aperture to placenta. $\times 6.5$. V.40528.
25. Short broad carpel, dorsal, with germination valve missing. Testa adheres to the ventral wall of the locule and shows the broadly obcordate chalaza scar, *ch*. $\times 6.5$. V.40529.
26. Crushed carpel, dorsal, with germination valve removed. Testa again adheres to the ventral locule wall as in Fig. 25 and on it the chalaza is preserved (visible only obscurely at *ch* in the figure). $\times 15$. V.40530.

Figs. 1, 6–8, 10, 13, 19 Arne; Figs. 2–4, 9, 12 Sandbanks; Figs. 5, 11 Branksome Dene; Figs. 14–18, 20–26 Lake.



PHELLODENDRON, RUTASPERMUM, PALAEOBURSERA

Explanation of Plate 11

Fig.

Euphorbiotheca (? Andrachne)
lakensis n.sp.

p. 80

1. Holotype. Capsule with exocarp abraded, tilted to show the apex. Loculicidal dehiscence has started and one seed, *s*, is exposed in a gaping suture; *l, l, l*, the three locules. × 6.5. V.40533.
2. Same, base. The fruit is slightly dorsiventrally compressed in fossilization. × 6.5.
3. Two closely adpressed seeds lying in one locule. The left-hand seed has the chalazal aperture exposed at *ch* owing to abrasion of its thin outer integument. × 15. V.40537.
4. Seed. The mucro, *m*, marks the micropyle and hilum; *ch*, the chalaza. × 15. V.40534.
5. Seed, side. Hilum, *h*, chalaza, *ch*. × 15. V.40535.
6. Another, distorted and crushed so as to display the chalazal end with its aperture and tumescence at *ch*. The aperture leads into the shallow cavity which overlies the inner chalaza. × 15. V.40536.

Euphorbiotheca digitata n.sp.

p. 86

7. Holotype. Crushed fruit split longitudinally as in diagram Fig. 9. The locules are exposed, one seed is seen in the left-hand locule and two to right of axis. × 15. V.40543.
8. Diagram to explain Fig. 7. A locule lies on each side of the axis (cf. Fig. 9), *S1-3* are seeds. *ch*, chalaza; *r*, raphe; *p*, placentae. *S3* is broken longitudinally exposing the seed-cavity. *spt*, a broken septum overlying seed 2 and overlain itself by remains of seed 3.
9. Diagrammatic transverse section to show mode of splitting of fruit in Figs. 7, 8. *L1-3* are the three locules; *SP1-3* the three septa. The dotted line shows the plane of fracture which has removed most of the third locule and its seed as well as the septa covering the other two locules. The specimen broke irregularly through the seed in the third locule, part of this seed and septum 3 still adhering to the seed in locule 2.
10. Part of a carpel enclosing a seed with shining outer coat of digitate cells. The short funicle in its passage from the placenta to the hilum can be seen, also the fibre which passes from the placenta to the exterior of the fruit (cf. Fig. 11). × 15. V.40551.
11. Diagram to explain Fig. 10. *p*, placenta; *f*, fibre to exterior; *h*, hilum.
12. Detached carpel looking onto a septum which shows the characteristic diagonal split, *sp*. An enclosed seed, *s*, is exposed where the slit widens above. × 15. V.40545.

Fig.

13. Three-loculed fruit, side, with exocarp missing. × 6.5. V.40544.

14. Chalazal end of a seed with shining outer integument preserved. *ch*, chalaza; *r*, raphe which appears as a thin longitudinal ridge. × 15. V.40549.

15. Immature or poorly preserved seed cracking longitudinally at the hilar end. Outer shining integument preserved only at the chalazal end, *ch*, chalaza. × 15. V.40550.

16. Seed showing the large chalazal scar, *ch*, and the rim surrounding the deep micropylar depression at *m*. Note the rugose surface. × 15. V.40547.

17. Another well developed rugose seed, crushed and splitting longitudinally. *ch*, chalaza; *m*, micropylar and hilar region. × 15. V.40546.

18. Typical seed, imperfect at the chalazal end. *m*, micropylar-hilar region. × 15. V.40548.

19. Small seed, crushed and split longitudinally. The micropylar end at *m*. Chalazal end broken and incomplete. Lining layer of testa exposed at *l*. × 15. Decayed.

Euphorbiotheca platysperma n.sp.

p. 83

20. Holotype. Crushed fruit fractured longitudinally. Two seeds, *s, s*, can be seen in the right locule. × 15. V.40569.

21. Same differently lighted to show up the broken septa at *sp*. × 15.

22. Detached seed from another fruit showing the diaphanous loose-fitting outer coat forming shining folds on the rough surface of the coat within. × 15. V.40570.

23. Another seed still attached to a fragment of fruit, *f*. Fine pitting on the hard coat which underlies the diaphanous coat can be seen. × 15. V.40571.

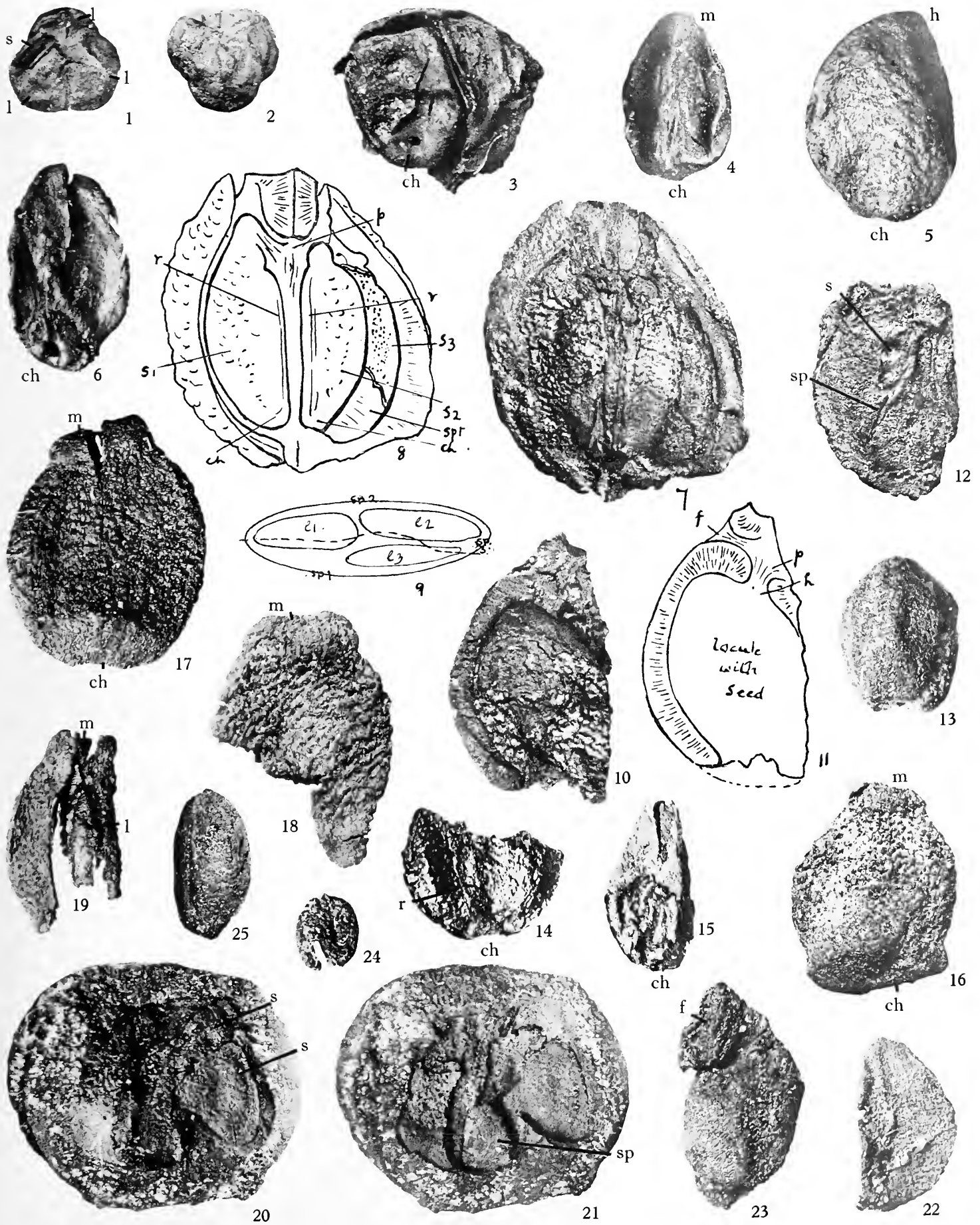
Euphorbiotheca spp.

p. 88

24. Small crushed subglobular endocarp. × 6.5. V.40583.

25. Ovoid endocarp with exocarp abraded. The carpel wall is beginning to disintegrate along the fibres of which it is composed. × 6.5. V.40582.

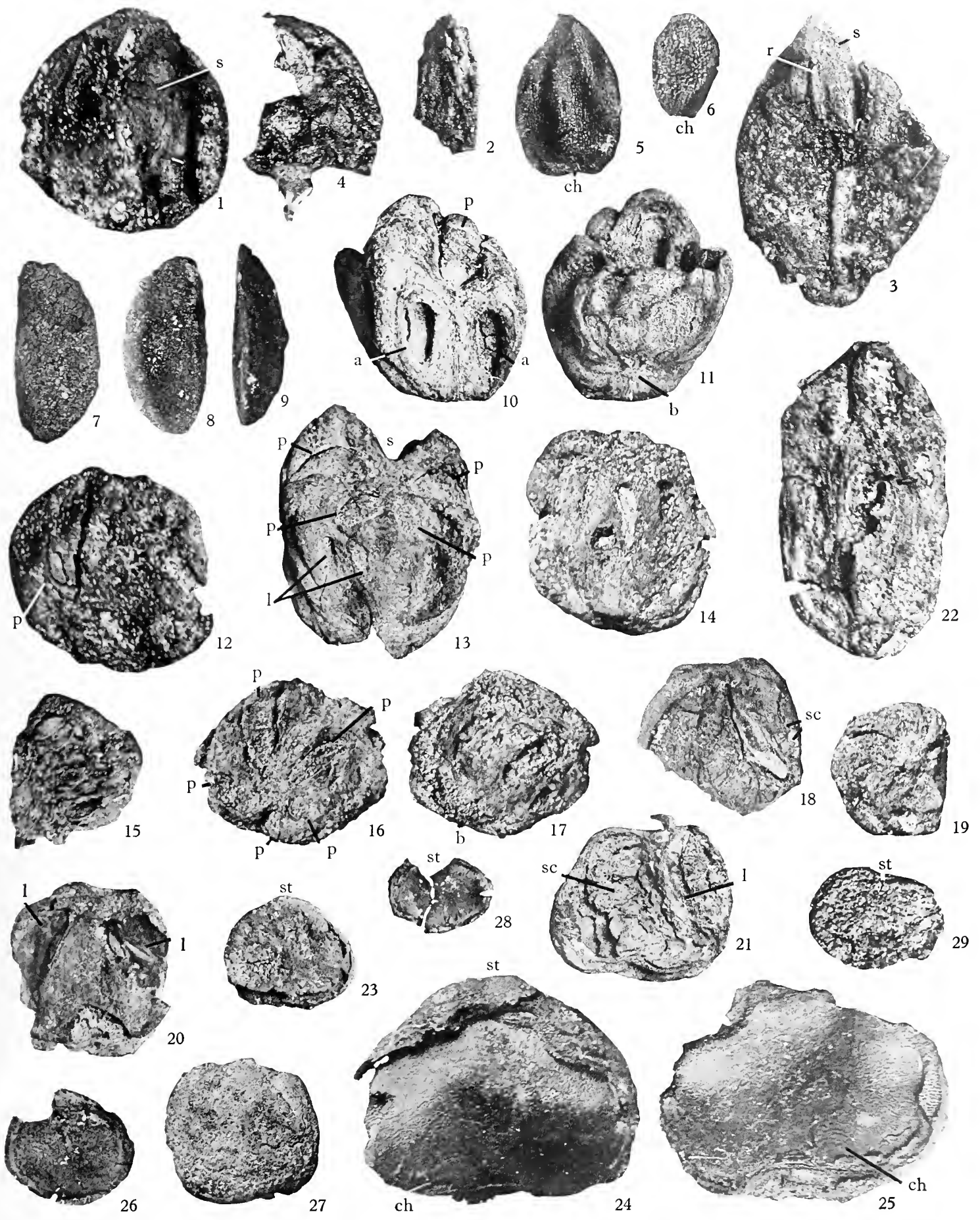
All the above from Lake, Figs. 1-6 from coarse sands.



EUPHORBIOTHECA

Explanation of Plate 12

- Fig. ***Euphorbiotheca tuberculata*** n.sp. p. 85
1. Crushed fruit with carpel wall broken on the right where a seed, *s*, with cracked surface is exposed. $\times 15$. V.40577.
 2. Right-hand fragment of the same fruit after it had broken. Seeds with convex cells are exposed. $\times 15$.
 3. Holotype. Two-loculed fruit, broken to expose one of the seeds, *s*, on which the raphe, *r*, is seen as a longitudinal ridge. $\times 15$. V.40576.
 4. Part of a much broken two-loculed fruit showing a seed with convex cells. $\times 15$. V.40578.
- Euphorbiospermum punctatum*** n.sp. p. 89
5. Holotype. Seed showing form, mucro at the hilar-micropylar end and truncation at the chalazal end, *ch*. $\times 15$. V.40581.
- Euphorbiospermum*** sp. p. 89
6. Seed, *ch*, chalaza. $\times 18$. V.40585.
- Wetherellia variabilis*** Bowerbank p. 89
7. Valve of a coccus, outer surface. $\times 2.8$. V.40586.
 8. Same, looking onto locule. $\times 2.8$.
 9. Same, inner margin of valve. $\times 2.8$.
- Dracontocarya glandulosa*** n.gen. & sp. p. 90
10. Crushed and distorted endocarp with loosened plug at *p* and two unusually large lateral apertures at *a*, *a*. $\times 6.5$. V.40591.
 11. Same, opposite side showing base, *b*. $\times 6.5$.
 12. Endocarp with one plug, *p*, partly removed exposing a longitudinal groove in the wall beneath. $\times 6.5$. V.40588.
 13. Holotype. Endocarp crushed and partly split longitudinally. Dorsiventral distortion has occurred so that four apical plugs, *p*, of unequal size can be seen. A fifth plug appears to have fallen from the split carpel at *s*. A pair of lateral apertures, *l*, as in *Dracontomelon*, can be seen alternating with the apical plugs, and a more obscure pair is seen on the right. $\times 6.5$. V.40587.
 14. Another crushed and distorted endocarp. $\times 6.5$. V.40589.
 15. Broken fragment of endocarp showing six small flat oval or elliptical secreting cavities lying at right angles to one of the large apical apertures. $\times 6.5$. V.40596.
- Fig. 16. Crushed endocarp, apex. Five unequal plugs, *p*, are visible. $\times 6.5$. V.40592.
17. Opposite surface of the same showing lateral apertures through distortion. Base at *b*. $\times 6.5$.
18. Endocarp fractured longitudinally. It shows a curved shining locule flanked on both sides by oval secreting cavities, *sc*, seen obscurely only in the figure. $\times 6$. V.40593.
19. Apex of small distorted endocarp, imperfect on the right with three of the large apical plugs visible. $\times 6.5$. V.40590.
20. Longitudinally fractured endocarp showing two of the curved locules, *l*, *l*. $\times 6$. V.40594.
21. Endocarp fractured longitudinally so as to expose a curved shining locule, *l*, and a series of large transversely oriented secreting cavities, *sc*, to the left. $\times 6$. V.40595.
- ? ***Lanea*** sp. p. 92
22. Elongate endocarp showing sinuous woody fibres. $\times 6.5$. V.40602.
- Rhus lakensis*** n.sp. p. 93
23. Holotype. Endocarp showing marginal splitting. *st*, style. $\times 6.5$. V.40603.
- 24, 25. Same after maceration, the two valves separated to show the locule surface and remains of seed. *st*, style and placenta; *ch*, chalaza. In Fig. 24 part of the valve seen broken in Fig. 25 still adheres at the placental end. $\times 15$.
26. Endocarp, inner surface of valve after maceration. Probably this species. $\times 6.5$. V.40604.
- Rhus*** spp. pp. 93, 94
27. Endocarp, exterior. $\times 6.5$. V.40607.
28. Endocarp, inner surface of a valve, broken as the result of maceration. *st*, position of style and placenta. $\times 6.5$. V.40605.
29. Somewhat abraded and sand-pitted endocarp, exterior. *st*, style and placenta. $\times 6.5$. V.40606.
- Figs. 1-6, 10-29 Lake, Fig. 6 from fine silt, base of section, western end; Figs. 7-9 Arne.



EUPHORBIOTHECA, EUPHORBIOSPERMUM, WETHERELLIA,
DRACONTOCARYA, LANNEA, RHUS

Explanation of Plate 13

Fig.

Iodes acutiformis n.sp. p. 95

1. Holotype. Valve of an endocarp showing coarse reticulation. *st*, perfect stylar end; base and right margin slightly broken; *f*, funicular margin; *h*, horn-like projections which flank the style here much flattened onto the surface of the endocarp. $\times 6.5$. V.40608.
2. Broken valve of another endocarp; stylar end missing. $\times 6.5$. V.40609.
3. Endocarp, surface rather worn. $\times 6.5$. V.40610.
4. Another, apex missing, surface better preserved. $\times 6.5$. V.40611.
5. Another with distorted apex. $\times 6.5$. V.40612.

Natsiatum eocenicum Chandler p. 96

6. Endocarp, somewhat crushed and abraded, sand encrusted in the depressions between the network of superficial ridges; *f*, margin which carries funicle; *s*, position of stylar canal (along which the endocarp has cracked); *a*, attachment. $\times 6.5$. V.40617.
7. Stylar end of another sand-encrusted endocarp showing the orifice of the stylar canal, *st*; *f*, indicates the position of the funicle. $\times 2.8$. V.40619.
8. Same, opposite side after the broken basal half has been replaced in its original position. *st*, style; *th*, external thickening over the placenta; *a*, attachment; *f*, margin carrying the funicle, actual canal filled with sand (white) being now exposed by abrasion. $\times 2.8$.
9. Stylar end of the same. Lettering as in Fig. 8. $\times 6.5$.
10. Basal half of another endocarp showing marked median ridge arising from the attachment, *a*. $\times 2.8$. V.40620.
11. One valve of an endocarp, slightly imperfect along both margins as shown by dotted lines, complete at the apex. Splitting has begun along the stylar canal, *st*; *th*, external thickening over placenta; *f*, funicular canal (broken below). The surface, almost free of sand, shows clearly the sharpness of the unabraded ridges which ornament it. $\times 6.5$. V.40618.

Fig.

12. Inner surface of same valve showing upper end of funicular canal at *f* and the incurving to the sub-apical placenta. Outer wall of funicle broken below although the groove of its canal can be seen. Slight convexities on the locule wall correspond with external concavities between the ridges. $\times 6.5$.

13. Neotype. Beautifully preserved endocarp. *st*, stylar opening (near which there is a slight crack); *f*, funicular margin. $\times 6.5$. V.40614.

14. Much compressed small immature endocarp. $\times 2.9$. V.40615.

15. Another small endocarp with simpler surface ornamentation and conspicuous stylar opening, *st*. Funicular canal broken below *a*. $\times 5$. V.40616.

16. Same looking on to the funicular margin (broken below *a*). $\times 5$.

? **Palaeophytocrene foveolata** Reid & Chandler p. 97

17. Upper part of endocarp showing deep narrow depressions associated with internal ruminations which produce projections on the locule wall. Broken funicular margin on left; *th*, thickening over placental area; *st*, style. $\times 2.9$. V.40623.

18. Same. $\times 6.5$.

19. Same, opposite side. $\times 2.9$.

Icacinicarya inornata n.sp. p. 98

20. Holotype. Endocarp, side, *f*, margin with funicle, style at apex. $\times 2.8$. V.40624.

21. Smaller endocarp with network of ridges. Shows slight thickening over placenta at *th*. $\times 2.8$. V.40625.

22. Somewhat crushed endocarp showing shallow superficial network of ridges. $\times 2.8$. V.40626.

23. Another. $\times 2.8$. V.40627.

24. Much abraded endocarp with adherent crust of sand. $\times 3$. V.40633.

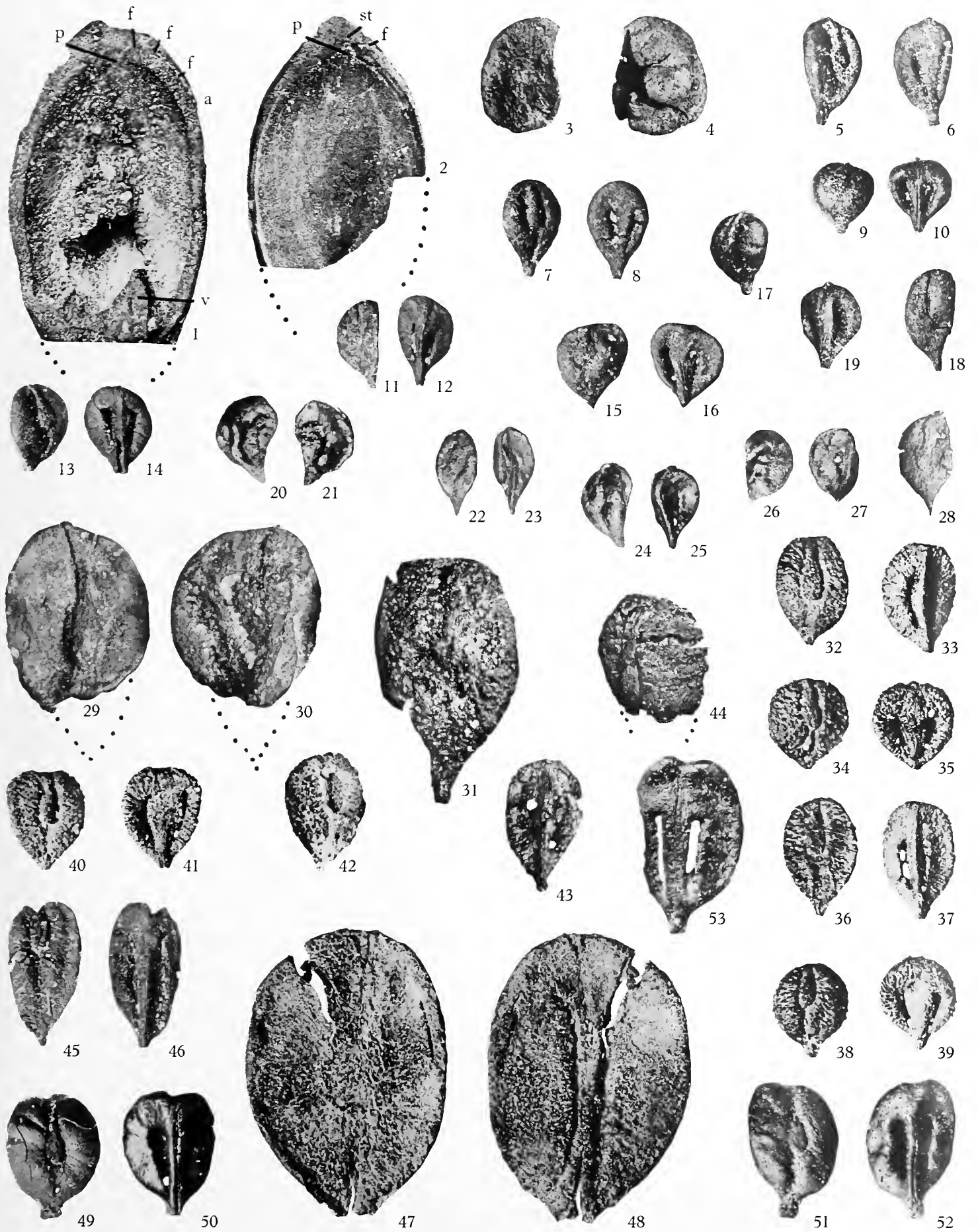
Figs. 1, 2, 6-12, 17-23 Lake; Figs. 3-5, 24 Arne; Figs. 13-16 Hordle.



IODES, NATSIATUM, PALAEOPHYTOCRENE, ICACINICARYA

Explanation of Plate 14

- Fig. ***Icacinicarya inornata* n.sp.** p. 98
1. Inner surface of one valve of an endocarp. The other valve has broken away except at *v* at the base (partly cut off by edge of negative). *f*, funicle, a white line crossing suture of valve diagonally to sub-apical placenta, *p*. Below *a* the funicle is obliterated by abrasion where it had lain very close to surface of endocarp. $\times 6.5$. V.40628.
 2. Another specimen, inner surface of incomplete valve (base missing). *p*, placenta; *f*, upper end of funicle as described above; *st*, position of stylar canal. $\times 6.5$. V.40629.
- Meliosma* sp. (? *M. sheppeyensis* Reid & Chandler)** p. 100
3. Laterally crushed endocarp, side. $\times 6.5$. V.40634.
 4. Same, opposite side showing on left the ventral opening formerly filled by a plug associated with the attachment. $\times 6.5$.
- Vitis pygmaea* Chandler** p. 100
5. Seed, dorsal, showing smooth contours, stipitate base, small outer chalaza. $\times 6.5$. V.40641.
 6. Same, ventral, showing typical short infolds. $\times 6.5$.
 - 7-16. Five seeds, showing dorsal and ventral aspects. $\times 6.5$. V.40642-46.
 - 17, 18. Two seeds, dorsal. $\times 6.5$. V.40651-52.
 19. Another seed, ventral. $\times 6.5$. V.40653.
 - 20, 21. Opposite sides of a slightly crushed and distorted seed. Fig. 20 is dorsilateral; Fig. 21 shows one ventral facet. $\times 6.5$. V.40635.
 - 22, 23. Dorsal and ventral aspects of a slender seed. $\times 6.5$. V.40636.
 - 24, 25. Holotype. Dorsilateral and ventrilateral aspects of a typical seed. $\times 6.5$. V.34675.
 - 26, 27. Dorsilateral and ventrilateral aspects of a small distorted seed. $\times 6.5$. V.40637.
 28. Dorsal surface of a seed showing chalaza and stipitate base. $\times 6.5$. V.40640.
 29. Crushed seed with distorted base, dorsal. $\times 15$. Decayed.
 30. Same, ventral. $\times 15$.
 31. Another seed represented by its dorsal surface only. $\times 15$. Decayed.
- Fig. ***Vitis goodharti* n.sp.** p. 101
- 32, 33. Holotype. Dorsal and ventral surfaces of seed showing rugosities of surface, character of chalaza, ventral infolds and stipitate base. $\times 6.5$. V.40655.
 - 34-41. Four seeds showing dorsal and ventral surfaces to demonstrate variations of size and form. $\times 6.5$. V.40656-59.
 42. Seed, dorsal, showing elongate chalaza clearly. $\times 6.5$. V.40664.
 43. Another, ventral. $\times 6.5$. V.40665.
 44. Unusually large seed, upper half only preserved, possibly this species. $\times 6.5$. V.40666.
- Vitis cuneata* n.sp.** p. 102
45. Holotype. Seed, dorsal, showing narrow form, deep apical notch and situation of chalaza near apex. $\times 6.5$. V.40668.
 46. Same, ventral, showing long narrow raphe ridge and slightly divergent infolds. $\times 6.5$.
- Vitis lakensis* n.sp.** p. 102
47. Holotype. Seed dorsiventrally crushed and flattened, dorsal, showing large median chalaza and somewhat rough scaly surface. $\times 6.5$. V.40669.
 48. Same, ventral, showing long narrow raphe ridge and narrow infolds convex to the ridge. $\times 6.5$.
- Vitis glabra* n.sp.** p. 103
49. Holotype. Seed, dorsal, showing median chalaza, stipitate base and smooth testa with very slight flutings which diverge from the chalaza. $\times 6.5$. V.40671.
 50. Same, ventral, showing short, broad, sub-parallel infolds. $\times 6.5$.
 - 51, 52. Another seed, dorsal and ventral aspects. $\times 6.5$. V.40672.
 53. Ventral side only of a somewhat larger seed probably this species. $\times 6.5$. V.40674.
- Figs. 1-16, 32-41, 45-53 Lake; Figs. 17-19, 42-44 Arne; Figs. 20-27 Sandbanks; Figs. 28-31 Branksome Dene.



ICACINICARYA, MELIOSMA, VITIS



Explanation of Plate 15

- | | |
|---|---|
| <p>Fig. Vitis platysperma n.sp. p. 104</p> <ol style="list-style-type: none"> 1. Holotype. Seed, dorsal, showing laterally compressed form and median sunk chalaza scar. $\times 6.5$. V.40676. 2. Same, side showing one of the ventral facets, raphe ridge to left; the ventral infold is partly obscured by an outer integument. Owing to the lateral compression the seed rests on one ventral facet which is therefore not seen at all. $\times 6.5$. 3. Another seed, raphe ridge to right, showing one ventral facet. The curved line of the ventral infold is seen, the outer integument having gone; other lines are due to partial collapse of the seed. $\times 6.5$. V.40677. 4. Another seed, raphe ridge to left, showing one ventral facet and ventral infold. $\times 6.5$. V.40678. 5. Seed, bursting and decaying, raphe ridge to left, showing ventral facet. $\times 6.5$. V.40681. <p style="text-align: right;">Vitis symmetrica n.sp. p. 105</p> <ol style="list-style-type: none"> 6. Holotype. Seed, dorsal, showing outline of large chalaza obscurely. $\times 6.5$. V.40683. 7. Same, ventral, showing triangular raphe ridge and long divergent infolds like those of <i>Parthenocissus</i>. $\times 6.5$. <p style="text-align: right;">Vitis triangularis n.sp. p. 105</p> <ol style="list-style-type: none"> 8. Holotype. Seed showing typical outline, dorsal or slightly dorsilateral view with large median chalaza (partially obscured by sand grains). $\times 6.5$. V.40684. 9. Same, ventral. The left infold diverges rapidly outward towards <i>i</i>. Right infold, more clearly seen, diverges gradually throughout its length (white marks on raphe ridge are cracks). $\times 6.5$. 10. Another typical but much sand-encrusted seed, dorsal. $\times 6.5$. Decayed. 11. Same, ventral, infolds obscure owing to compression, but the left infold gradually diverges upwards, that on the right diverges more quickly. $\times 6.5$. 12. Seed, somewhat abraded below, dorsal. Chalaza scarcely distinguishable owing to abrasion. $\times 6.5$. V.40685. 13. Same, ventral. Rapid upward divergence of the left infold is clearly shown. $\times 6.5$. <p style="text-align: right;">Vitis sp. (<i>V. triangularis</i>?) p. 106</p> <ol style="list-style-type: none"> 14. Seed, imperfect at the hilar end, dorsal, showing typical large chalaza (sand encrusted). $\times 6.5$. V.40688. 15. Same, ventral, differing from typical <i>V. triangularis</i> in the concavity of the ventral facets which therefore appear rimmed. $\times 6.5$. | <p>Fig. Vitis poolensis n.sp. p. 106</p> <ol style="list-style-type: none"> 16. Holotype. Seed, dorsal, showing form and chalaza; note the broken projecting raphe at apex. $\times 6.5$. V.40689. 17. Same, ventral. $\times 6.5$. 18. Another seed, dorsal, showing the rugose radial markings which diverge from the chalaza. $\times 6.5$. V.40690. 19. Same, ventral, showing short infolds. $\times 6.5$. <p style="text-align: right;">Vitis arnensis n.sp. p. 107</p> <ol style="list-style-type: none"> 20. Seed, dorsal. $\times 6.5$. Decayed. 21. Same, ventral, showing infold on left and sharp raphe ridge separating the facets. $\times 6.5$. 22. Holotype. Seed, dorsal (much cracked). $\times 6.5$. V.40691. 23. Same, ventral, with narrow raphe ridge. $\times 6.5$. 24. A narrow seed, dorsilateral, ventral raphe ridge forming left margin. Narrow chalaza, <i>ch</i>, sunk, distinguished by its rough surface. $\times 6.5$. V.40694. 25. Same, ventral, showing narrow form and raphe ridge separating two steeply sloping facets. $\times 6.5$. 26. Same, lateral, resting on the right facet seen in shadow in Fig. 24. Raphe ridge on right. Short infold recurved at its upper end on left facet. $\times 6.5$. <p style="text-align: right;">Vitis ambigua n.sp. p. 108</p> <ol style="list-style-type: none"> 27. Holotype. Seed, dorsal, showing large chalaza. $\times 6.5$. V.40695. 28. Same, ventral, showing sharp raphe ridge and infold on left facet. $\times 6.5$. <p style="text-align: right;">Vitis excavata n.sp. p. 108</p> <ol style="list-style-type: none"> 29. Holotype. Seed, dorsal, broken to left of chalaza. Original outline indicated by dotted lines. $\times 6.5$. V.40696. 30. Same, ventral, showing deep concavities flanking sharp raphe ridge. Most of the right-hand concavity is broken away. $\times 6.5$. <p style="text-align: right;">Vitis spp. p. 109</p> <ol style="list-style-type: none"> 31. Seed, dorsilateral, tilted to right owing to sharp faceting of ventral surface. The chalaza is close to a white mark in the figure due to a crack in the seed. $\times 6.5$. V.40698. 32. Same, ventral, infolds obscure in figure. An oval crack lies close to the raphe ridge on right. $\times 6.5$. 33. Seed, dorsilateral, showing thick raphe and narrow chalaza. $\times 6.5$. V.40699. 34. Same, ventral, with broad rounded raphe ridge and deep long infolds. $\times 6.5$. |
|---|---|

- Fig. ? *Tetrastigma lobata* Chandler p. 110
35. Seed, dorsal, showing rounded lobes diverging from small central chalaza. $\times 6.5$. V.40700.
 36. Same, ventral, showing long divergent infolds and rounded lobes diverging from them. $\times 6.5$.
 37. Distorted laterally compressed seed, dorsal, sunk chalaza obscured by sand, lobes and furrows diverging from it. $\times 6.5$. V.40701.
 38. Same, ventrolateral aspect. The raphe ridge is towards the right. One ventral facet and its infold faces the observer. $\times 6.5$.

- Fig. *Tetrastigma acuminata* n.sp. p. 110
39. Holotype. Seed, dorsilateral, tilted to right with raphe ridge on left. Note elongate base and deep radial rounded lobes around the sunken chalaza. $\times 6.5$. V.40702.
 40. Same, ventral, showing emarginate apex and deep infolds flanked by long divergent lobes (that on right partly obscured by sand). $\times 6.5$.

Figs. 1-4, 6, 7, 16-19, 27-30, 35-38 Lake, Figs. 16-19 from fine silt, base of section, western end; Figs. 5, 8-15, 20-26, 31-34, 39, 40 Arne.



VITIS, TETRASTIGMA

Explanation of Plate 16

Fig.

Actinidia sp. p. 111

1. Seed, broken at hilar end, *h*. × 16. V.40703.

Theaceae Genus? (cf. **Gordonia**) p. 114

2. Dehisced three-valved capsule, side. × 6.5. V.40704.
3. Same, opposite side. Septum, *s*, is visible on the inner face of the valve behind although partly out of focus. × 6.5.
4. Same, aspect as in Fig. 3 after two valves were further broken. Columella is exposed at *c*. × 6.5.

Oncoba rugosa n.sp. p. 114

5. Seed, side; *ch*, chalaza; *h*, hilum. × 8.5. Decayed.
6. Same looking onto large subcircular chalaza, *ch*. × 8.5.
7. Fragment of another seed showing characteristic surface sculpture. × 15. V.42367.
8. Holotype. Much compressed seed; *ch*, chalaza; *h*, hilum. × 15.5. V.42366.
9. Another much compressed seed. Lettering as in Fig. 8 except *r*, ? raphe. × 15.5. V.42368.
10. Crushed and longitudinally puckered seed; *ch*, chalaza. × 15.5. V.42027.

Thymelaespermum lakense n.gen. & sp. p. 116

11. Holotype. Seed, side, chalazal end imperfect; *m*, micropyle and hilum. × 15. V.40705.
12. Hilar end of a seed, external surface. Breadth increased by crushing and bursting. × 15. V.40708.
13. Fragment of seed, chalazal end, external surface; *ch*, part of chalazal prominence. × 15. V.40709.
14. Same, inner surface; *ch*, chalazal prominence; *te*, columnar tegmen in section. × 15.

Fig.

15. Chalazal end of a seed; *ch*, position of chalaza (burst). × 15. V.40707.

Thymelaespermum (?) **sulcatum** n.sp. p. 117

16. Holotype. Crushed seed, burst at hilar end. *ch*, chalaza. × 15. V.40718.

Ammannia lakensis n.sp. p. 118

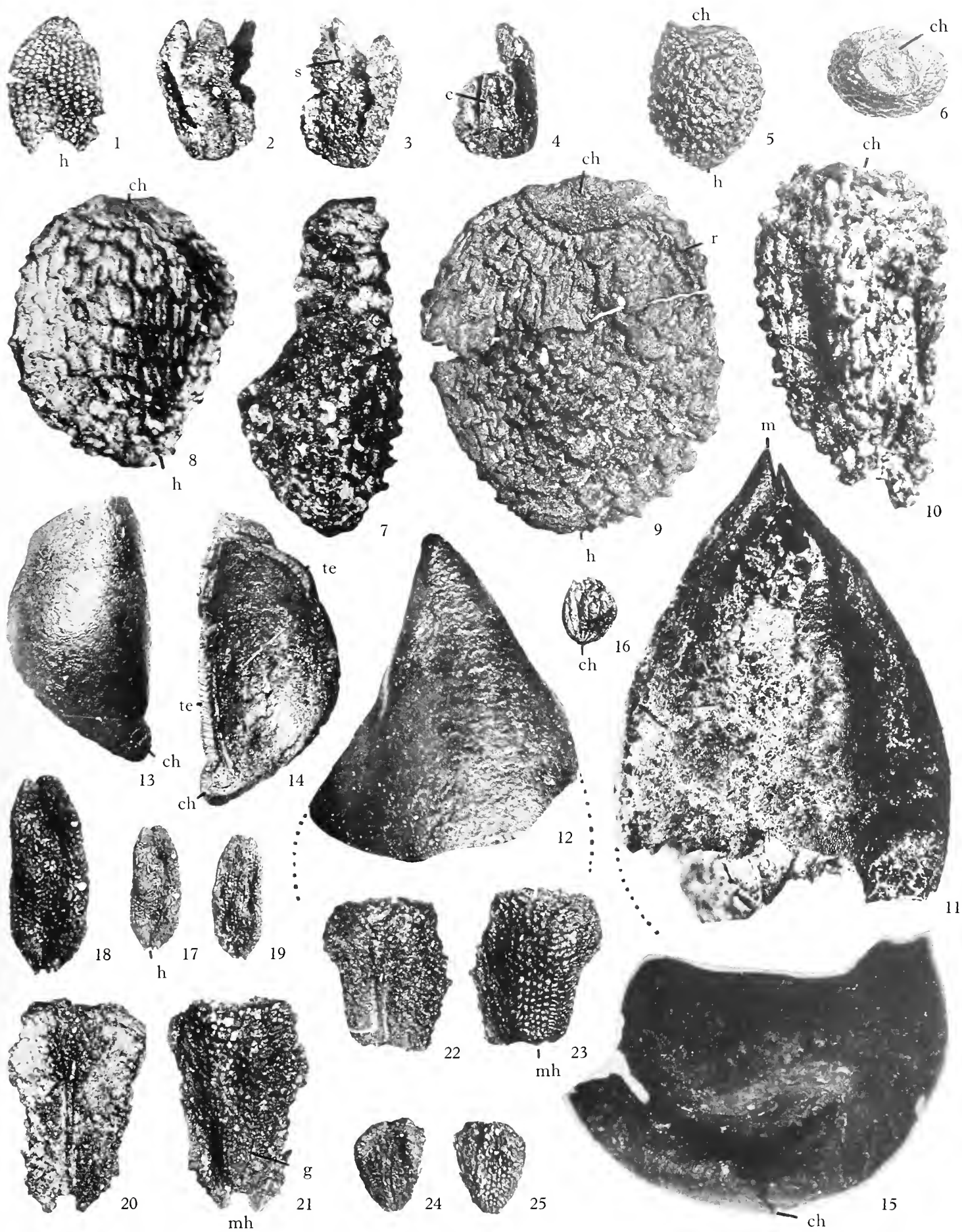
17. Holotype. Seed, raphe side; *h*, hilum. × 20. V.40719.
18. Same. × 32.

19. Same, opposite side. × 20.

Alatospermum lakense n.gen. & sp. p. 119

20. Holotype. Seed, ventral surface showing median raphe, its fibres diverging at the upper end over the chalaza. × 20. V.40720.
21. Same, dorsal surface showing the seed-body with rows of pits flanked on both sides by a narrow wing. Germination valve over body has begun to gape at *g* on right side; *mh*, hilar-micropylar region. × 20.
22. Another seed, ventral. × 20. V.40721.
23. Same, dorsal, lines of pits over valve clearly seen, wings narrow showing transverse alignment of cells of outer layer of testa; *mh*, micropyle and hilum. × 20.
24. Small oboval seed, ventral. × 15. V.40722.
25. Same, dorsal. × 15.

Figs. 1-4, 11-25 Lake, Figs. 17-19 basal beds in foreshore, Figs. 20-25 fine silt, base of section, western end; Figs. 5-7 Cliff End, Mudeford; Fig. 8 Sandbanks; Fig. 9 Branksome Dene; Fig. 10 Arne.



ACTINIDIA, THEACEAE GENUS (?), ONCOBA, THYMELAEASPERMUM, AMMANIA, ALATOSPERMUM



Explanation of Plate 17

Fig.

Alatospermum lakense n.gen. & sp. p. 119

1. Asymmetrically developed seed, ventral, with one large lateral wing, the other being represented by a narrow flange (right). $\times 20$. V.40723.
2. Same, dorsal; *mh*, micropyle and hilum. Transversely aligned cells on right wing are clearly seen. $\times 20$.
3. Triangular seed with broad blunt pitted body, dorsal. Wings narrow below, broad above (tip of right wing cracked obliquely). $\times 20$. V.40724.
4. Smaller seed, ventral, with clearly marked raphe from which cells diverge obliquely. $\times 20$. V.40725.
5. Same, dorsal. $\times 20$.
6. Seed, dorsal, asymmetrically developed with only one wing. $\times 15$. V.40726.

Cleyera ? obliqua n. sp. p. 111

7. Holotype. Seed, much compressed so that the condyle between the limbs is impressed through the testa on the external surface. $\times 15$. V.40728.

Hordwellia crassisperma (Chandler) p. 112

8. Crushed fruit, side, with persistent superior perianth, *p*. $\times 15$. V.40729.
- 9, 10. Opposite ends of a dorsiventrally crushed three-loculed fruit from which the pericarp has been abraded exposing three seed-masses in locules with septa between. $\times 6.5$. V.40732.
11. Another fruit, side, with pericarp abraded exposing relatively uncrushed seed-masses as in growth. $\times 15$. V.40740.
- 12, 13. Two seeds, side. $\times 20$. V.40743, V.40746.
14. Small seed, ventrilateral view showing incipient separation of the two valves as for germination on the right. $\times 15$. V.40741.
15. Another seed, side. $\times 20$. V.40744.
- 16-18. Three shorter, broader seeds. $\times 20$. V.40742, V.40745. Fig. 17 decayed.
19. Seed showing splitting in plane of symmetry. $\times 15$. V.44776.
- 20-25. Six seeds showing variations of size and shape. $\times 15$. V.20069*a*, V.40761.
26. Exterior of one valve of a well preserved seed. $\times 15$. Decayed.
27. Other valve of same seed, inner surface showing raphe in thickness of testa on the right; *h*, hilum; *m*, micropyle. $\times 15$.

Fig.

28. Valve of a seed, inner surface, for comparison with Fig. 27, raphe on left; *h*, hilum; *m*, micropyle. $\times 15$. V.40731.
29. Short broad seed, external surface. $\times 15$. Decayed.
30. Larger typical seed. $\times 15$. V.40733.
31. Valve of a seed, inner surface, with unusually prolonged hilar end. Wall in section is clearly seen. $\times 15$. V.40734.
32. Unusually short broad seed, interior of valve; raphe on right; *h*, hilum; *m*, micropyle. $\times 15$. V.40735.
- 33, 34. Two seeds showing variations of form and size. $\times 15$. V.40736-37.
35. Short seed, ventrilateral, showing separation into two valves in plane of symmetry as in germination. $\times 15$. V.40738.
36. Long narrow seed. $\times 15$. V.40739.
37. Seed somewhat crushed dorsiventrally. $\times 15$. V.40730.
38. Valve of a seed, inner surface, raphe in thickness of testa on right; *h*, hilum; *m*, micropyle. $\times 15$. V.44771.
39. Wedge-shaped seed, side, exterior. $\times 15$. V.44772.
40. Ventrilateral view of small seed showing suture between the two valves. $\times 15$. V.44773.
- 41, 42. Two seeds, side. $\times 15$. V.44774-75.
43. Seed (slightly damaged on left), side; *h*, hilum; *m*, micropyle. $\times 15$. V.40752.
44. Imperfect seed. $\times 15$. Decayed.
45. Small but typical seed. $\times 15$. V.40753.
46. Ventrilateral view of a long narrow wedge-shaped seed. $\times 15$. V.40756.
47. Seed, side, *h*, hilum; *r*, raphe. $\times 15$. V.40754.
- 48-50. Three seeds, that in Fig. 49 slightly imperfect. $\times 15$. V.40755, V.40757. Fig. 49 decayed.
51. Exterior of a valve (cracking transversely). $\times 15$. Decayed.
52. Interior of same; *h*, hilum. $\times 15$.
- 53, 54. Opposite sides of a seed; *h*, hilum; *m*, micropyle. $\times 15$. V.40759.
55. Same seed, ventrilateral, showing mode of separation of two valves. $\times 15$.

Fig.

56. Valve of small seed, exterior. $\times 15$. V.40760.

57. Other valve of same, interior. Raphe can be seen in thickness of wall on right; *h*, hilum; *m*, micropyle. $\times 15$.

58, 59. Two halves of seed in Figs. 53-55 which broke irregularly along the dorsal side; *m*, micropyle; *h*, hilum. $\times 15$. V.40759.

60. Valve of a seed, inner surface. $\times 15$. Decayed.

61. Valve of another seed showing raphe in testa on left (filled with white sand). Lettering as above. $\times 15$. V.40758.

Figs. 1-7, 11-19 Lake, Figs. 1-6 from fine silt, base of section, western end; Figs. 8, 37-42 Branksome Dene; Figs. 9, 10, 28-36 Sandbanks; Figs. 20-27 Hordle; Figs. 43-50 Southbourne, Figs. 43, 44 from leafy lenticle, cliff base, Fig. 45 from sands cliff base, Figs. 46-50 from Lignite above Boscombe Sands; Figs. 51-61 Cliff End, Mudeford.



ALATOSPERMUM, CLEYERA, HORDWELLIA



Explanation of Plate 18

Fig.

? *Mastixia cantiensis* Reid & Chandler p. 122

1. Fruit with apical perianth disc (indicated at margins by *p*, *p*). Longitudinal fibres on sides of fruit clearly seen. $\times 3$. V.40762.
2. Same broken surface of interior (as found in matrix) looking onto ventral wall of locule. Longitudinal ridges on left of locule are puckering due to compression. There is a natural suture of the germination valve on the right; on the left the broken wall of the endocarp is seen. $\times 3$.
3. Counterpart half corresponding to the upper end of Fig. 2 showing the germination valve with its suture on the left and the crushed infold at *f*. Fractured endocarp wall adheres to and obscures the right-hand suture of the valve. $\times 3$.

Eomastixia rugosa (Zenker) p. 124

4. Endocarp looking onto one of the valves. The furrow which corresponds with the internal longitudinal infold is seen in the middle of the figure. $\times 2.8$. V.40770.
5. Another, now cracking, showing rugose surface. $\times 2.8$. V.40771.
6. Much crushed endocarp. $\times 2.8$. V.40772.
7. Endocarp with valve outline clearly shown. $\times 2.8$. V.40775.
8. Endocarp, much cracked. One germination valve faces the camera with its median external furrow seen near the apex (white sand filled). Resin is exposed on right below through cracking of the outer layers. $\times 6.5$. V.40776.
9. Symmetric endocarp looking onto one valve with its external groove. $\times 2.8$. Decayed.
10. Another endocarp looking onto the septum between the two locules. The valves (*v*, *v*) have begun to gape at the apex. $\times 2.8$. V.20081*a*.
11. Uncrushed endocarp looking onto a valve with its median groove. $\times 2.8$. V.20081*b*.
12. Short broad endocarp showing characteristic irregularities of the surface. $\times 2.8$. V.20080*a*.
13. Obovoid endocarp. One valve is turned a little to the right as indicated in the figure by its median groove. $\times 2.8$. V.20080*b*.
14. Endocarp with one valve removed looking onto the locule. Remains of a seed adhere along the median line. $\times 2.8$. V.20081*c*.
15. Valve detached from the above, external surface showing median groove. $\times 2.8$.

Fig.

16. Same valve, internal surface showing median infold and smooth sutures at the margins. $\times 2.8$.
17. Endocarp (fractured transversely) external surface. $\times 2.8$. V.40779.
18. Typical rugose endocarp showing an infold over one valve. $\times 2.8$. V.41962.
19. Another. $\times 2.8$. V.40780.
20. Endocarp tilted to show apex. $\times 2.8$. V.41963.
21. Fruit with exocarp preserved, slightly distorted. Resin in a duct can be seen near top right side of figure. Its expansion has ruptured the duct wall. $\times 2.3$. V.40767.
22. Same, opposite side. The superior perianth disc with median style base is seen at the apex. The longitudinal fibres on the sides of the fruit terminate against the disc. $\times 2.3$.
23. Fruit tilted to show perianth disc. $\times 2.3$. V.40768.
24. Fruit showing apical perianth disc, *p*, and style base in profile. $\times 2.8$. V.40769.
25. Same, opposite side, gaps in the exocarp due to expansion of the resin in the longitudinally aligned ducts can be seen. $\times 2.3$.
26. Endocarp with one valve removed looking into the locule. $\times 2.7$. V.40784.
27. Valve from the above (broken at apex), inner surface showing infold. $\times 2.7$.
28. Much battered endocarp. $\times 2.7$. V.40785.
29. Endocarp with one valve removed looking into the locule. $\times 2.7$. V.40786.
30. Upper half of the valve from the above, inner surface showing infold. $\times 2.7$.
31. Endocarp. Resin is seen breaking through the wall at *t* and other places. $\times 2.8$. V.40787.
32. Crushed endocarp. $\times 2.7$. V.40788.
33. Battered endocarp. $\times 2.7$. V.41964.
34. Much abraded endocarp. $\times 2.7$. V.41965.
35. Three-loculed endocarp looking onto a septum, *s*, flanked by two of the locules. $\times 2.6$. Decayed.
36. Same looking onto one of the valves. The external furrow can be seen. $\times 2.6$.

Fig.

37. Same, apex, showing the three valves, *v*, and septa between them. $\times 2.6$.
38. Endocarp looking onto one valve with its median furrow along which cracking is taking place. $\times 2.7$. Decayed.
39. Small, perhaps immature, fruit with exocarp preserved and superior perianth scar, *p*. Longitudinal fibres are seen below the scar. $\times 2.8$. Decayed.
40. Same, opposite side. $\times 2.8$.
41. Same seen at right angles to the previous figures. $\times 2.8$.

Figs. 1-3, 7, 8 Arne; Figs. 4-6 Lake; Figs. 9-16 Hordle; Fig. 17 Sandbanks; Figs. 18-27 Bournemouth, Figs. 18-20 between Branksome and Canford Chines, Figs. 21-25 base of east cliff, Figs. 26, 27 east of east cliff lift; Figs. 28-30 Honeycomb Chine, Boscombe; Figs. 31, 32 Southbourne, Fig. 31 carbonaceous lenticle at base of Boscombe Sands, Fig. 32 Lignite above Boscombe Sands; Figs. 33, 34 Cliff End, Mudeford, Fig. 33 coarse sands formerly seen in foreshore by old "Run" of river at extreme low water, Fig. 34 fine sandy beds in cliff (Highcliff Sands); Figs. 35-41 Barton.



MASTIXIA, EOMASTIXIA

Explanation of Plate 19

Figs

Eomastixia rugosa (Zenker) p. 124

1. Transverse section of a slightly distorted endocarp showing two locules, septum, and infolds on the middle of the germination valves. $\times 2.7$. V.20081*d*.
2. Another undistorted endocarp in transverse section showing the same features and the tendency for the valves to split down the infolds. $\times 2.7$. V.20079*b*.
3. Three-loculed endocarp, transverse section showing same features. Edges of the three germination valves indicated by *v*. $\times 6.5$. V.40778.
4. Section across a somewhat crushed three-loculed endocarp shown before sectioning in Pl. 18, fig. 19. $\times 6.5$. V.40780.
5. Two-loculed fruit in transverse section showing septum and two slightly distorted locules with infolds. The thin exocarp, *ex*, can be distinguished in places from the thick woody endocarp. Resin cavities, *r*, are seen near the margin and in the median plane of the infolds. $\times 6.5$. V.40764.
6. Endocarp in Pl. 18, fig. 34 in transverse section showing two somewhat crushed locules and the septum, a few scattered resin cavities, circular in section can also be seen. $\times 6.5$. V.41965.
7. Transverse section of endocarp in Pl. 18, figs. 35–37 showing the three crushed locules (numbered 1, 2, 3). $\times 6.5$. Decayed.

Eomastixia urceolata n.sp. p. 126

8. Holotype. Small fruit with three tiny persistent superior perianth segments at the apex. $\times 6.5$. V.41970.
9. Larger specimen showing perianth segments. The longitudinal groove lies opposite the middle of a valve on the endocarp within. $\times 6.5$. V.41971.
10. Small endocarp showing a valve (left) splitting away longitudinally. Infold of valve indicated by a shallow longitudinal furrow, *i*. $\times 6.5$. V.41972.
11. Another with one valve removed on the left exposing the ventral surface of the locule, *l*. $\times 6.5$. V.41973.

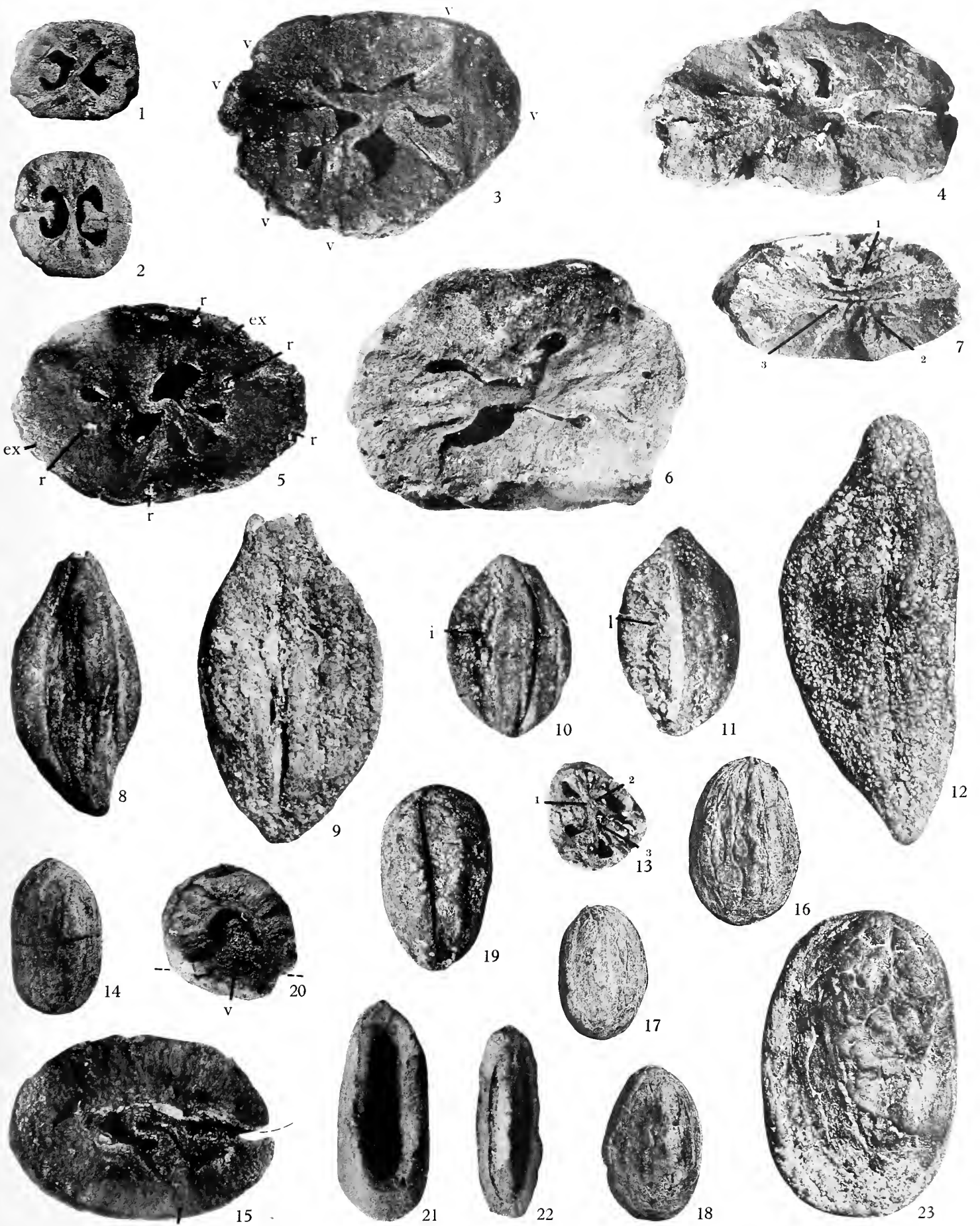
Fig.

12. Large, but abraded fruit showing urceolate form. Perianth segments abraded. $\times 6.5$. V.41974.
13. Transverse section of a small three-loculed endocarp, locules indicated by figures. $\times 6.5$. V.41975.

Mastixicarpum crassum Chandler p. 128

14. Endocarp, side. $\times 2.3$. V.41979.
15. Same seen in transverse section. Germination valve lies between dotted lines. The single crushed locule and splitting of valve along its median infold are clearly seen. $\times 6.5$.
16. Fruit with epicarp and network of fibres preserved. $\times 2.3$. V.41980.
17. Similar but smaller fruit. $\times 2.3$. V.41981.
18. Another example in which the tiny superior perianth scar is obscurely seen at the apex. $\times 2.3$. V.41982.
19. Holotype. Endocarp, side with valve on right; gaping left suture of valve clearly visible. $\times 2.8$. V.20074*a*.
20. Another endocarp in transverse section showing the single locule; germination valve, *v*, with median infold lies between dotted lines. Slightly distorted. $\times 2.8$. V.20074*b*.
- 21, 22. Endocarp (Fig. 21) laterally compressed with valve removed looking into the locule. Valve inner face (Fig. 22) with projecting infold. $\times 2.8$. V.20074*c*.
23. Large but much crushed fruit showing network of fibres in the epicarp. Its identity was proved by a transverse section. $\times 2.8$. V.41976.

Figs. 1–3, 19–22 Hordle; Figs. 4, 5, 14–18 Bournemouth, Fig. 4 between Branksome and Canford Chine, Figs. 5, 14–18 base of east cliff; Fig. 6 Cliff End, Mudeford; Fig. 7 Barton; Figs. 8–13, 23 Lake.



EOMASTIXIA, MASTIXICARPUM

Explanation of Plate 20

Fig.

Mastixicarpum crassum Chandler p. 128

1. Much crushed fruit which shows the exocarp and in places the network of fibres. (There are impressions of other vegetable débris squeezed on it near the apex.) $\times 2.7$. V.41985.
2. Somewhat laterally compressed endocarp, now broken. $\times 6.5$. V.41987.
3. Much worn endocarp, incomplete above, with valve partially corroded along its median plane of weakness. $\times 6.5$. Decayed.
4. Another endocarp, seen in transverse section, showing in-fold, *i*, on valve to right projecting into locule. $\times 6.5$. V.41986.

Nyssoidea eocenica n.gen. & sp. p. 120

5. Holotype. Endocarp, dorsal, showing short apical valve, *v*. $\times 2.8$. V.41942.
6. Same, ventral. $\times 2.7$.
7. Small fruit with exocarp well preserved so that it hides the dorsal valve. Small apical perianth disc visible at *a*. $\times 2.8$. V.41943.
8. Same, ventral. $\times 2.8$.
9. Endocarp, dorsal, showing valve, *v*. $\times 2.8$. V.41945.
10. Another, dorsal, valve has fallen away showing locule cavity, *l*. $\times 2.8$. V.41946.
11. Same, ventral. $\times 2.8$.
12. Locule cast (imperfect at base and apex), dorsal side showing deep furrow which is impression of ridge on locule wall (furrow partly hidden by a film of clay). $\times 2.8$. V.41947.
13. Same, ventral. $\times 2.8$ approx.
14. Endocarp, dorsal, showing valve. The transverse crack is a break in fossilization and has no connexion with the structure. $\times 2.9$. V.41948.
15. Same seen in oblique transverse section after removal of broken tip and valve; *r*, ridge projecting into locule from the dorsal wall just below the valve; *v*, lateral limits of valve; *d*, dorsal surface of endocarp below valve. $\times 6.5$.
16. Large endocarp, dorsal, base incomplete, apex very slightly imperfect. Germination valve missing exposing sandy locule cast, *l*. $\times 3$. Decayed.

Fig.

17, 18. Two small but perfect specimens. Fig. 17 shows obscurely the short dorsal germination valve at *v*. Fig. 18 appears to be a fruit as the apical perianth disc is indicated by a slight contraction of the outline. $\times 3$. V.41949-50.

19. Endocarp, dorsal. Valve, *v*, still in position (white specks are adherent sand grains). $\times 2.8$. V.41944.
20. Basal end of a compressed decaying endocarp. $\times 6.5$. Decayed.
21. Transversely broken surface of the above. *r*, ridge projecting into compressed locule on right. Locule filled with matrix, *m*. $\times 6.5$.

Dunstania lakensis n.sp. p. 129

22. Holotype. Endocarp, side. Wall broken at the apex so that the apical depression, *a*, is exposed in section. One of the locules is seen at *l*; *v*, valve of this locule. $\times 6.5$. V.41992.

Cornus quadrilocularis n.sp. p. 130

23. Holotype. Endocarp, side, looking onto one of the valves. $\times 6.5$. V.41988.
24. Same, opposite side with its valve removed, looking into the locule. $\times 6.5$.
25. Same, apex before removal of the valve. It shows opening (emphasized and obscured by white sand) of the shallow apical hollow. Two of the four valves have begun to gape. The endocarp has been laterally compressed in fossilization. $\times 6.5$.
26. Same, inner surface of the detached valve. A seed, somewhat displaced, adheres to it below; it shows the sharply pointed hilar end, *h*. The transverse alignment of the cells can be seen but is even clearer in the actual specimen. $\times 15.5$.

Cornaceae? Genus? p. 131

27. Side of endocarp which has lost two of its valves exposing locules at *l*, *l*. $\times 15.5$. V.41994.

Diospyros headonensis Chandler p. 133

28. Somewhat crushed four-fid calyx; surface much obscured by sand pitting. Sepals numbered 1-4. $\times 6.5$. V.41995.
29. Same with sepal 2 removed. $\times 6.5$.

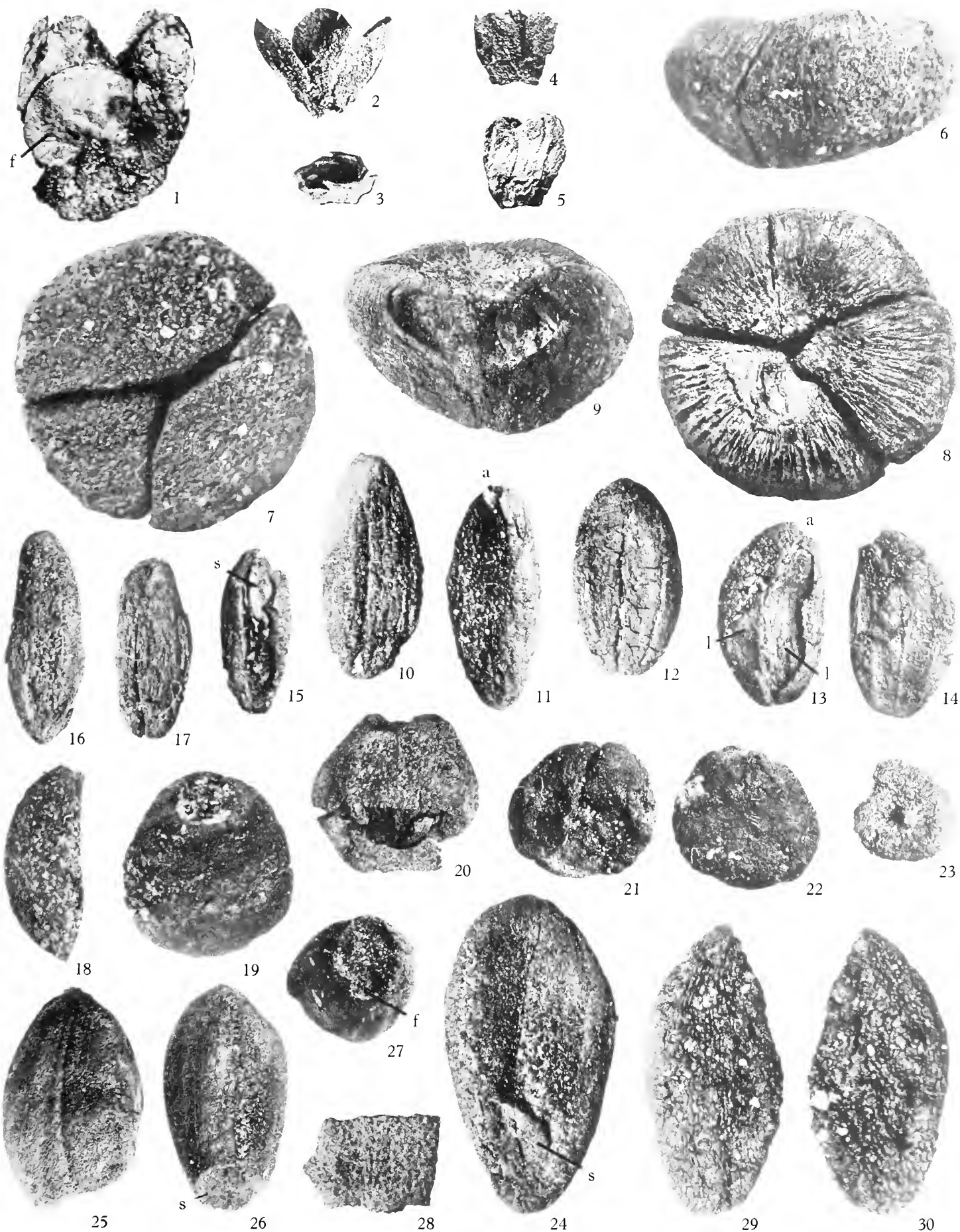
Fig. 1 Lignite above Boscombe Sands, Southbourne; Fig. 2 Hengistbury Head; Figs. 3, 4, 20, 21 Cliff End, Mudeford; Figs. 5-13 west of Pier, Bournemouth; Figs. 14, 15, 22-29 Lake; 16-18 Arne; Fig. 19 Sandbanks.



MASTIXICARPUM, NYSSOIDEA, DUNSTANIA, CORNUS,
CORNACEAE GENUS (?), DIOSPYROS

Explanation of Plate 21

- Fig. **Diospyros headonensis** Chandler p. 133
1. Specimen in Pl. 20, figs. 28, 29 after removal of another sepal to show the crushed (immature) fruit, *f.* × 6·5. V.41995. [Image reversed.]
 2. Holotype. Four-partite calyx, side. × 4. V.20086.
 3. Another, apex, showing imbricate aestivation. × 4. V.20086c.
 4. Another, side, with more rounded sepals than Fig 2. × 4. V.20086b.
 5. Another, side. × 4. V.20086a.
- ? **Sapoticarpum** sp. p. 132
6. Immature (?) fruit, side, showing relative length and breadth. Longitudinal striae seen obscurely in the upper part are due to elongate ducts. × 6·5. V.40875.
 7. Same, base, showing irregular rough surface. × 6·5.
 8. Same, apex. Four natural planes of fracture are here seen (three only in previous view). The elongate longitudinally aligned ducts on the surface in the upper part of the fruit are displayed well. × 6·5.
 9. Same, inner surface after longitudinal splitting showing two of the locules, the one on the right encloses a small ?immature seed. × 6·5.
- Symplocos lakensis** n.sp. p. 134
10. Holotype. Fruit, side, showing small truncation due to apical depression. × 6·5. V.41996.
 11. Another, slightly distorted so that the apical depression, *a*, is seen at the apex. Much of the exocarp is missing. × 6·5. V.41997.
 12. Another. × 6·5. V.41998.
 13. Another with part of the wall chipped away so that two locules, *l*, *l*, are exposed. The fruit is slightly distorted and the apical truncation, *a* (due to the depression), therefore appears oblique to the fruit axis. × 6·5. V.41999.
 14. Same, exterior; opposite surface to the above with most of the exocarp gone. × 6·5.
 15. Another with part of the wall removed exposing a seed, *s.* × 6·5. V.42000.
 - 16–18. Three endocarps, side. Fig. 18 shows the truncation due to the small apical depression. × 6·5. V.42007–09.
- Fig. **Symplocos headonensis** Chandler p. 135
19. Endocarp, side, slightly tilted to show apical depression with its three apertures (somewhat obscured by sand grains). × 6·5. V.42011.
- Symplocos** sp. (? **S. headonensis**) p. 136
20. Endocarp, side, showing truncation of apex. Wall cracking and gaping transversely below where two seeds can be seen. × 6·5. V.42013.
- Symplocos** sp. p. 136
21. Endocarp, side, slightly distorted so that the basal attachment is seen at the junction of three lobes which correspond to the three locules. × 6. V.42012.
 22. Opposite side of same with small sand filled apical depression. × 6.
- Symplocaceae? (or Cornaceae?) p. 137
23. Styler plug or perianth disc, outer surface with style base, from apex of a fruit. × 6·5. V. 42014.
- Styrax elegans** Chandler p. 137
24. Somewhat crushed endocarp, ventral, showing the oblique basal attachment scar, *s.* × 6·5. V.40876.
 25. Another endocarp, somewhat compressed laterally, ventral side to right. The oblique truncation at the base is caused by the attachment scar. × 6. Decayed.
 26. Holotype. Uncrushed endocarp, ventral. *s.*, scar of attachment. × 6. V.20091.
 27. Base of same endocarp with attachment scar. *f.*, aperture for entrance of funicle. × 6·5.
 28. Fragment of an endocarp showing typical surface pits. × 15. Decayed.
- Apocynospermum lakense** Chandler p. 138
29. Holotype. Seed, ventral. × 15·5. V.34674.
 30. Same, dorsal. × 15·5.
(In both white patches are sand grains.)
- Figs. 1, 10–15, 21–24, 29, 30 Lake; Figs. 2–5, 25–28 Hordle; Figs. 6–9, 16–20 Arne.



DIOSPYROS, SAPOTICARPUM, SYMPLOCOS, SYMPLOCACEAE GENUS (?),
STYRAX, APOCYNOSPERMUM

Explanation of Plate 22

Fig.

Apocynospermum lakense Chandler p. 138

1. A seed, ventral, showing elongation of cells and tendency to split along scar formed by raphe and hilum. $\times 15.5$. V.40877.

Apocynospermum acutiforme n.sp. p. 139

2. Holotype. Seed, ventral, showing median ridge associated with hilum and raphe. $\times 6.5$. V.40880.

Ehretia lakensis n.sp. p. 140

- 3, 4. Opposite sides of a somewhat crushed fruit enclosing two pyrenes. $\times 19$. V.42018.
5. Pyrene, ventral, showing (somewhat obscurely in the figure) the pair of suboval thickenings, *t*, at the apex. The beginning of sub-marginal splitting along the lateral margins can be seen on both sides towards the upper end. $\times 19$. V.40881.
6. Holotype. A pyrene, dorsal, showing inconspicuous ridges which produce longitudinal meshes. $\times 19$. V.40882.
7. Another, ventral. Pair of thickenings seen obscurely just below the apex. $\times 19$. Decayed.
8. Another, slightly imperfect at the base, ventral. Sub-marginal splitting shows on both sides. Sub-apical median thickenings are obscurely seen. $\times 19$. V.40883.
9. Another pyrene somewhat compressed from top to bottom, dorsal. $\times 19$. Decayed.
10. Upper part of a pyrene, ventral, showing particularly clearly the median thickenings at the apex. $\times 19$. V.40884.
11. Distorted pyrene, slightly imperfect at base (shown at top of figure), dorsal. It shows the displaced median furrow flanked by ridges and meshes. $\times 19$. V.40885.

Solanum arnense n.sp. p. 141

12. Holotype. Seed; *h*, hilum. $\times 15$. V.40898.

Fig.

13. Another, less perfect; *h*, hilum. Sinuous testa cells are obscurely seen on light patches. $\times 15$. V.40899.

Solanispermum reniforme Chandler p. 142

14. Well preserved seed, undistorted in growth, flattened in fossilization. $\times 15$. V.40891.
15. Interior of one valve of a seed which has split marginally; *h*, hilar cavity separated by a thin curved partition from main seed-cavity. $\times 15$. V.40893.
16. Seed, imperfect at one end, distorted in growth so that the hilar opening, *h*, lies on one broad surface and not at the margin. $\times 15$. V.40894.
17. Seed, imperfect at one end, much battered so that it is beginning to split along the fibres of the testa. $\times 15$. V.40897.
18. Typical seed, imperfect at one end splitting along the fibres as in Fig. 17; *h*, hilum. $\times 15$. V.40895.
19. Perfect seed with unusual hooked form at micropyle; *h*, hilum. $\times 15$. V.42091.

Solanispermum reniforme var? p. 143

20. Large subquadrangular seed, splitting along the fibres. $\times 15$. V. 40887.
21. More or less hooked seed, burst in fossilization. $\times 15$. V.40888.
22. Another smaller, slightly imperfect seed, much worn, testa splitting along fibres. $\times 15$. V.40889.

Figs. 1-11 Lake, Figs. 3-11 from fine silt, base of section, western end; Figs. 12, 13, 20-22 Arne; Fig. 14 Sandbanks; Figs. 15, 19 Branksome Dene; Figs. 16, 18 Lignite above Boscombe Sands, Southbourne; Fig. 17 Cliff End, Mudeford.



APOCYNOSPERMUM, EHRETIA, SOLANUM, SOLANISPERMUM

Explanation of Plate 23

Fig.

Sambucus parvula Chandler p. 144

1. Seed, dorsal, showing characteristic ornamentation. $\times 20$. V.40903.
2. Same, ventral. Hilum and micropyle at base, *m, h.* $\times 20$.
- 3-10. Eight typical seeds. Holotype Fig. 6. Figs. 3, 6-8 dorsal, Figs. 4, 5, 9, 10 ventral. $\times 15$. V.20096, V.20096a, V.20097a-f.

Cucurbitospermum lakense n.sp. p. 144

11. Seed, hilum and micropyle closely adjacent at pointed end. $\times 6.5$. V.40905.
12. Holotype, with lower end of one valve removed but the valve is still adherent over the chalaza; *h*, hilum; *m*, micropyle. $\times 6.5$. V.40904.
13. Valve of another seed, incomplete. Inner surface; *h*, hilum; *m*, micropyle; *ch*, chalaza. $\times 6.5$. V.40906.
14. Lower end of the other valve of the same seed. *m, h*, as above. $\times 6.5$.

Cucurbitospermum obliquum n.sp. p. 145

15. Holotype. Seed, exterior of one valve. $\times 6.5$. V.40909.
16. Interior of other valve of same, slightly imperfect at apex. $\times 6.5$.
17. Valve in Fig. 15, inner surface, with adherent remains of the other valve around the margin on left and at apex; *m, h*, micropyle and hilum; *ch*, chalaza. $\times 6.5$.

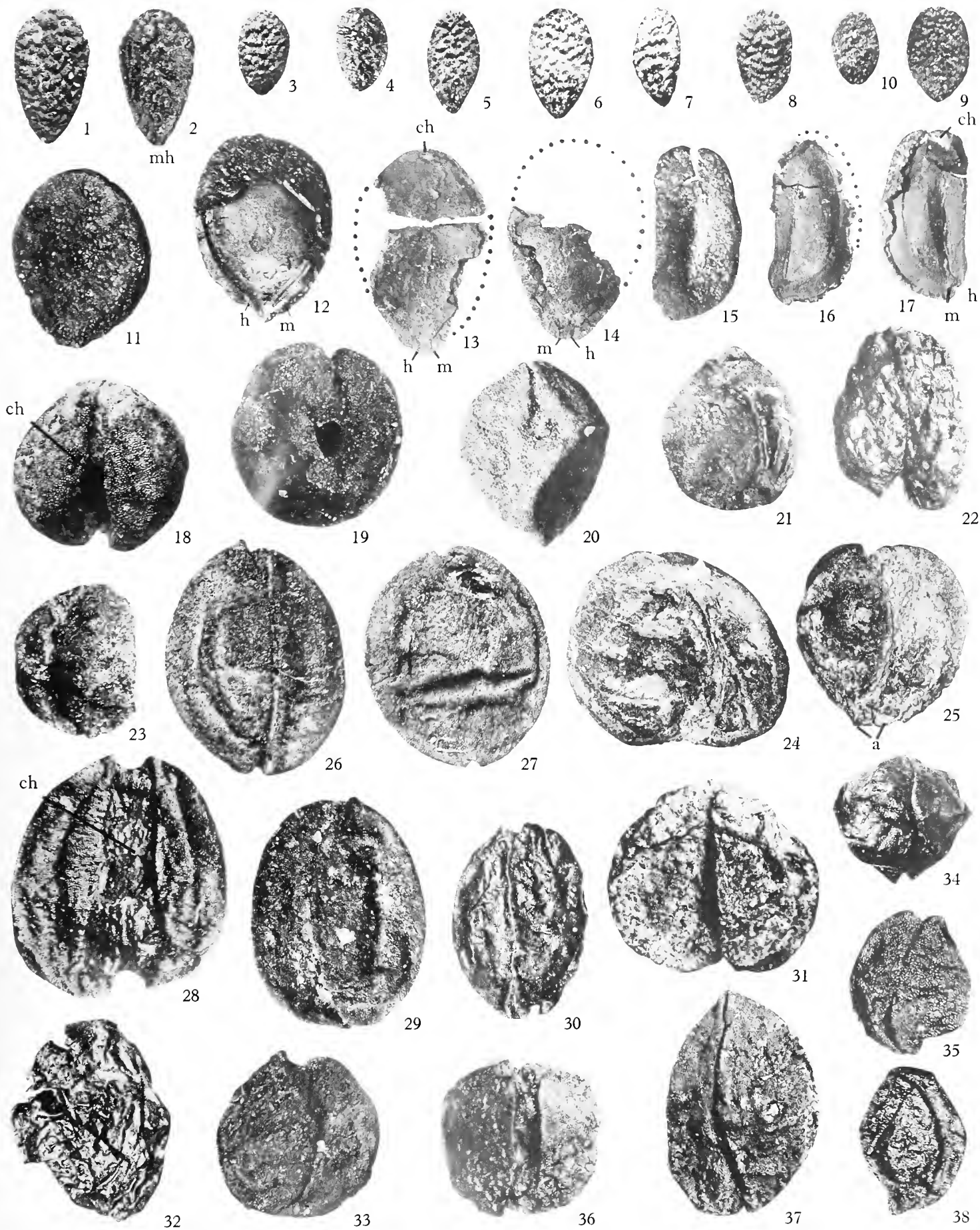
Rhamnospermum bilobatum Chandler p. 146

18. Holotype. Typical well preserved inflated seed, showing two lobes and large chalazal aperture, *ch*, in furrow between. $\times 15$. V.20064b.
19. Another, apex, the terminal aperture has lost its plug. Two lobes towards top of figure. $\times 15$. V.20064c.
20. Seed, same position as Fig. 19, with plug preserved. (One side below has collapsed and is in shadow.) $\times 15$. V.40920.
21. Crushed seed with lobes flattened one upon the other on the left of the figure. $\times 15$. V.40910.
22. Sand pitted and abraded seed, represented by shining tegmen only; it shows two lobes facing camera. $\times 15$. V.40911.

Fig.

23. Inflated seed, dorsilateral. Two lobes turned slightly to the left. $\times 15$. V.40912.
- 24, 25. Two seeds, dorsal, with adherent patches of fruit wall; *a*, attachment in Fig. 25. $\times 15$. V.40915-16.
26. Large somewhat flattened seed, dorsal, with lobes pressed closely together. $\times 15$. V.40921.
27. Another, opposite surface, flattened and slightly distorted so that the apical aperture is displayed (plug missing). $\times 15$. V.40922.
28. Large seed, dorsal, flattened in such a manner that the lobes are pressed apart showing the large round chalazal aperture, *ch*, between them. $\times 15$. V.40923.
29. Somewhat flattened seed, dorsal, showing the two lobes. $\times 15$. V.40924.
30. Smaller flattened seed to illustrate that large and small seeds are associated. $\times 15$. V.40925.
31. Somewhat flattened seed, dorsal. $\times 15$. V.40926.
32. Another, much battered and torn, the lobes are pressed one upon another on right. $\times 15$. V.42016.
33. Much abraded seed, dorsal. $\times 15$. V.40927.
34. Very small but inflated seed, dorsal. $\times 15$. V.40928.
35. Small, somewhat crushed seed, dorsal. $\times 15$. V.40929.
36. Another seed, dorsal, showing the two lobes. $\times 15$. V.40930.
37. Another, dorsal. $\times 15$. V.40931.
38. Small compressed seed, dorsilateral view. $\times 15$. V.40932.

Figs. 1, 2, 11-17, 21-23 Lake, Figs. 1, 2 basal beds in foreshore; Figs. 3-10, 18-20 Hordle; Figs. 24, 25 Arne; Figs. 26-28 Sandbanks; Figs. 29, 30, 37, 38 Branksome Dene; Figs. 31, 32 Bournemouth, Fig. 31 between Alum and Middle Chines, Fig. 32 between Middle and Durley Chines; Figs. 33, 34 Honeycomb Chine, Boscombe; Figs. 35, 36 leafy lenticle, cliff base, Southbourne.



SAMBUCUS, CUCURBITOSPERMUM, RHAMNOSPERMUM

Explanation of Plate 24

Fig.

Rhamnospermum bilobatum Chandler p. 146

1. Flattened seed, dorsal. $\times 15$. V.40933.
2. Another compressed from top to bottom showing apical aperture in the centre (plug missing). Cell structure particularly clearly shown in figure (cf. in this respect Pl. 23, figs. 18, 28, 35). The two lobes are towards the left. $\times 15$. V.40934.
3. Seed similarly compressed to Fig. 2, but much distorted also. It shows the apical aperture (plug missing). $\times 15$. V.40935.
4. Seed, dorsal, showing two lobes. $\times 15$. V.40936.
5. Typical small uncrushed seed, dorsal. $\times 12$. V.40937.
6. Very large seed (such as occurs in certain seams of the Hamstead Beds), dorsal, somewhat flattened so that the lobes are forced apart. Chalazal aperture at *ch*. $\times 15$. V.40938.
7. Seed, dorsal. $\times 15$. V.40939.
8. Laterally flattened seed showing the two lobes, towards the left. It appears to show a peduncle, *p*, at the junction of which with the fruit are a few small bracts, *b* (calyx lobes?). $\times 15$. V.40940.
9. Same, opposite side, displaying better the peduncle, *p*, and bracts or perianth segments, *b*. $\times 15$.

Carpolithus arnensis n.sp. p. 147

10. Holotype. Base of fruit, apex ruptured and remains partly incurved showing constricted area of attachment at base and fibres which begin to branch at the edge of the basal constriction. $\times 3$. V.40941.

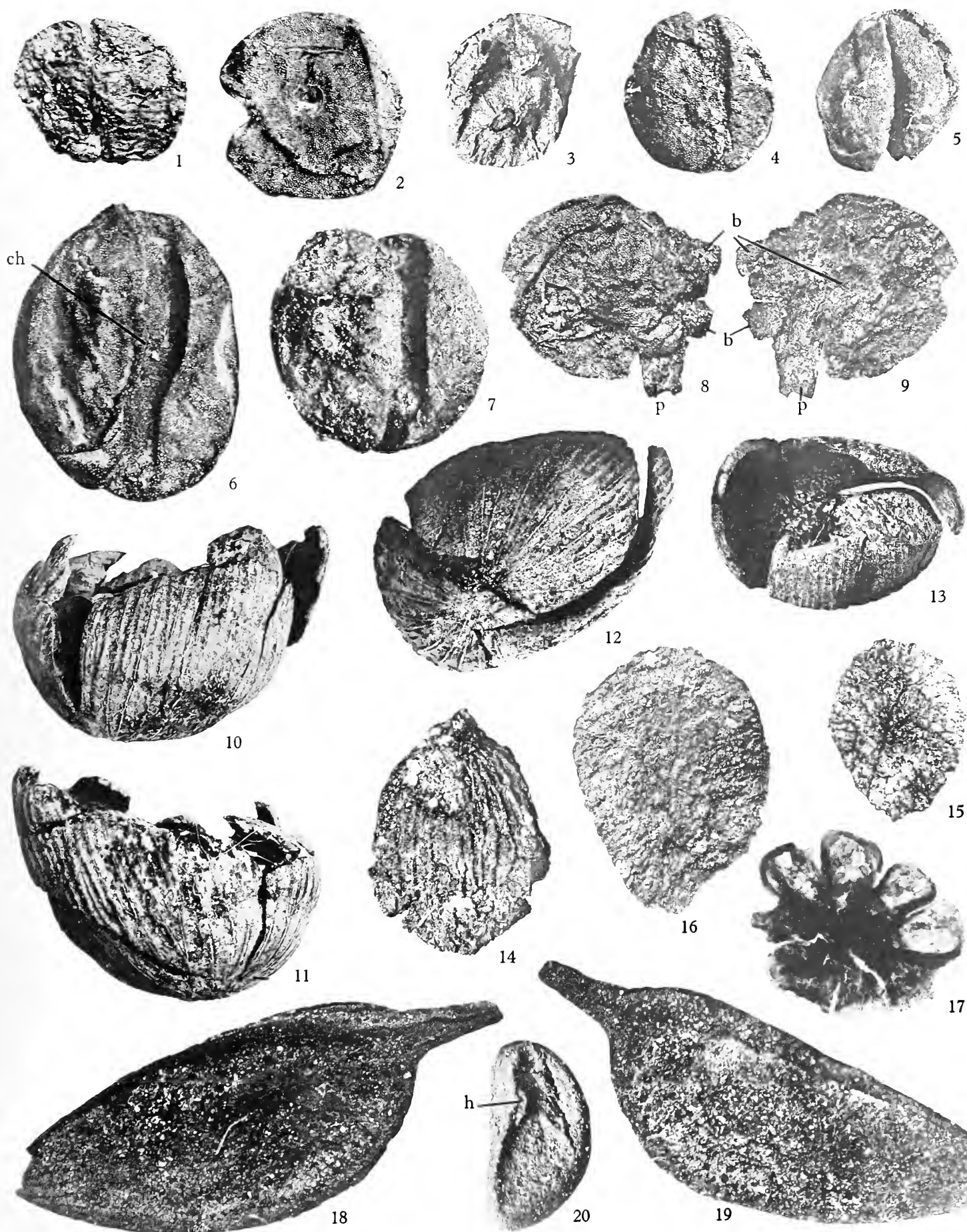
Fig.

11. Same, opposite side, branching of fibres more clearly shown. $\times 3$.
12. Same, base showing divergence of fibres from a small circular central area. $\times 3$.
13. Same from above looking into the interior where the chalaza lies. $\times 2.5$.

Carpolithus spp. pp. 148-150

14. Fruit, side, showing veined and puckered exocarp. $\times 15$. V.40942.
15. Much sand-pitted, plate-like organ showing branching nervation. $\times 9$. V.40943.
16. Another. $\times 16$. V.40944.
17. Whorl of fruits or sporangia? $\times 49$. V.40946.
18. Pod with stalk preserved; extreme tip broken. $\times 19.5$. V.40947.
19. Same, opposite surface showing low rounded tubercles more clearly than in Fig. 18 (tip of pod cut off by edge of negative). $\times 19.5$.
20. Seed, ventral margin near left edge of figure; *h*, hilum. $\times 15$. V.40948.

Figs. 1, 2 Lignite above Boscombe Sands, Southbourne; Figs. 3, 4 Cliff End, Mudford; Fig. 5 Hamstead cliff; Fig. 6 Bouldnor cliff; Figs. 7-9 Colwell Bay; Figs. 10-13 Arne; Figs. 14-20 Lake, Fig. 17 from basal beds in foreshore, Figs. 18, 19 from fine silt, base of section, western end.



RHAMNOSPERMUM, CARPOLITHUS

Explanation of Plate 25

Fig.

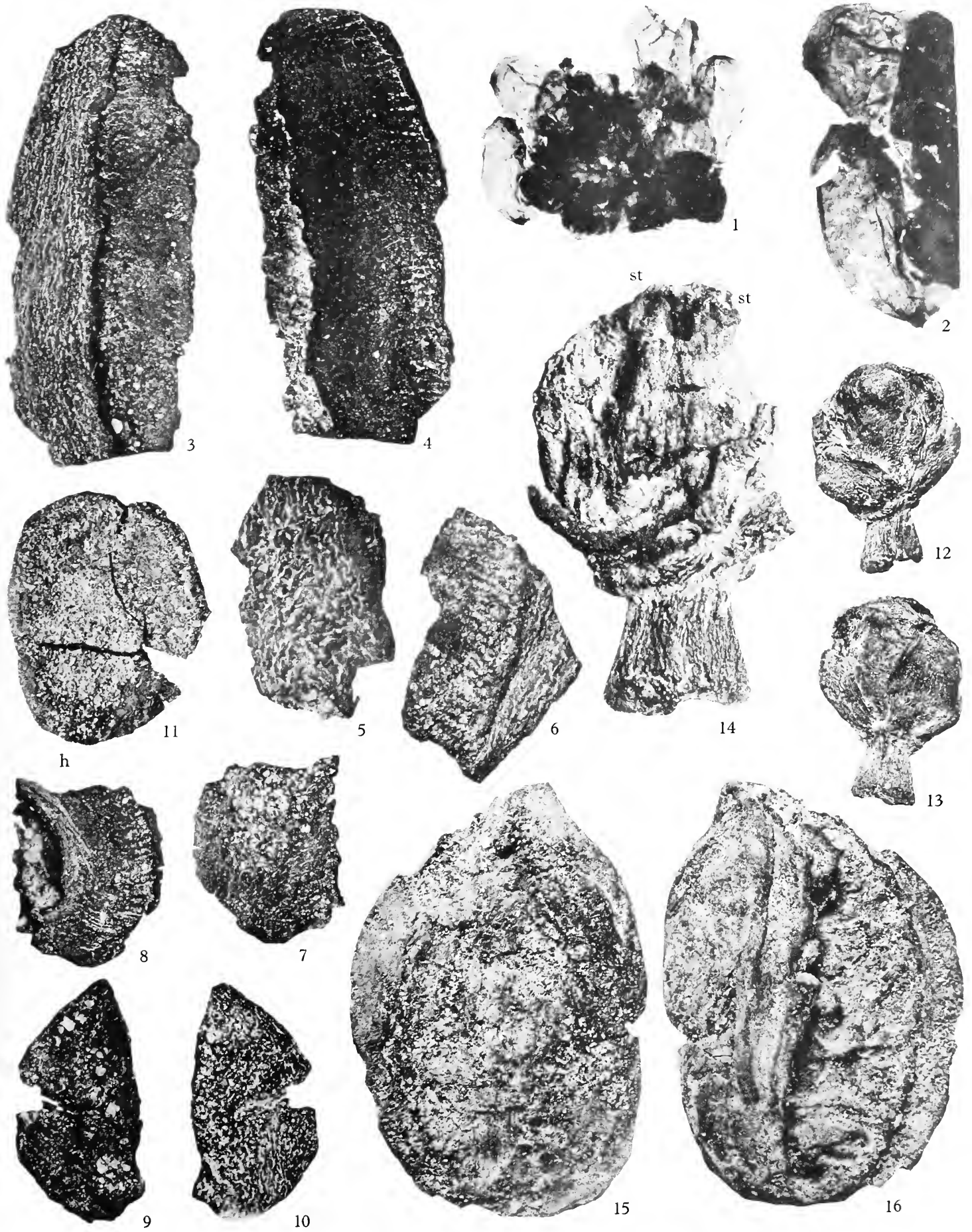
Carpolithus spp. pp. 150-152

1. Group of fruits or seeds, with only a translucent inner integument preserved. Organs at extremities indicated by thickened dark patches. $\times 50$. V.40949.
2. Two individual specimens out of the same group. A longitudinal line on the sides may represent merely a fold in the semitranslucent testa or a lateral raphe. $\times 100$ approx.
3. Valve of a large capsule showing the rugosities of the external surface on the left and the slight transverse furrowing of the locule surface on the right. $\times 6.5$. V.40950.
4. Opposite side of same valve showing more transverse furrows of the locule surface; also the ragged broken gaping edges of two adjacent locule walls which have separated on the left. $\times 6.5$.
5. Another fragment, rugose external surface. $\times 6.5$. V.40951.
6. Another fragment showing external rugosities on the right, and transversely striate locule surface on the left. $\times 6.5$. V.40952.
7. Another, rugose external surface. $\times 6.5$. V.40953.
8. Same, opposite side, showing transverse striations and, on the left, a hollow. The transverse fibres change their direction and curve so as to form the edge of the hollow. $\times 6.5$.

Fig.

9. Inner surface of a broken fragment of fruit. $\times 6.5$. V.40954.
10. Same, external surface with characteristic rugosities. The left-hand margin represents a thick broken edge. $\times 6.5$.
11. Crushed and cracking obovoid fruit (now flattened) with basal hollow at *h*, marking the attachment. $\times 6.5$. V.40955.
12. Small superior fruit with thick truncate peduncle and wrinkled leathery perianth segments showing two segments of the outer and one of the inner whorl. $\times 6.5$. V.40956.
13. Same, opposite side, showing part of one external perianth segment of the opposite side and the third segment of the outer whorl; also the second perianth segment of the inner whorl. $\times 6.5$.
14. Same, after removal of enveloping perianth segments in the upper part, showing the pistil of an ovary with stigmas, *st*, each with a deep funnel-like aperture. $\times 15$.
15. Flattened capsule, exterior. $\times 6.5$. V.40957.
16. Same, opposite side showing a gaping locule on the right with several tag-like projections (placentae?). $\times 6.5$.

Figs. 1-11, 15, 16 Lake, Figs. 1, 2 from basal beds near iron-stones, eastern end of section; Figs. 12-14 fine silt with rootlets, base of section, Arne.



CARPOLITHUS

Explanation of Plate 26

Fig.

Carpolithus spp. pp. 152-155

1. Inner somewhat concave surface of a bract or fruit. × 20. V.40958.
2. Same, convex outer surface. × 20.
3. Two-valved fruit with a pair of styles at *s*. Partial decay has shredded the fruit longitudinally into its fibre-like ducts? (latex canals?). It has a false appearance of a fibrous bract. × 8·5. V.40959.
4. Same, opposite side. × 8·5.
5. Another specimen, less decayed, showing the two closely adpressed valves beginning to separate above on the right. *s*, styles; *p*, inferior perianth segments. × 8·5. V.40960.
6. Same, opposite side. Lettering as in Fig. 5. The gaping of the valves seen below on the left. × 8·5.
7. Smaller specimen beginning to shred longitudinally. It shows a sepal adhering to the base at *c*. × 6·5. V.40961.
8. Five-partite fibrous fruit disintegrating into its component fibres. × 15. V.40966.
9. Hilar end of a seed, outer surface showing tubercles. The upper end is broken. A crested ridge on the left may indicate a raphe. × 20. V.40970.
10. Same, inner surface showing a tendency for longitudinal cracks to form along fibrous tissue which constitutes the main thickness of the inner coat. × 20.
11. Two-loculed capsule showing incipient separation of the two valves along the median line at the base. Indications of branching fibres are obscurely seen in the figure especially on the left-hand valve. × 20. V.40968.
12. Another specimen in which further splitting has occurred. × 20. V.40969.
13. Fibrous fruit with terminal style and basal attachment, now bursting and splitting into fibres at the base as the result of compression and decay. × 15. V.40971.
14. Another. × 15. V.40972.

Fig.

15. Symmetric five-angled ribbed fruit with apical style. Base slightly imperfect. × 15. V.40975.
16. Similar but smaller specimen. × 15. V.40976.
17. Somewhat similar but asymmetric specimen with longitudinal ridges, some crested. × 15. V.40977.
18. Part of a ribbed fruit with crested ridges, possibly closely related to Fig. 17. × 15. V.40978.
- 19, 20. Two thinly cuneate objects whose nature is obscure. × 15. V.40980. Fig. 20 now decayed.
21. Five-angled solid body; nature obscure. × 15. V.40982.
22. Same longitudinally fractured, inner surface, showing curved longitudinal lines of small convexities. × 15.

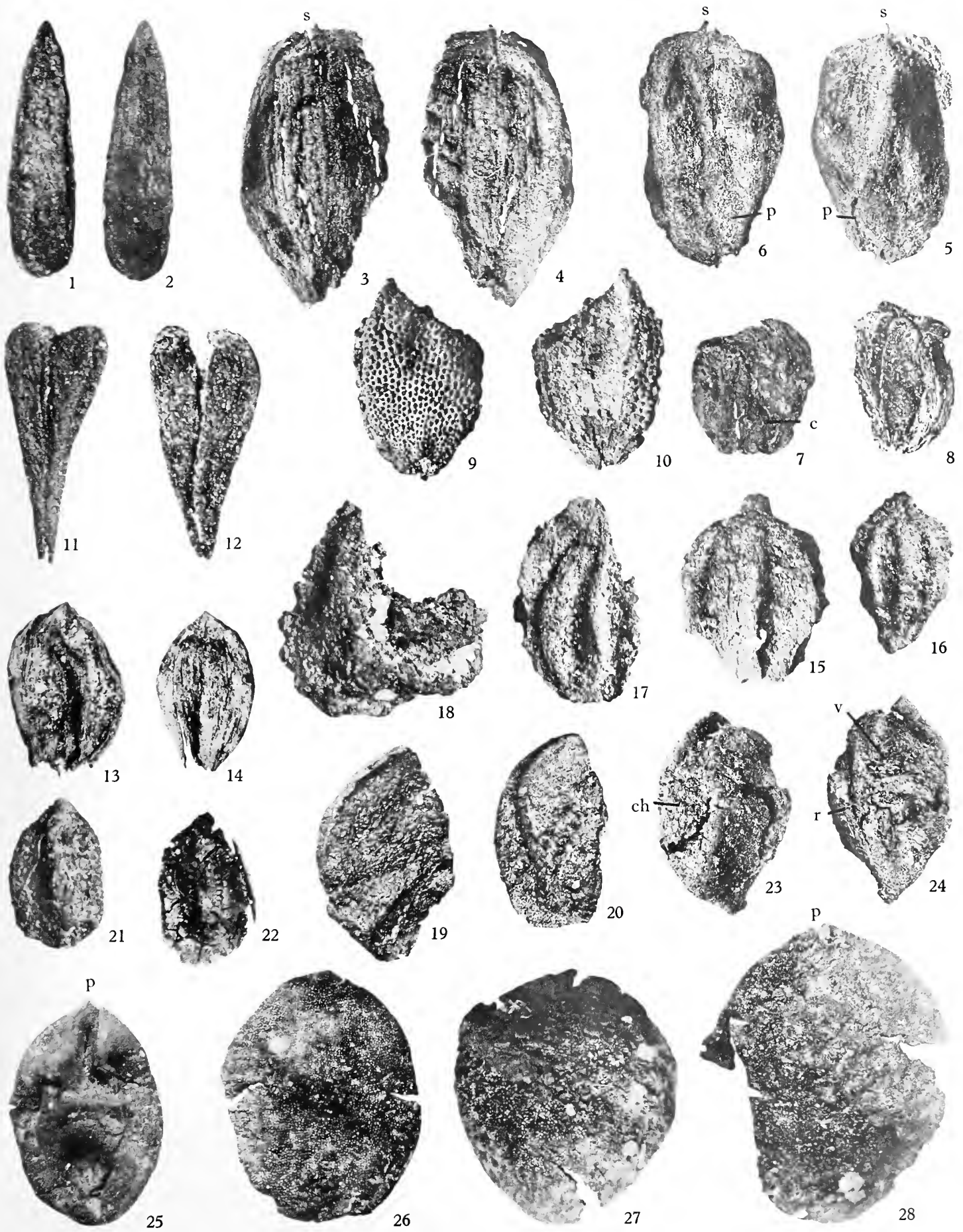
Vitis sp. p. 109

23. Dorsal surface of battered seed showing large chalaza, *ch*, slightly turned to the left. × 6·5. V.41961.
24. Same, ventral, raphe ridge, *r*, distorted so that one ventral facet, *v*, occupies most of the surface depicted. × 6·5.

Ovicarpum reticulatum n.gen. & sp. p. 59

25. Holotype. Small endocarp, rather crushed. At *p*, is a mucro marking the passage for the fibro-vascular strands to the placenta as in *Ficus*. × 15. V.40443.
26. Another, somewhat larger showing surface pitting. × 15. V.43102.
27. One valve of another endocarp, much cracked, surface pits clear. × 15. V.40444.
28. Valve of another large specimen, broken at the two lateral margins and somewhat distorted. *p* as in Fig. 25. × 15. V.40446.

Figs. 1-22 Lake, Figs. 1, 2, 11, 12 from fine silt, base of section, western end, Figs. 3-7 basal beds by ironstones, eastern end; Figs. 23-28 Arne.



CARPOLITHUS, VITIS, OVICARPUM

Explanation of Plate 27

- Fig. **Unknown Organisms** pp. 156-157
1. Compressed skeletonized specimen. $\times 6.5$. V.40990.
 2. Part of the same to show details of the meshwork of fibres. $\times 15$.
 3. Another specimen. $\times 6.5$. V.40991.
 4. Another, incomplete, exterior. $\times 6.5$. V.40992.
 5. Same, other half but more perfect than that in Fig. 4, interior after opening sac-like specimen. It shows the finer meshwork which forms a compact inner wall. $\times 6.5$.
 6. Fragment to show the character of the coarse outer network of fibres. $\times 15$. V.43516
 7. Imperfect specimen showing the outer coat of coarse fibres and the fine fibres which build up a shining more compact inner surface. $\times 15$. V.42020.
 8. Fragment of the inner finer layer of the above. $\times 6.5$. V.42020.
 9. Same, inner surface showing the thin skin. $\times 6.5$.
 10. Specimen with remains of coarse external fibres, the fine close fibres inside lining an internal cavity. $\times 6.5$. V.43517.
 - 11, 12. Fine textured mesh, *m*, enclosed between two thick woody carbonaceous fragments, *c* (fruit wall?). The two figures show opposite sides. $\times 6.5$. V.40993.
- Fig.
13. Same, meshwork removed from between the two woody fragments. $\times 15$.
 14. Fragment of coarse network. $\times 15$. V.43518.
 15. Small fragment of a similar network. $\times 6.5$. V.43519.
 16. Coarse network. $\times 6$. After Reid (1915, pl. 20, fig. 1).
 - 17-21. Organisms of a somewhat similar character showing the coarse mesh and in some cases (Figs. 18, 19) the finer mesh within in patches only. $\times 6.5$. V.40994-97, V.43520.
 22. Opposite side of specimen in Fig. 19. $\times 15$. V.43520.
 23. Skeletonized fragment showing radial arrangement of fibres about numerous centres. $\times 32$. V.42031.
- Insect eggs or Tubers? p. 157
24. Curiously marked chitinous fragment. $\times 6.5$. V.40983.
 25. Part of the same. $\times 15$.
 26. Small subglobular hollow chitinous body. $\times 6.5$. V.40984.
- Figs. 1-6, 23-26 Lake, Fig. 6 from fine silt, base of section, western end; Figs. 7-13 Southbourne, Figs. 7-9 from leafy lenticle, cliff base, Figs. 10-13 from Lignite above Boscombe Sands; Fig. 14 dark sands, cliff base, west end, Hengistbury Head; Fig. 15 Bovey Tracey; Fig. 16 Reuver, Limburg, Netherlands; Figs. 17-22 Pakefield, Norfolk.



UNKNOWN ORGANISMS, INSECT EGGS OR TUBERS?

Explanation of Plate 28

Fig.

Trachycarpus raphifolia (Sternberg) p. 158

1. Impression of lower surface of central part of a fan-palm. It shows the apex of the petiole and rachis and a large part of the blade on the left-hand side. Right half of petiole missing. Multifid character of blade can be seen near the left margin. Elsewhere it is multiplicate. The more conspicuous of the radial lines are the midribs of the pinnules. $\times 0.28$ approx. Dorset County Museum, Dorchester.
2. Central part of the same leaf showing the sub-triangular apex of the petiole narrowing into the rachis which can be traced in the figure for about 3 to 4 cm. The tapering distal part of the rachis is obscured by adherent remains of the leaf itself. The point of origin of the pinnules can be seen. *m, m*, indicate midribs of pinnules; *r*, is the line of the covered rachis. Missing part of leaf and petiole indicated by dotted lines (hypothetical) where the impression ends against the edge of the block of matrix. $\times 0.5$ approx.
3. Same, differently lighted to show passage from petiole to rachis more clearly. $\times 0.5$ approx.

Genus ?

p. 164

4. Impression of a winged fruit. Fruit-body apparently shortly stalked at *st* and embraced by wing. Rounded scars may be perforations caused by insects. $\times 2.8$. V.40281.

Fig.

5. Lower part of same showing body; *a*, its pointed apex. $\times 6.5$.

Protoaltingia hantonensis Chandler p. 163

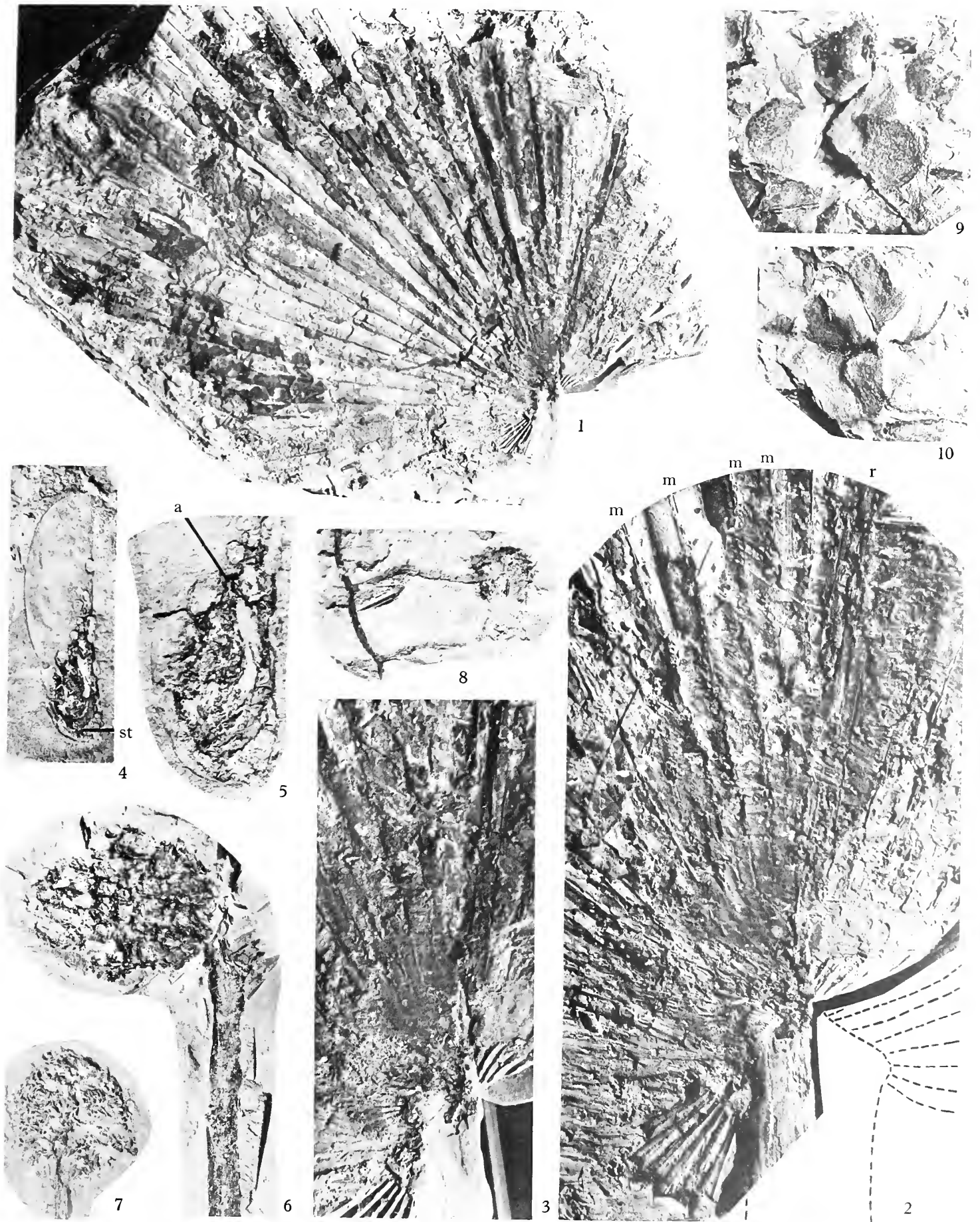
6. Fruiting head. The stem may, or may not belong as it is not in organic connection. Areoles for fruitlets can be seen. $\times 1.9$. V.40294.
7. Smaller head. $\times 1.9$. V.40295.
8. Immature head still attached to a branched peduncle. $\times 1.9$. V.40296.

? **Cupanoides** sp.

p. 163

- 9, 10. Counterpart impressions of a deeply three-lobed capsular fruit. Distortion of the loculicidal valves has occurred after dehiscence. $\times 2.7$. V.40292.

Figs. 1-5 Corfe; Figs. 6-10 Bournemouth area probably from Pipe-Clay Series.



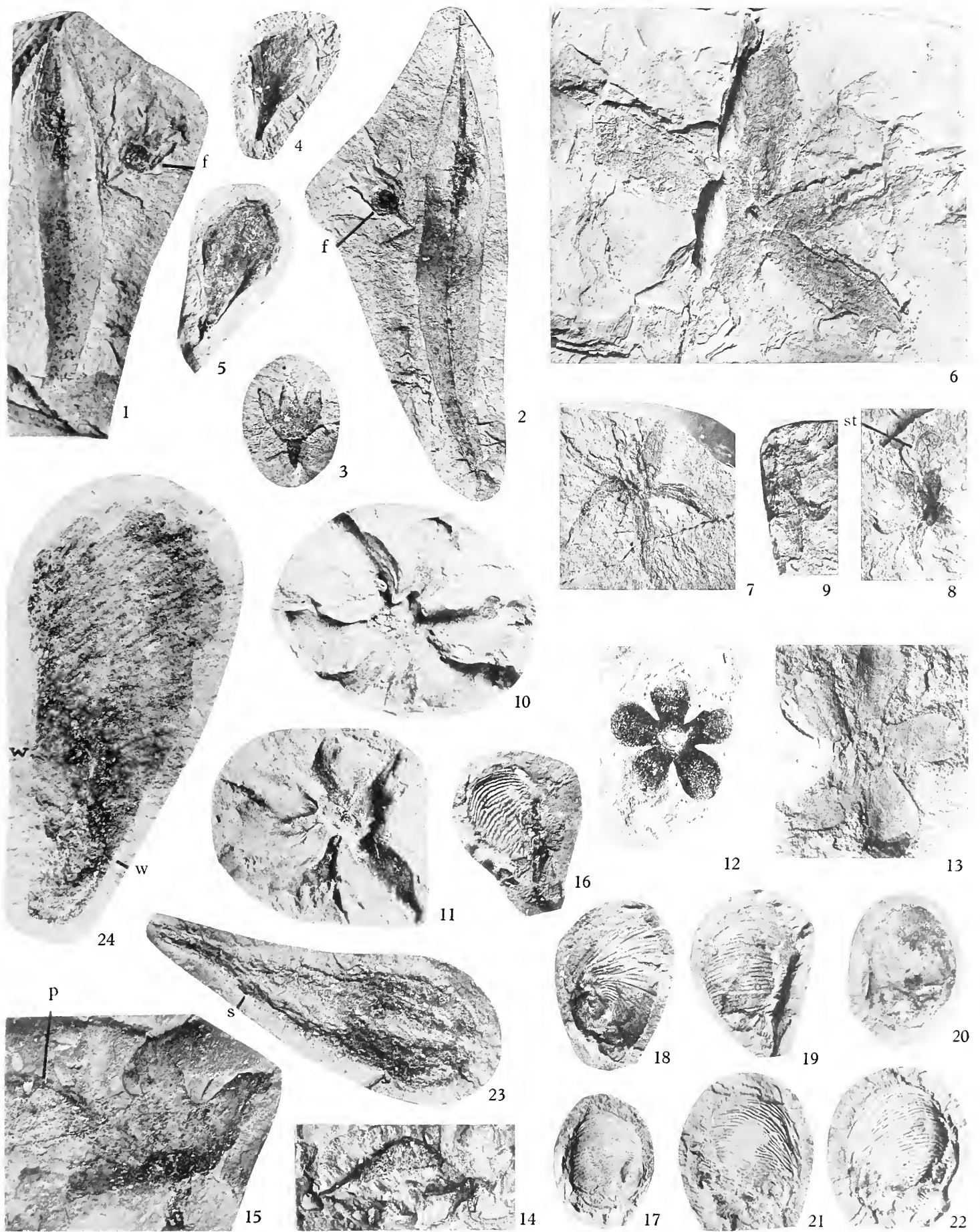
TRACHYCARPUS, GENUS (?), PROTOALTINGIA, CUPANOIDES

Explanation of Plate 29

- Fig. **Undetermined Genera** pp. 164-167
- 1, 2. Counterpart impressions of a small superior fruit, *f*, enclosed in a persistent perianth with free pointed lobes. On the same block is the impression of an unidentified lanceolate leaf with its petiole towards the top of the figure. $\times 2.7$. V.40285.
 3. Small inferior fruit with persistent perianth. $\times 2.7$. V.40278.
 - 4, 5. Detached petals, or segments of a winged fruit. $\times 2.7$. V.40282-83.
 6. Obscure impression of a five-partite bract or persistent perianth. $\times 1.6$. V.40293.
 7. Obscure impression of a four-partite gamosepalous (?) persistent perianth or flower. $\times 2.8$. V.40288.
 - 8, 9. Counterpart impressions of a flower with five-fid gamosepalous perianth. Fig. 8 shows long curved style, *st*. $\times 2.8$. V.40287.
 - 10, 11. Counterpart impressions of a five-partite perianth with twisted and curled lobes. Apparently somewhat asymmetric with two larger lobes below and three slightly smaller above. $\times 2$. V.40291.
 - 12, 13. Two specimens of a flat gamosepalous perianth with five rounded lobes. Fig. 12 $\times 2.5$, V.11862; Fig. 13 $\times 2.8$, V.40290.
 14. Impression of valve of fruit or pod with one broad semi-translucent margin. $\times 2.8$. The margin is better shown in Fig. 15 where part of the same pod is visible at *p*. $\times 6.5$. V.40286.
 15. Side view of a superior fruit with short stalk and lobed bract. Three of the lobes can be seen each with parallel longitudi-

- Fig.
nal nerves. $\times 6.5$. The same specimen is also seen in Fig. 14 to the right of the pod.
- 16-22. Impressions of six carpels or carpal linings attached by the ventral margin, dehiscing around the circumference. Surface with conspicuous grooves and ridges (impressions of fibres). $\times 2.8$. V.40307-12.
- Fig. 16 shows remains of a carbonaceous peduncle on the right to which a carpal (left) is ventrally attached. In Figs. 17, 19, 21 ventral margin is on right. In Figs. 18, 22 ventral margin is on left. A differentiated area near ventral margin may indicate a seed. Figs. 21, 22 are counterparts, 21 being the internal cast of the valve, and 22 the external impression. Fig. 20 although obscure probably represents the same species in which the ridges (nerve impressions) are not clearly defined. Its ventral margin is on the right.
23. Impression of an elongate-obovoid fruit. Slight projection, *s*, marks the junction with the stalk. $\times 6.5$. V.40284.
 24. Fruit or seed with a wing arising obliquely from the seed-body at *w*, *w* and obliquely striate. Lower end of seed-body surrounded by a narrow rim of wing. The straight wingless edge of the body in line with the straight margin of the wing suggests that the specimen is one of a pair originally united along their ventral edges. $\times 6.5$. V.40280. Corfe.

All the above except Fig. 24 from the Bournemouth area.



UNDETERMINED GENERA





