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DEPARTMENT OF SUPPLY AND SHIPPING
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BULLETIN No. 9.
(PALAEONTOLOGICAL SERIES No. 4.)

THE STRATIGRAPHY OF THE TERTIARY MARINE ROCKS IN GIPPSLAND, VICTORIA

BY

IRENE CRESPIN B.A.
COMMONWEALTH PALAEONTOLOGIST

Issued under the authority of the Hon. J. A. Beasley,
Minister for Supply and Shipping.

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CANBERRA.

10th August, 1943.

FOREWORD

This Bulletin presents the results of detailed studies of the Tertiary marine sequence in Gippsland, Victoria. Most of the information used in it has been obtained as a result of scout drilling jointly by the Victorian and Commonwealth Governments and of wildcat drilling by private companies. Though primarily a detailed study of a local problem, the results cannot fail to have an important bearing on the stratigraphy of the Tertiary rocks in the Australasian region and this in turn will facilitate the study of problems involving palaeogeography and correlation with extra-Australian areas. The results will also have an important bearing on a major economic problem - the search for oil in Australia.

There are many exposures of marine Tertiary rocks in Victoria which are easily accessible for detailed study, but nowhere are there outcrops exposing more than limited parts of the complete sequence. In general, dips in the Tertiary rocks are very gentle. Workers on the Victorian Tertiaries have thus been obliged to study a large number of sections, whose stratigraphical position could not be demonstrated except by comparison of their fossil content. This method has fundamental weaknesses common to all sampling. It cannot be known to what extent the section studied is representative of the formation; a fossil which more extensive sampling may reveal as having zonal value may easily be missed and faunal differences due to facies changes may be misinterpreted. For these reasons serious errors have been made in the juxtaposition of some parts of the sequence and the resultant nomenclature has been unsatisfactory.

The very factors which militate against good stratigraphical results from the study of surface sections, enable the records of drilling operations to be accepted with confidence. Thousands of feet of core drilling have ensured adequate sampling of the foraminiferal content of the beds and have determined their structure and order of succession beyond doubt. The examination of these cores has been one of Miss Crespin's duties in her position of Commonwealth Palaeontologist. In this work she has always kept before her the necessity to bring together her results in a unified picture. The suspension of exploratory drilling while the Lakes Entrance shaft is being sunk, presents a convenient opportunity of reviewing past results, as has been done in this Bulletin.

Planning a work of this scope inevitably led to a review of the whole question of stratigraphical nomenclature. There is no thoroughly satisfactory system of classification and nomenclature of rock units, but the one put forward by the American Association of Petroleum Geologists in July 1939, goes nearest to satisfying most requirements. The adoption of this system requires the use of "formation" and "group" in senses foreign to normal English and Australian usage, but this is a small matter compared with the advantages gained. It is not proposed to go into this in any detail now, since the problem is fully discussed in the Bulletin of the American Association of Petroleum Geologists, No.7, Vol.23, 1939, which is available in Australia.

Two points only will be mentioned. The terms "stage" and "substage", which are not used in the A.A.P.G. scheme, are well established in Australian literature generally and are very commonly used all over the world (especially in descriptions of Tertiary stratigraphy) and to attempt to abandon them would cause confusion. Moreover, it is useful to have time units of lower rank than series for purposes of correlation and this can be done without difficulty

as has been shown by Kleinpell (1938) and Schenck and Muller (1941). The procedure adopted by these authors has been followed closely in this Bulletin.

The A.A.P.G. classification deals satisfactorily with the naming of stratigraphical units, well established by boring but unknown in outcrop. Reference to Miss Crespin's Table 1 will show how important it is to have some guiding principle here. It is quite probable that some facies of the Gippsland Miocene may never be seen in outcrops, and according to some authorities, therefore should remain forever nameless. It is also pertinent to point out that the lowest units of the Kalimnan and Anglesean stages at their type localities, cannot be defined without reference to sub-surface data.

The issuing of this Bulletin follows upon the publication of F.A.Singleton's "Tertiary Geology of Australia" (1941). Dr. Singleton's paper represents the results of many years of detailed study and condenses a great volume of work. Such a statement has long been required and Dr.Singleton has earned the gratitude of the geological fraternity in writing it.

Bearing in mind what has been written above concerning the incompleteness of the data available to him, it is not surprising that there should be some significant difference between Dr.Singleton's account of the Tertiary sequence and that given by Miss Crespin for the Gippsland basin. These are briefly:-

The Cheltenhamian stage (of Singleton) is considered to be a facies of the Kalimnan, but a new stage (Mitchellian) is described overlying the Balcombian and underlying the Kalimnan.

The Balcombian is recognised by Miss Crespin as a stage but the Batesfordian is not; the Batesford is shown to be only a substage of the Balcombian. This substage together with the Bairnsdale and Longford substages, both newly defined herein, make up the Balcombian as now described.

The foregoing changes have been rendered necessary by the growing disharmony between the accumulated facts and the existing classification. All are believed to be soundly based.

The term "Anglesean" has been retained for the lignitiferous stage at the base of the Gippsland Tertiary section though a good case could be made out for reversion to Singleton's original "Yallournian", a name which instantly suggests the main lithological feature of the sequence. However, since lithology is the basis upon which formations are named the term "Yallourn formation" serves the purpose adequately. Using evidence available, Singleton abandoned his term "Yallournian" on the sound ground that time intervals are best defined by reference to marine sections. It is interesting to note, however, that in the eastern part of the Gippsland basin, lignites were laid down in a marine environment, and recently, marine foraminifera have been identified by Miss Crespin in lignites and ligneous clays, (at Boolarra and Mirboo North), which can be reliably correlated with the well known lignites of Yallourn and Morwell.

Miss Crespin shows that the fauna of the Anglesean, Janjukian and Balcombian stages are closely related; and she regards all of these as stages of the Middle Miocene.

Because of the necessity of presenting results in the most economical way possible during wartime, this publication is issued in ronoeod form. This method has imposed some unavoidable restrictions on the presentation of the distribution list of fossils but it is hoped that after the war, this Bulletin will be printed in the form of previous publications in this series.

CANBERRA
10th August,1943.

H.G.Raggatt
DIRECTOR.

THE STRATIGRAPHY OF THE TERTIARY MARINE ROCKS IN GIPPSLAND, VICTORIA.

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REFERENCE TO SECTORS

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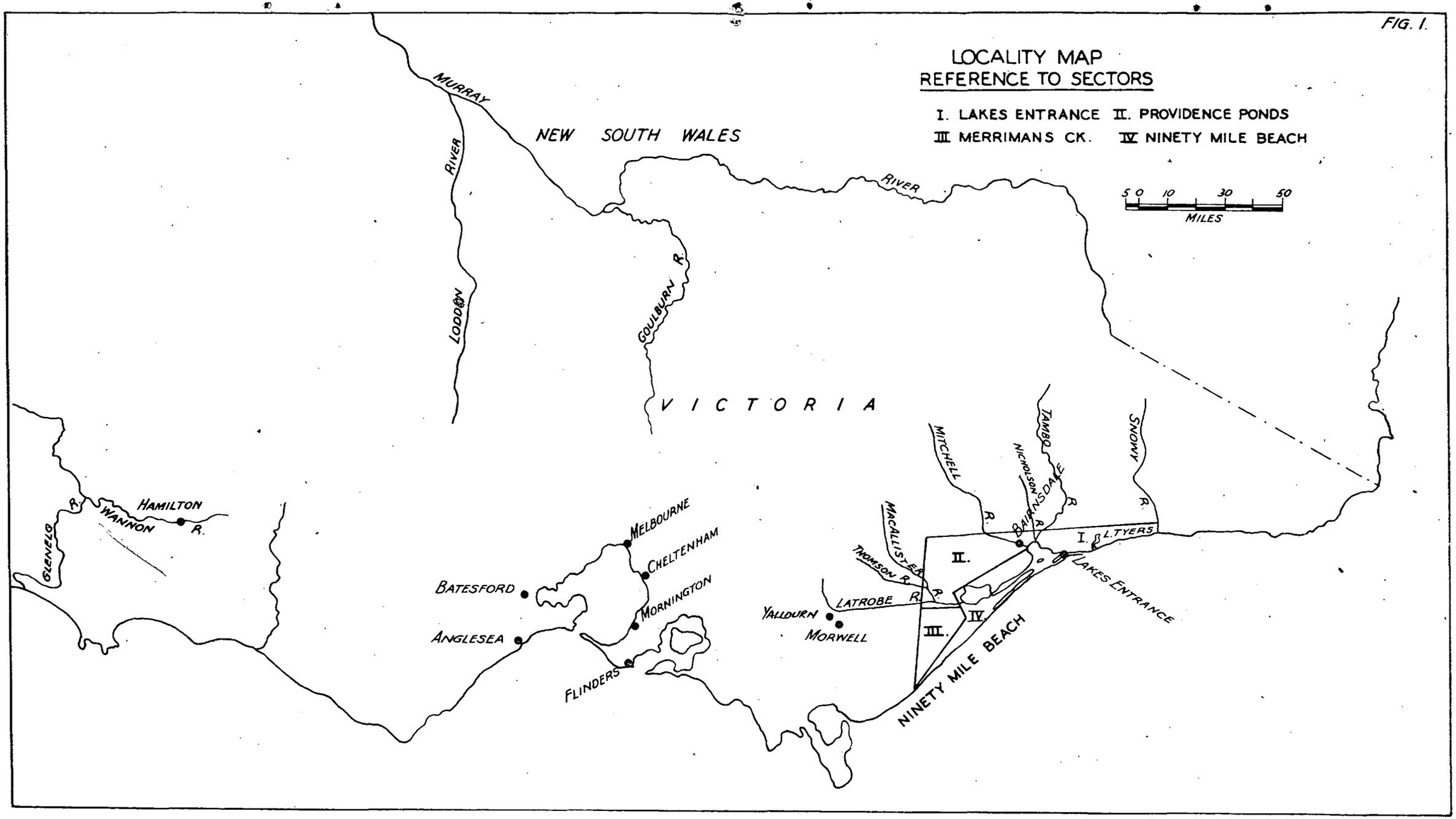
III MERRIMANS CK. IV NINETY MILE BEACH



1. INTRODUCTION.

The stratigraphic sequence of the Tertiary marine rocks in Gippsland as postulated in this work, is based not only on the palaeontological investigation of surface sections but on an intensive study of bore cores, which have been made available for examination through the extensive drilling operations that have been carried out in the search for oil in that region. Although the presence of oil was proved in the Lakes Entrance area in 1924, an intensive drilling programme was not proceeded with for some years.

The results of the information derived from these subsurface operations has made it necessary to reconsider certain features in the Victorian Tertiary stratigraphic sequence. Where possible such considerations have been substantiated by evidence from surface sections.

Until recently the various stratigraphic stages in the Victorian sequence have been based primarily on the mollusca. The zoning of the Tertiary beds in Gippsland has been determined, in the main, by the foraminifera. This method is of especial value in respect to subsurface sections because the Miocene sediments are for the most part, unusually barren of typical molluscan shells. The faunal assemblage is dominated by bryozoa. Mollusca are well represented in the Lower Pliocene sections. Lithology is signiff-icant in many cases.

The area under review takes the form of a scalene triangle as illustrated in Fig.1. The northern side, which extends for nearly 100 miles, from the Snowy River at Orbost on the east to the borings in the Parishes of Bundalaguah and Wurruk Wurruk on the west, is bounded by basement rocks. The western boundary passes 40 miles south from the Parish of Bundalaguah to No.6 Bore, Parish of Woodside. The south-eastern boundary extends from No.6 Bore, Parish of Woodside east for about 100 miles in the direction of the Ninety Mile Beach to Orbost.

Palaeontological examination has been made of material from 71 bores involving nearly 92,000 feet of drilling. These bores have been put down by the Victorian Government in collaboration partly with the Commonwealth Government and partly with various private companies engaged in the search for oil. Most of the cores have been personally investigated, not only in the laboratory but on the bore sites. At the same time the majority of surface sections available have been examined and collections of fossiliferous material made. Unfortunately the above footage of drilling does not include that of the actual number of bores sunk in Gippsland in recent years, and as a result valuable information is missing in some areas. In most cases core samples were taken at every tem feet by the driller. Personal visits have been made to many of the bores, where further collecting was done so as to bridge over the gaps between the various stratigraphical horizons.

In this review the various stages and zones will be discussed and the results applied to surface and subsurface sections in different sectors into which the region has been divided.

In compiling the data, it has been necessary to revise the names of fossils listed in early reports, owing to recent changes in nomenclature. This revision has not been carried out in its entirety, as it is unsatisfactory to alter the generic name of one form until the whole group has been investigated, and, also, continual alterations in nomenclature baffle the practical worker.

The letter designations given to various zones by Chapman and Crespin in 1932 have been abandoned. The stratigraphic sequence shows a slight variation from that put forward by Singleton in 1941. One new stage and two new substages have been introduced, with further subdivision of substages in zones and zonules.

2. DESCRIPTION OF SECTORS.

The detailed study of bore cores in the Gippsland Tertiary basin indicates that there are four distinct sectors, each sector having some characteristic feature, based on variation in sedimentation and in fossil content. For convenience these sectors have been given the following designations, the limiting bores and outcrops each being those investigated palaeontologically.

I. Lakes Entrance Sector.
II. Providence Ponds Sector.
III. Merriman's Creek Sector.
IV. Ninety Mile Beach Sector.

The boundaries of the sectors are shown in Fig.1, each one being discussed in detail in Part 6.

I. Lakes Entrance Sector (Fig.4). As no marine Tertiary deposits are known at present east of the Snowy River, the Balcombian deposits near Orbost are taken as the eastern boundary of the sector. It is bounded on the north by the basement rocks and on the west by the Nicholson River in a line thence to Eagle Point. The coastline forms the southern boundary.

The characteristic features of this sector are -

(a) The presence of the type section for the Kalimnan stage at Jemmy's Point, Lakes Entrance.

(b) The standard subsurface section for the new stage "Mitchellian" is located in No.11 Bore, Ph. Colquhoun.

(c) The extensive outcrops of Balcombian beds in the eastern and northern portions.

(d) The richly micaceous marls and glauconitic sandstone (partially oil-bearing) in the Janjukian stage.

(e) The comparatively shallow depth, compared with the other sectors, at which bedrock is reached.

II. Providence Ponds Sector (Fig.5). This sector has derived its name from Providence Ponds Creek which traverses the central portion of the area. It includes all outcrops west of the Nicholson River and along the Mitchell River, together with bores extending from No.3 Bore, Ph. Bairnsdale (Cobbler's Creek) on the east to those in the parishes of Stratford, Bundalaguah and Wurruk Wurruk on the west.

The features of this sector are -

(a) The extensive cliff section along the Mitchell River near Bairnsdale, containing large echinoids, brachiopoda and mollusca, and belonging to the Balcombian and Mitchellian stages.

(b) The development of an argillaceous facies in the Mitchellian stage in bores west of No.3 Bore, Ph.Bairnsdale, in which a rich foraminiferal and molluscan assemblage of Balcombian species is intermingled with Lower Kalimnan forms.

(c) Abundant mollusca of Balcombian species associated with Balcombian foraminifera (Lepidocyclina, Cycloclypeus and Austrotrillina howchini) in Skinner's section, Mitchell River.

III. Merriman's Creek Sector (Fig.6). This sector extends from No.2 Bore, Ph.Glencoe south to No.5 Bore, Ph.Woodside and east to the Lake Wellington Bore, and includes several quarry sections.

The characteristic features of the sector are -

(a) The special development of Lepidocyclina and Cycloclypeus in the Balcombian stage.

(b) The presence of the type locality for the Longford substage at Dowd's Quarry, Longford.

(c) The presence of the type localities for the zonules of the Batesford substage at Brock's and McColl's quarries.

(d) The occurrence in bores of thick sections of lignitiferous sands and brown coals.

IV. Ninety Mile Beach Sector (Fig.7). This sector includes bores that have been put down in an area adjacent to the Ninety Mile Beach, extending from No.4 Bore, Ph.Darriman and No.14 Bore, Ph. Giffard on the west, to No.1 Bore, Ph. Boole Poole (Sperm Whale Head) on the east.

The characteristic features of the sector are -

(a) The marked thickening of sediments in the Balcombian, Janjukian and Anglesean stages as compared with the Lakes Entrance sector.

(b) The occurrence of typical Janjukian foraminifera in the Balcombian up to the Batesford substage.

(c) The scarcity of molluscan shells in the Miocene.

(d) Absence of outcrops for comparative study.

3. SCHEME OF CLASSIFICATION AND STRATIGRAPHIC NOMENCLATURE.

The scheme of classification of stratigraphic units herein suggested for the Tertiary marine sediments in Gippsland (Table 1), is based on that used at the present time by American workers. Kleinpell in his "Miocene Stratigraphy of California" (1938), and Schenck and Muller in "Stratigraphic Terminology" (1941) used a method which can be ideally applied to Victorian stratigraphy, while the American Association of Petroleum Geologists, realising the chaos which surrounded the stratigraphic nomenclature, in 1939, compiled a set of rules upon which future

work was to be based. The terms series, stage, formation, zone, and zonule, which are used in this work, were also defined.

The beds in the Gippsland basin have been divided into five stages - Kalimnan, Mitchellian, Balcombian, Janjukian and Anglesean, in downward sequence. The Balcombian has been divided into three substages, Bairnsdale, Batesford and Longford, with further subdivision into zones and zonules. Four formations are recognised, namely, Jemmy's Point (Kalimnan), Gippsland limestone (Balcombian), Lakes Entrance (Janjukian) and Yallourn (Anglesean). The main classification combines features of the two put forward by Singleton in 1937 and 1941 respectively.

In 1935 Singleton used the term "Yallournian" for the "freshwater sands and clays in part carbonaceous in the Sale - Longford area in East Gippsland". In 1941, he replaced this name by "Anglesean" (p.25) at the same time proposing the term "Yallourn Series" for the beds in Gippsland. The term "Yallournian" is ideally suited to the bore sections in Sectors II, III and IV where marine alternate with fluvio-lacustrine conditions, foraminifera being fairly common in many of the sands. But as the term "Anglesean", though not truly applicable to Gippsland, has come into literature it is advisable to adhere to it. As the lithology of the lignitiferous sands and brown coals are so consistent in the Gippsland basin, the name "Yallourn formation" has been instituted to include them. When discussing the Anglesean stage later, a description of a bore section will be given.

The Janjukian stage contains the foraminiferal marls, in part richly micaceous and glauconitic, which lie between the Anglesean lignitiferous sands and the Balcombian bryozoal marls and limestones.

The Balcombian stage in Gippsland has beendivided into three substages, the Longford, the Batesford and the Bairnsdale, in upward sequence. Sedimentation throughout these substages is practically uniform in all sectors. They comprise the chief "polyzoal series", and the foraminifera listed by Chapman and Parr (1934) as typical of the Balcombian are persistent throughout. Nevertheless each substage has its distinctive features.

> The basal substage has been termed "Longford". It includes those beds which are recorded from bores between the Janjukian stage and the Lepidocyclina zone and referred to in the palaeontological report on the Holland's Landing Bore (1941) as "B1 stage". Singleton (1941) stated that "No exposed section is as yet known where this (the relationship between the Janjukian and Balcombian) may be demonstrated and reliance must be placed on the relation above discussed between Janjukian and Balcombian, together with the conformable relations dealt with hereunder between the Batesfordian and Balcombian. It is possible, however, that the missing evidence may be supplied by the stratigraphy of the East Gippsland basin of which numerous bore cores are being investigated". The required section is located in the quarry at Dowd's, near Longford, Ph. Coolungoolum.
>
> The middle substage is the "Batesford" which represents the Lepidocyclina horizon. Singleton (1937) included the "Lepidocyclina and polyzoal limestones of Batesford, Keilor, Flinders, Muddy Creek and East Gippsland bores" as a facies of the Balcombian stage. In 1941 he elevated the Batesfordian to the status of a

stage, underlying the Balcombian. This classification was followed by the writer in the report on the Holland's Landing Bore (1941). Since then investigations on the Lepidocyclinae (1942) have been published, in which the horizon has been made a substage of the Balcombian. It has been further divided into three zones, a lower one referred to as the zone of Lepidocyclina (Trybliolepidina) gippslandica Crespin, which is characteristic of all Gippsland bores and outcrops, an intermediate one, the zone of L. (T.) howchini Chapman and Crespin, typical of Hamilton and Flinders, and an upper one, the zone of L. (T.) batesfordensis Crespin, characteristic of Batesford and Keilor. The lower zone is further subdivided into two zonules, a lower or zonule of Cycloclypeus victoriensis var. gippslandica Crespin and an upper or zonule of Hofkerina semiornata (Howchin).

The uppermost substage is termed "Bairnsdale", which has been instituted for those beds which immediately overlie the Lepidocyclina horizon. Conditions of sedimentation and fossil content of the beds between the top of the Batesford substage and the base of the Mitchellian stage in bores are so uniform in Sectors I, III and IV that it seemed advisable to give them a definite designation. At the same time it is extraordinarily well developed in cliff sections and road cuttings in the northern and eastern portions of the Gippsland basin. In the western portion of Sector II, a more marly facies is present, numerous Balcombian mollusca persisting through to the Mitchellian. The substage is characterised by the presence of the large echinoid Clypeaster gippslandicus McG. and large pelecypoda such as Hinnites corioensis McCoy, Spondylus baileyanus Chapman and Serripecten yahliensis (T.Wds.). Two zones are apparent and these will be discussed in Part 5.

A new stage name "Mitchellian" has been instituted to include the passage beds which are present in all subsurface sections between the Balcombian and Kalimnan. It was originally suggested that these beds may belong to the Cheltenhamian, a stage recently created by Singleton (1941) for certain beds at Beaumaris. The fossil fauna of that stage has been incompletely described, the fossils listed by Singleton suggesting a close relationship with the Kalimnan. The new stage will be discussed under Part 5.

Two zones in the Kalimnan stage are perfectly demonstrated at the type locality for the stage at Jemmy's Point, Lakes Entrance. The upper zone contains numerous large molluscan shells representing only a few species. The lower zone is characterised by a rich assemblage of numerous species.

The four formations mentioned above - Jemmy's Point, Gippsland Limestone, Lakes Entrance and Yallourn, have lithological and palaeontological characteristics which can be recognised throughout the Gippsland basin.

The Jemmy's Point Formation refers to the shelly, sandy beds belonging to the Kalimnan stage and includes both bore and surface sections.

The Gippsland Limestone Formation includes the bryozoal limestones and marly limestones of the Balcombian stage.

The Lakes Entrance Formation includes the micaceous marls of the Janjukian stage so well developed in the Lakes Entrance area, together with the underlying oil-bearing glauconitic sandstone. This latter facies is only represented as such in Sector I, but the massive pyrites and glauconite found in bores west and south from Bairnsdale are probably referable to it.

The Yallourn Formation embraces the series of lignitiferous sands and brown coals which dominate subsurface sections west of Bairnsdale and which are referable to the Anglesean stage.

4. THE POSITION OF THE LEPIDOCYCLINA HORIZON IN THE TERTIARY SEQUENCE AND THE AGE OF THE BEDS GENERALLY.

In attempting to determine the exact position of the Victorian marine beds in the Tertiary sequence, the only fossils upon which age can be reliably based are the Orbitoids, a family of the foraminifera, which is represented in Victoria by the genus Lepidocyclina. The genera and subgenera comprised in the family are so restricted in their stratigraphic range, that they are regarded as of considerable importance in zoning the Tertiary rocks throughout the world. The Victorian Lepidocyclinae show the closest relationship with the Indo-Pacific region.

Present knowledge of the Victorian Tertiaries indicates that Lepidocyclinae occur only in the Batesford substage of the Balcombian, three zones being determined. An upper one, the zone of Lepidocyclina (Trybliolepidina) batesfordensis Crespin has its type locality at Batesford near Geelong, where associated forms include Cycloclypeus victoriensis Crespin and abundant Calcarina verriculata Parr; an intermediate one, the zone of L. (T.) howchini Chapman and Crespin, typical of Hamilton and Flinders, with associated forms C. verriculata, Hofkerina semiornata (Howchin) and Cycloclypeus victoriensis; a lower one, the zone of L. (T.) gippslandica Crespin, characteristic of Gippsland, where it is associated with H. semiornata and C. victoriensis var. gippslandica Crespin. This zone, as proved by borings can be further subdivided, typical sections being present in Brock's and McColl's quarries, Ph. Glencoe. Unfortunately no stratigraphic section is available showing a continuous sequence of these zones.

Lepidocyclina-bearing rocks are known from several localities and bores around Port Philip Bay, at Hamilton, Western Victoria, and from numerous bores and several quarry and cliff sections in Gippsland. Singleton's view (1941) as to the age of the "Batesfordian" is that it is "either a late Lower or early Middle Miocene stage" which is "characterised by nephrolepidines and a trybliolepidine but no eulepidines and probably to be correlated with part of the East Indies Tertiary "f". The horizon is now correlated with the upper part of "f" stage. The lepidocycline assemblage is dominated by the subgenus Trybliolepidina, so typical of that horizon in the Indo-Pacific. The subgenus Nephrolepidina, and the Miocene genera Flosculinella and Miogypsina, characteristic of the upper part of "e" stage and the lower and middle portion of "f" stage are absent.

Since 1931 until recently (1941), the age of the Lepidocyclina-bearing beds was considered, by the Geological Branch, Department of the Interior, now the Mineral Resources Survey Branch of the Department of Supply and Shipping, to be Lower Miocene. This age was based on the record by F. Chapman, the first Commonwealth

Palaeontologist, and the writer (1932) of Spiroclypeus which was determined from a vertical section in a ferruginous limestone in the Hamilton Bore, Western Victoria. This genus is typical of stage "e" (Lower Miocene of the Netherlands East Indies geologists and palaeontologists). At the same time a beautifully rayed species of Lepidocyclina was also found in the Gippsland borings and recorded as L.radiata (Martin), a species regarded as also representative of stage "e". As a result of these two determinations a Lower Miocene age was given to all rocks associated with Lepidocyclina. The result has been considerable confusion.

The writer (1936) stated that further investigation proved the determination of Spiroclypeus to be incorrect, the section being referable to Lepidocyclina. The age "Lower Miocene" was retained, although it was suggested that the subgenus Nephrolepidina, into which the Victorian species of Lepidocyclina were placed, pointed to a younger horizon. In 1939 she was privileged to visit the Netherlands East Indies to study with Dr. Tan Sin Hok, at the Geological Museum, Bandoeng, Java, the relationship of the Lepidocyclinae from Victoria, North-West Australia, Papua and New Guinea with those from the Indies and other portions of the Indo-Pacific region. It was learned that L.radiata does not belong to stage "e" in Java but rather to an horizon fairly high in stage "f" and that the subgenus with which the Victorian species are comparable is Trybliolepidina, which is prominent in the upper part of the Miocene. The results of these investigations have just been published by the writer(1942) and it has been demonstrated that instead of the twelve species previously listed, only two, both new, and one variety are present, the age of the horizon being referred to the upper Middle Miocene.

This age is further supported by the specific determination of the genus Cycloclypeus. A systematic study of the genus in Victoria (1941) proved the existence of one species, C.victoriensis, with a variety gippslandica. This species has close relationship with the Indo-Pacific form C.indopacificus Tan which is characteristic of the Upper Middle Miocene and basal Upper Miocene, where it is associated with an assemblage of Trybliolepidines.

Another form of zonal importance is Austrotrillina howchini, which is comparatively common in the Indo-Pacific region, and which was originally described by Schlumberger from beds belonging to the Balcombian stage at Hamilton, Western Victoria. In the Indo-Pacific this form ranges from Lower to Middle Miocene. In Victoria it is found associated with the tropical shallow-water species Marginopora vertebralis in bores in the Mallee, where other foraminiferal species characteristic of the Lepidocyclina facies at Batesford and Hamilton are also present. M.vertebralis is also found in limestones of upper Middle Miocene and Upper Miocene age in North-West Australia, Papua and New Guinea, and in certain bores in Gippsland, in the Bairnsdale substage (Balcombian) and in the Mitchellian stage, which overlie the Lepidocyclina horizon.

Further evidence supporting the view that the Lepidocyclina horizon in Victoria and the beds immediately associated with it, belong to the upper portion of the Middle Miocene, has already given by the writer (1942).

In the beds underlying the Batesford substage no fossil is available upon which age can be based. Zonal forms are useful for local correlative purposes but are of little value for long range correlation. It has been proved in the Gippsland bores that certain foraminiferal species originally described from the Balcombian and considered restricted to that stage, have an earlier origin in the Anglesean stage. These forms include Cassidulinoides chapmani, Hofkerina semiornata and Operculina victoriensis. As far as can be determined there are no restricted species in the Anglesean, some

STRATIGRAPHIC SEQUENCE OF THE MARINE TERTIARY ROCKS IN GIPPSLAND

Table 1:

STRATIGRAPHIC UNITS IN THE TERTIARY OF THE GIPPSLAND BASIN							SECTOR I LAKES ENTRANCE	SECTOR II PROVIDENCE PONDS	SECTOR III MERRIMAN'S CREEK	SECTOR IV NINETY MILE BEACH	Maximum Thickness in Bore
Series	Stage	Sub-stage	Zone	Zonule	Zonal Mollusca Etc.	Formation					
LOWER PLIOCENE	KALIMNAN		Nonion victoriense		Nucula kalimnae	Jemmy's Point	Thin bed of fossiliferous sands at top of Jemmy's Point section, with abundant large mollusca, but few species. Streblus beccarii common. Not recorded in bores.				19 feet at Jemmy's Point
			Planulina kalimnensis		Venericardia gippslandica		Lower bed at Jemmy's Point with abundant large and small mollusca in sandstone. Typical foraminifera. Outcrops in cliff sections and cuttings on north shore of Lakes from Nyerimalang to Lake Tyers. Present in bores.	Chiefly in bore sections in eastern and southern portion, outcrops of shelly, ferruginous limestone along Mitchell River near Bairnsdale.	Present in bores in eastern portion. Shells not so abundant as in Sectors I and II. No outcrops known.	Present in all bores. No outcrops.	265 feet in Sperm Whale Head Bore.
UPPER MIOCENE	MITCHELLIAN		Anomalina sp. 1.		Ditrupa cornea var. wormbetiensis		Mixed assemblage of Kalimnan and Balcombian species of mollusca and foraminifera. Pelecypoda predominant, bryozoa common towards base. Present in most bores. Outcrop in cliff section at Swan Reach, Tambo River.	Shelly, ferruginous limestones at Bairnsdale and along Mitchell River. Rich, shelly facies in bores of mixed Kalimnan and Balcombian species of foraminifera and mollusca.	Typically developed in bores. No outcrops known.	Typically developed in bores. No outcrops.	335 feet in Huntin No.2 Bore.
MIDDLE MIOCENE	BALCOMBIAN	Bairnsdale	Cibicides victoriensis		Clypeaster gippslandicus	"Polyzoal Series"	Bryozoal limestones present in bores. Sections containing rich assemblage of Clypeaster gippslandicus, Hinnites corioensis, Serripecten yahliensis, Spondylus baileyanus at Orbost, Hospital Creek, Toorloo Arm, Tambo and Nicholson Rivers.	Cliff sections along Mitchell River, richly shelly, bryozoal limestones. Bore sections more shelly than in Sector I.	Grey, bryozoal limestone present in bores but facies containing characteristic, large shells and echinoids missing. Ditrupa common, and Marginopora vertebralis present. Material frequently hard. No outcrops known.	Conditions as in Sector III, but Marginopora vertebralis absent.	771 feet in Holland's Landing Bore.
			Operculina victoriensis		Serripecten yahliensis		Bore sections containing S.yahliensis, S.baileyanus in bryozoal limestones. Other forms rare. Operculina and Amphistegina. Outcrops at Mississippi Creek, Orbost and Toorloo Arm.	Sections along Mitchell River. Shelly in bores, Operculina always present.	Operculina and Amphistegina in moderately hard, grey, marly limestones. No outcrops known.		
		Batesford	Lepidocyclina (Tryblio-lepidina) gippslandica	Hofkerina semiornata	Cytheropteron batesfordiense	Gippsland Limestone	Lepidocyclina (Trybliolepidina) gippslandica present but not common in bryozoal limestones and marls with typical assemblage, Gypsina howchini and Hofkerina semiornata. Sherbonina present. Outcrops near Orbost.	L.(T.) gippslandica and associated assemblage as in Sector I.	Bores and quarry sections-McColl's, Robertson's. Amphistegina common, Sherbonina present.	Lepidocyclina not common. Cyclammina present throughout. Lithology bryozoal marls. Beds thick. No outcrops.	857 feet in Glencoe No.2 Bore.
				Cycloclypeus victoriensis var. gippslandica			C.victoriensis var.gippslandica with numerous L.(T.) gippslandica. Bed rarely more than 10 feet thick. Molluscan shells rare. No outcrops.	Well developed at Skinner's Mitchell River, where rich molluscan assemblage associated with Austrotrillina howchini, Cycloclypeus and Lepidocyclina. Mollusca not common in bores.	Well developed in bores and quarries, Le Grand's and Brock's. Numerous Amphistegina, Lepidocyclina and Cycloclypeus present. Brachiopoda common at Le Grand's.	Cycloclypeus and Lepidocyclina present but not common as in other sectors. No outcrops.	
		Longford	Clavulinoides szaboi var. victoriensis		Ecionema newberyi		Bryozoal marls and marly limestones in bores. Mollusca rare. Few distinct foraminifera. Facies more marly in several bores. No outcrops.	Only seven bores penetrated stage. Lithology, marls in bores in western portion. Cyclammina and Ammodiscus present in Wurruk Wurruk Bore. No outcrops.	Type section at Dowd's quarry, Longford. Whitish, bryozoal marls with abundant spicules of Ecionema newberyi. Mollusca few but Chlamys foulcheri usually present at base of section.	Bryozoal marls, sometimes hard, thick. Cyclammina present throughout, bryozoa fewer at base of section. Mollusca rare. No outcrops.	616 feet in Huntin No.2 Bore.
	JANJUKIAN		Cyclammina incisa		Turritella aldingae	Lakes Entrance	Brownish, micaceous marls with typical foraminiferal assemblage, Cyclammina, Vaginulina gippslandica, Victoriella plecte, small mollusca (Turritella aldingae). Several bands of hard, calcareous, shelly sandstone in basal portion. Glauconitic sandstone, partially oil-bearing. No outcrops.	Grey to brownish marls, slightly micaceous, shelly with band of hard, shelly limestone at base. Foraminifera as in Sector I. No outcrops.	Grey marls, glauconitic and pyritic at base, mollusca not common. Bed fairly thick. Typical foraminifera including Cyclammina. No outcrops.	Grey marls, fine-grained, frequently hard, glauconitic and pyritic at base. Mollusca rare. Typical foraminifera present. Beds thick. No outcrops.	776 feet in Holland's Landing Bore.
	ANGLESEAN					Yallourn	Sands and sandstone sideritic in part containing occasional foraminifera, sharks' teeth and fragments of brown coal. No outcrops.	Stage only reached in bores in western portion, lignitiferous sands and brown coal. Bed 160 feet, of black sands and coal in No.1 Bore, Ph.Wurruk Wurruk. Foraminifera present in sands.	Lignitiferous sands and brown coals in bore section found at shallow depths along axis of "Baragwanath Anticline", but at much greater depths in bores to south and east. Foraminifera and bryozoa present in sands.	Lignitiferous sands and brown coals strongly developed in bores. 60 feet of brown coal in Sperm Whale Head Bore. Foraminifera including Amphistegina present. Fragments of bryozoa. No outcrops.	1476 feet in Tanjil-Pt. Addis No.2 Bore.

forms ranging through the sequence to Recent. Restricted species are comparatively rare in the Janjukian. Victoriella plecte has not been recorded out of this stage in Gippsland, while Vaginulina gippslandica, so typical of the Janjukian in the area and above which stage it is absent, makes its first appearance in the Anglesean. Cyclammina, which is of zonal importance in the Janjukian, occurs throughout the underlying Anglesean, while it ranges up persistently to the Batesford substage of the Balcombian in Sector IV with occasional occurrences in Sectors I, II and III. Fine distinctions in many of the smaller forms may be partially due to facies, not age. On the other hand the range of species of Lepidocyclina and Cycloclypeus is definitely limited, and are therefore especially adapted for age determination.

Amongst the other groups of fossils, bryozoa are of little value in determining age but are important for the purpose of zonal correlation. The same applies to mollusca which vary considerably with environment. Tertiary fossil plants are also unreliable. No adequate reason therefore can be given for insisting that the age of the Anglesean is older than Middle Miocene, since many of the foraminifera and bryozoa in the lignitiferous sands make an early appearance here before becoming of zonal value in higher stages, and no restricted forms are available. This evidence is derived from many bore sections. The only part of the stratigraphic sequence which exhibits any change in age is to be found in the Kalimnan stage in which a certain assemblage of foraminiferal, bryozoal and molluscan species is restricted with some species to be found living in recent seas.

5. STRATIGRAPHIC SUCCESSION.

A systematic scheme of the stratigraphic succession in Gippsland is given in Table 1. A general discussion of stages now follows, but the characteristic features of each stage in each sector will be dealt with in detail in Part 6. It is unfortunate that, in the early selection of type localities for stages in Victoria, in no case has there been a description of a continuous vertical section in which the relationships between the overlying and underlying stages have been included. Actually such sections are rare in Victoria, specially in the Port Philip region whence the early description of the stages were taken. The exact vertical extent of any of the type sections is not known. Therefore it is not surprising that the thicknesses of the majority of the stages as shown in the Gippsland bores are rather startling. This lack of information as regards the relationship of stages in the Port Philip area is one of the causes of previous uncertainty as to the position in the stratigraphic sequence of some of the stages. Consequently the evidence now put forward regarding this sequence is of considerable importance and permits fairly exact correlation with outcrops throughout the State. Even in Gippsland, surface sections exhibiting relationship between stages is rare. Neither the Anglesean-Janjukian nor the Janjukian-Balcombian junctions are exposed in the basin. The Balcombian-Mitchellian relationship is shown at the Water Trust Excavation near Bairnsdale, at a few localities along the Mitchell River, and at Devil's Backbone near Orbost.

The present general remarks will be supported by descriptions, for the Gippsland basin, of "standard sections", a term instituted by Finlay and Marwick (1940) for similar conditions in certain stages in various areas of the New Zealand Tertiaries. These standard sections will relate to the Anglesean, Janjukian and Mitchellian stages and to substages of the Balcombian. No surface sections are available for the Anglesean and Janjukian in Gippsland, therefore subsurface sections will be described.

The main departures in the present classification from that put forward by Singleton are in the institution of the new stage name for the beds between the Kalimnan and Balcombian stages, in the division of the Balcombian into three substages, and in the reduction of status of the Batesford (Lepidocyclina horizon) from a stage to a substage of the Balcombian.

Anglesean Stage

One of the most important features of the investigation into the marine Tertiaries in Gippsland, is the proof of the existence of extensive deposits of lignitiferous sands and brown coals underlying the fossiliferous marls of the Janjukian and overlying the Jurassic sandstones, and referred to the Anglesean stage. Furthermore, these sands contain numerous foraminifera and are therefore not entirely of fluvio-lacustrine origin as previously considered.

Singleton (1935) proposed the term "Yallournian" for this series of "lignites and clays of Yallourn". In 1941, he substituted "Yallourn Series" for that appropriate name, correlating the beds with the Anglesean stage "since for purposes of correlation stage names should preferably be based on marine formations". He admits that the Anglesean locality is "by no means ideal as a type section, but nearly all other occurrences of beds correlable with the Anglesean, as in the East Gippsland, Mallee and Dartmoor areas are known of from borings and are thus unsuitable for selection". This is only partially true. It is unsatisfactory to have to refer these extensive Gippsland deposits to a section such as exposed at Anglesea, which is not typical of the Gippsland beds. The objection against taking the Yallourn section as a type because "stage names should be based on marine formation" cannot be upheld for the section as recorded from bores, in which up to 1,463 feet have been proved, contains numerous foraminifera, not only in the fine, lignitiferous sands but in the sands which contain numerous fragments of brown coal. As regards the statement that sections from borings are "unsuitable for selection" as types, the most recent work on the stratigraphic classification of marine sediments as put forward by American geologists (1939), indicates that a subsurface section can be taken as a type section, if a suitable surface section is not available. When such a section is found then the subsurface section is dispensed with.

Recent examination of the Nelson Bore in Western Victoria has brought to light some striking differences between the Anglesean beds as developed in areas west of Gippsland and the Yallourn Formation in Gippsland, referred to the Anglesean.

(1) The Anglesean as proved in the Nelson Bore consists almost entirely of lignitiferous sandstone containing Cyclammina and is typical of the type section of this stage at Anglesea.

(2) Bands of brown coal which dominate the Yallourn Formation in all bores in Sectors II, III and IV are absent in the Nelson Bore where only a small quantity of carbonaceous material is present.

(3) The foraminiferal assemblage in the two areas is strikingly at variance. In the Nelson Bore, Cyclammina which dominates the assemblage at Anglesea, is common throughout the section in lignitiferous sands, other forms being rare. In the Yallourn Formation, Cyclammina is present only occasionally, but small hyaline forms are persistent, while genera such as Operculina and Amphistegina, characteristic of the Balcombian, are frequently recorded.

It is therefore with great reluctance that the lignitiferous sands and brown coals of the Yallourn basin are referred to the Anglesean stage. So that the character of the deposits can be conveniently studied, a description of a standard section from one of the bores in the area will be given.

The greatest development of the Anglesean stage is in Sectors II, III and IV, 684 feet being recorded in No.1 Bore, Ph. Bengworden South (Holland's Landing) and 1,463 feet in Tanjil Pt. Addis Bore No.2, Ph.Glencoe South. Unfortunately, none of the bores east from No.2 Bore, Ph.Nuntin (Lake Kakydra) to No.5 Bore, Ph.Bairnsdale (Eagle Point) penetrated the formation so that the north-eastern limit in the area under review is unknown. . It is not known whether the deposits near the mouth of the Snowy River at Orbost are referable to the Anglesean while no boring is present in the most easterly portion of the basin to prove the extent in that direction. In Sector I, the sands which directly underlie the glauconitic sandstone are not very thick; some are sideritic, whilst others contain numerous fish remains. Except in Sector I brown coal is prominent throughout the Anglesean. In the most westerly bore, No.1, Ph.Wurruk Wurruk, the first band was met at 2,516 feet. In No.5 Bore, Ph.Glencoe, about 6 miles south-east, it occurred immediately underlying the glauconitic marls at 520 feet. To the east a thickness of 90 feet of brown coal is recorded from the Lake Kakydra Bore between the depths of 3,041 and 3,131 feet. To the south-east bands of varying thicknesses were present in No.2 Bore, Tanjil-Point Addis and in the Holland's Landing Bore; still further east 60 feet of brown coal was proved in the Sperm Whale Head Bore between 2,729 and 2,789 feet.

Foraminifera are numerous in some of the sands and are occasionally associated with the brown coal. Species which become of zonal value in the overlying Janjukian include Cyclammina incisa and Vaginulina gippslandica. Species also recorded in the Janjukian and typical of the Balcombian are Gaudryina (Pseudogaudryina) crespinae, Cassidulinoides chapmani, Carpenteria rotaliformis, Hofkerina semiornata, Notorotalia howchini, Heronallenia lingulata, Eponides scabriculus, Elphidium howchini, Operculina victoriensis and Amphistegina lessonii. Long ranging forms include Cassidulina subglobosa which is common, Trifarina bradyi, Eponides repandus, Epistomina elegans and Discorbis orbicularis. Bryozoa are represented by species which become abundant in the Balcombian, such as Cellaria rigida var.perampla, Caberea grandis, Porina gracilis, Retepora beaniana, Crisia acropora, Idmonea trigona, Hornera tuberculata and H.striata. Molluscan shells are absent, conditions being unsuitable for their existence. Ostracoda include Bairdia subdeltoidea and Cytherella lata. Fish remains are present in bores in Sector I.

The above faunal assemblage shows the close relationship of the Anglesean sands with the overlying Janjukian marls and the Balcombian bryozoal limestones and marls. Consequently there seems little doubt that all these beds should be included in the Miocene series.

A standard section for the Yallourn formation is taken from No.2 Bore, Ph.Nuntin which is situated on the bank of Lake Kakydra in Allotment 86A, Section 2. The hole was drilled by the Commonwealth Government in conjunction with the Victorian Mines Department with an "Ideal" Model 68, rotary plant, during the months of January to June, 1939. This plant was also used in drilling operations at Holland's Landing, Sperm Whale Head, Romawi (Goon Nure), and at the Pilot Station and No.10 Bores, Ph.Colquhoun, Lakes Entrance. The bore reached the depth of 3,560 feet after passing through 500 feet of Post Kalimnan sands, 170 feet of Kalimnan, 355 feet of Mitchellian, 1,270 feet of Balcombian, 683 feet of Janjukian, and 490 feet of

Anglesean before reaching Jurassic bedrock at 3,515 feet. The basal beds of the overlying Janjukian consisted of dark greenish-brown glauconite and micaceous marl, containing pyrite and foraminifera. A description of the bore samples, in downward sequence, is as follows:-

3025 feet - Dark greyish-brown sandstone with glauconite.

3029-3039 feet - Brown coal.

3039-3041 feet - Greyish-white, sandy clay with quartz grains, pyrites, glauconite grains, foraminifera, bryozoa, mollusca and ostracoda.

FORAMINIFERA - Pyrgo bulloides; P.depressa; Quinqueloculina seminulum; Q.vulgaris; Triloculina schreiberiana; Spiroloculina tenuiseptata; Cyclammina incisa; C.longicompressa; C.rotundata; Ammodiscus incertus; A. sp.(1); Bdelloidina aggregata; Textularia sagittula; T.gramen; T.carinata; Clavulina antipodum; C.parisiensis; Clavulinoides szaboi var. victoriensis; Listerella communis; Gaudryina (Pseudogaudryina) crespinae; G.rugosa; Marssonella trochus; Dorothia parri; Verneuilina triquetra; Bolivina punctata; B.nobilis; B.amygdalaeformis; Cassidulina subglobosa; Bulimincila elegantissima; Bulimina pupula; Lagena laevis; L.striata; L.hexagona; L.marginata; L.orbignyana; L.sulcata var. interrupta; Nodosaria vertebralis; N.hispida var. sublineata; N. sp.; Dentalina obliqua; D.consobrina; Vaginulina legumen; Marginulina glabra; Saracenaria italica; Lenticulina tenuis; L.articulata; L.gibba; L. sp.(1); L. pseudorotulata; L. rotulata; Globulina gibba; Guttulina problema; G. lactea; Sigmoidella elegantissima; Glandulina laevigata; Uvigerina schwageri; U.asperula var. ampullacea; Globigerina bulloides; Globigerinoides trilobus; Orbulina universa; Sphaeroidina bulloides; Pullenia quinqueloba; P.sphaeroides; Globorotalia crassa; Cibicides ungerianus; C.victoriensis; C. sp.(1); Cibicidella variabilis; Anomalina ammonoides; Eponides repandus; E.concentricus; Nonionella sp.; Elphidium pseudoinflatum.

VERMES - Ditrupa sp.

BRYOZOA - Cellaria cf. australia; C.rigida var. venusta; Porina gracilis; Retepora beaniana; R. sp.; Mecynoecia proboscidea; Mesonea hochstetteriana; Filisparsa concinna.

PELECYPODA - Cucullaea corioensis; Tellina sp.

GASTEROPODA - Guralcus sp.

OSTRACODA - Bairdia amygdaloides; Macrocypris decora; Aglaia clavata; Argilloecia badia; Cythere dictyon; Xestoleberis margaritea; Krithe eggeri; Cytherella lata; C.pulchra.

3041-3131 feet - Brown coal.

3131-3134 feet - Greyish-white, sandy clay with carbonaceous material, glauconite and foraminifera (Quinqueloculina sp.).

3136 feet - Fine, greyish-white, felspathic sandstone with carbonaceous material.

3136-3146 feet - Moderately coarse, felspathic sandstone.

3146-3151 feet - Brown coal.

3151-3155 feet - Carbonaceous shale. No organisms.

3155-3166 feet - Brown coal.

3166-3171 feet - Carbonaceous shale.

3171-3177 feet - Brown coal.

3177-3180 feet - Carbonaceous shale. No organisms.

3180-3193 feet - Brown coal.

3193-3194 feet - Carbonaceous shale.

3194-3205 feet - Brown coal.

3205-3245 feet - Greyish-white sandstone, with occasional plant remains indeterminate.

3246 feet - Grey, calcareous mudstone with pelecypoda indeterminate, carbonaceous material, foraminifera (Quinqueloculina vulgaris, Cyclammina incisa, C.rotundata, Clavulina sp., Vaginulina gippslandica, Lenticulina sp., L.rotulata, L.cultrata, Guttulina problema, Globulina gibba, Globigerina inflata, G. sp., Globigerinoides trilobus, Sphaeroidina bulloides, Anomalina nonionoides, Cibicides lobatulus, C.ungerianus, Nonion sp.), bryozoa (Retepora sp., Hiantopora monoceros), coral (Notophyllia sp.).

3251-3296 feet - Light grey sandstone. No organisms.

3296-3302 feet - Brown coal.

3303 feet - Light brown shale with plant remains indeterminate.

3304 feet - Ditto, with foraminifera (Quinqueloculina sp., Pullenia sphaeroides, Cibicides victoriensis, Gyroidina soldanii) and fragments of bryozoa (Amphiblestrum simplex, Retepora sp., Crisia sp.).

3310-3333 feet - Brown, carbonaceous shale and sandstone.

3338 feet - Brown, shelly marl with glauconite, pyrite, carbonaceous material, foraminifera, occasional bryozoa, numerous shell fragments and ostracoda.

FORAMINIFERA - Pyrgo depressa; Quinqueloculina vulgaris; Haplophragmoides sp.; Listerella communis; Verneuilina triquetra; Textularia carinata; Dorothia gibbosa; Cassidulina subglobosa; Buliminella elegantissima; Dentalina consobrina; Lenticulina sp.; L.gibba; Guttulina problema; G.regina; Globulina gibba; Uvigerina cf.pigmea; Globigerina bulloides; Globigerinoides trilobus; Sphaeroidina bulloides; Globorotalia crassa; Gyroidina soldanii; Anomalina ammonoides; A.nonionoides; Cibicides refulgens; C.ungerianus; Siphonina australis; Planulina sp.; Notorotalia howchini; Cibicides sp.(1); C. sp.(2); Eponides sp.; Elphidium crespinae.

BRYOZOA - Selemaria marginata; Retepora sp.; Entalophora longipora.

PELECYPODA - Nuculana sp.

GASTEROPODA - Marginella sp.

OSTRACODA - Cythere sp.; Cytherella lata.

3348-3370 feet - Greyish sandstone with carbonaceous material but no foraminifera.

3371 feet - Light grey mudstone with sandy patches.

3381-3385 feet - Greyish-white, sandy mudstone with foraminifera (Clavulina antipodum, Eponides sp.), and fragments of bryozoa indeterminate.

3391-3506 feet - Grey sandstone and greenish-grey clay. No organisms.

Several species of foraminifera which become characteristic of the overlying Janjukian, make their first appearance in these Anglesean beds. They include Cyclammina incisa, C.longicompressa, C.rotundata, Ammodiscus incertus and Vaginulina gippslandica. Other forms range as high as the Bairnsdale substage and even to Recent.

Janjukian Stage

This stage contains two lithological units, (i) the micaceous foraminiferal marls, brown to greenish-grey in colour, and frequently glauconitic at base, and (ii) the glauconitic sandstone, these units constituting the "Lakes Entrance formation". This glauconitic sandstone is oil-bearing in the Lakes Entrance Sector. Unfortunately, no outcrops of the stage have yet been discovered in Gippsland. A "standard section" for the Janjukian is described from No.11 Bore, Ph.Colquhoun. The zonal foraminifer is Cyclammina incisa which is persistent in all sectors. Turritella aldingae is the commonest molluscan form.

(i) The micaceous, foraminiferal marls overlie the glauconitic sandstone in Sector I and the Anglesean lignitiferous sands and brown coals in Sectors II, III and IV. The stage varies considerably in thickness, the best development being in the bores im Sector IV where 774 feet were recorded in the Holland's Landing Bore. In Sector I, the facies is represented in the basal portion, by brown, sandy, micaceous marls in which several hard bands of concretionary, shelly, calcareous sandstone are intercalated and im which fossils are rare. These pass upwards into fossiliferous marls containing abundant foraminifera. The sandy facies disappears in Sectors II, III and IV, while the micaceous character though present in II and III, is practically absent in IV. The abundance of mica seems to vary with the proximity of the basement rocks. The stage in Sector IV is marked by fine-grained grey to greenish-grey marls. Foraminifera are numerous but bryozoa and mollusca are extremely rare. The break between the Anglesean and the marly facies in Sectors II, III and IV is marked by a band of rock composed of massive pyrite and glauconite, which gradually passes upward into a glauconitic marl and finally into foraminiferal marls which are more or less micaceous.

The foraminiferal assemblage characteristic of the marls indicates quiet conditions of sedimentation in moderately deep water in Sector I, and with deeper conditions in Sectors II, III and IV. Zonal species include Ammodiscus sp., Cyclammina incisa, C.rotundata, Vaginulina gippslandica, Victoriella plecte and Lamarckina glencoensis as well as an assemblage rich in Polymorphinidae and Elphidium. V.plecte is not common but is definitely restricted to the Janjukian stage in Gippsland, but V.gippslandica is recorded from the underlying Anglesean sands. Cyclammina is persistent in the majority of bores, whilst Ammodiscus is more characteristic of those in Sectors I and IV. Bryozoal species are not numerous and include Adeonellopsis obliqua, A.symmetrica, Bracebridgia emendata, Otionella cupola, Trigonopora vermicularis and Aspidostoma airensis. Pyritic replacement of specimens is common. Molluscan shells are usually small and frequently crushed, Turritella aldingae, Triforis wilkinsoni and Collonia parvula are amongst the constant forms. Ostracoda include Bairdia subdeltoidea, Bythocypris tumefacta, Cytherella lata and Cytherelloidea intermedia.

(ii) The glauconitic sandstone facies is represented in all sectors, but there is variation in its composition in Sectors II, III, and IV from that in Sector I. Foraminifera, where recognisable, belong to species recorded commonly from the overlying marls. Molluscan shells are frequently present in the Lakes Entrance material, the principal species being Turritella aldingae.

A standard section for the Lakes Entrance formation is described from No.11 Bore, Ph.Colquhoun, situated in Allot.123A, at 190 feet above sea level. This bore was put down conjointly by the Commonwealth and Victorian Governments with a rotary plant, during the months of May to September, 1941.

The Janjukian stage was met in the bore at 926 feet where Cyclammina was recorded in brownish, shelly marls, the overlying bed belonging to the Longford substage. The marly facies continued down to 997 feet. Below this depth was a sandy facies containing few fossils but with intercalations of several bands of hard, calcareous sandstone. The glauconitic sandstone occurred at 1149 feet.

The detailed description of the section is as follows:-

926 feet - Greenish-grey marl with pyrite, foraminifera (Ammodiscus sp., Cyclammina rotundata, Dorothia parri, Vaginulina gippslandica and Lamarckina glencoensis), bryozoa (Adeonellopsis symmetrica, Deontopora mooraboolensis, Caleschara denticulata) and mollusca (Lissarca rubricata, Cuna radiata, Cerithiopsis mitchellensis, Turritella platyspira, Eulimella nitidula).

927-930 feet - Brownish-grey marl with patches of pyrite, foraminifera (Triloculina tricarinata, Cyclammina rotundata, Ammodiscus sp., Clavulinoides szaboi var. victoriensis, Clavulina antipodum), corals (Trematotrochus clarkei), bryozoa (Cellaria contigua, C.enormis, Melicerita angustiloba, Adeonellopsis grisea, A.obliqua, Velumella depressa, Hincksina geminata, Stamenocella fusiformis, Schizoporella submersa, Schizolavella phymatopora, Metroperiella transversa, Cucullipora tetrasticha, Otionella cupola, O.cupola var.spiralis, Trigonopora vermicularis, Metrarabdotos moniliferum, Spiroporina tubulifera) and mollusca (Chlamys foulcheri, Limopsis chapmani, Lissarca cincturata, Sarepta obelella, Collonia parvula, Cylichnella cuneopsis, Haurakia gabrieli, Astraea aster, Triforis wilkinsoni, Cerithiopsis mitchellensis, Cerithiella trigemmata, Turbonilla radicans.)

931 feet - Hard, yellowish marl with bryozoa.

934-942 feet - Grey, bryozoal and shelly marl with corals (Flabellum gambieriense, Placotrochus elongatus, Balanophyllia sp.), echinoderma (Goniocidaris prunispinosa, G.pentaspinosa, Psammechinus woodsi) and mollusca (Chlamys praecursor, Venericardia gracilicostata, Dimya dissimilis, Hemicardium sp., Cypraea sp. (large), C.subsidua, Megatebennus concatenatus, Collonia parvula, Vermicularia conohelix, V.asper, Tenagodes occlusus).

943-947 feet - Dark greenish-grey, bryozoal and shelly marl with pyrite also foraminifera (Lingulina metungensis, Sigmomorphina chapmani, Eponides scabriculus), corals (Trematotrochus clarkei, Deltocyathus sp.), bryozoa (Deontopora mooraboolensis, Amphiblestrum sp., Rhynchopora bi-spinosa), and mollusca (Chlamys sturtianus, small Cypraeas too crushed to determine, Turritella aldingae T.warburtoni, Inquisitor sandleroides, I.johnstoni, Buchozia hemiothone, Mathilda decorata, Cerithiopsis reticosa, Cerithiella trigemmata, Marginella micula, Crosseia cancellata, Teinostoma calva, Eulimina acutispira).

950-997 feet - Brownish-grey, micaceous, shelly with less bryozoa, and frequent pyrites, also foraminifera (Cyclammina rotundata, C.incisa, Lamarckina glencoensis, numerous small rotalines, Elphidium crespinae) and mollusca (Glycymeris maccoyi, Limopsis maccoyi, Cuna multilamella, Turritella aldingae, Cerithiopsis cribarioides, Cerithiella trigemmata, Morio wilsoni, Cypraea spp., including large fragment, Emarginula transenna, Cymatium textile, Buchozia hemiothone, Turbonilla tenuissima, Conomitra ligata, Brookula singletoni).

997-1006 feet - Brownish, micaceous, sandy marl with shells less common. Washings - chiefly fine, angular quartz grains, also green and brown glauconite, a few small foraminifera and molluscan shells (Limopsis chapmani valida (1006 feet), L.maccoyi, Cuna multilamella, Turritella aldingae).

1011 feet - Brownish, sandy marl with Ammodiscus sp. and Meliacerita angustilobe.

1012-1013'6" - Dark brownish-grey to dark grey marl.

1013'6"-1014'4" - Hard, calcareous sandstone with shell fragments indeterminate.

1014'4"-1026' - Brownish, micaceous, sandy marl with Corbula sp. Washings - chiefly fine, angular quartz grains, mica flakes, pyrite, foraminifera rare and a few shell fragments.

1026'-1026'4" - Hard, calcareous sandstone.

1026'4"-1040'3" - Similar to 1014'4"-1026', with aggregates of pyrites. Foraminifera and shell fragments rare.

1040'3"-1042'9" - Hard, dark greenish-grey, calcareous, shelly sandstone with Flabellum distinctum, Antigona dimorphophylla, Venericardia sp., Dentalium sp., Turritella murrayana, T.aldingae, Natica wintlei.

1042'9"-1067'6" - Dark brownish to greenish-grey, micaceous, sandy marl with pyritic segregations. Fossils rare.

1067'6"-1068'6" - Hard, calcareous sandstone.

1068'6"-1095'4" - Similar to 1042'9"-1067'6".

1095'4"-1096 feet - Hard, calcareous sandstone with shells indeterminate.

1096-1110 feet - Similar to 1042'9"-1067'6".

1110-1110'8" - Hard, calcareous sandstone with shells indeterminate.

1110'8"-1122'6" - Greenish, micaceous, sandy marl with pyritic concretions.

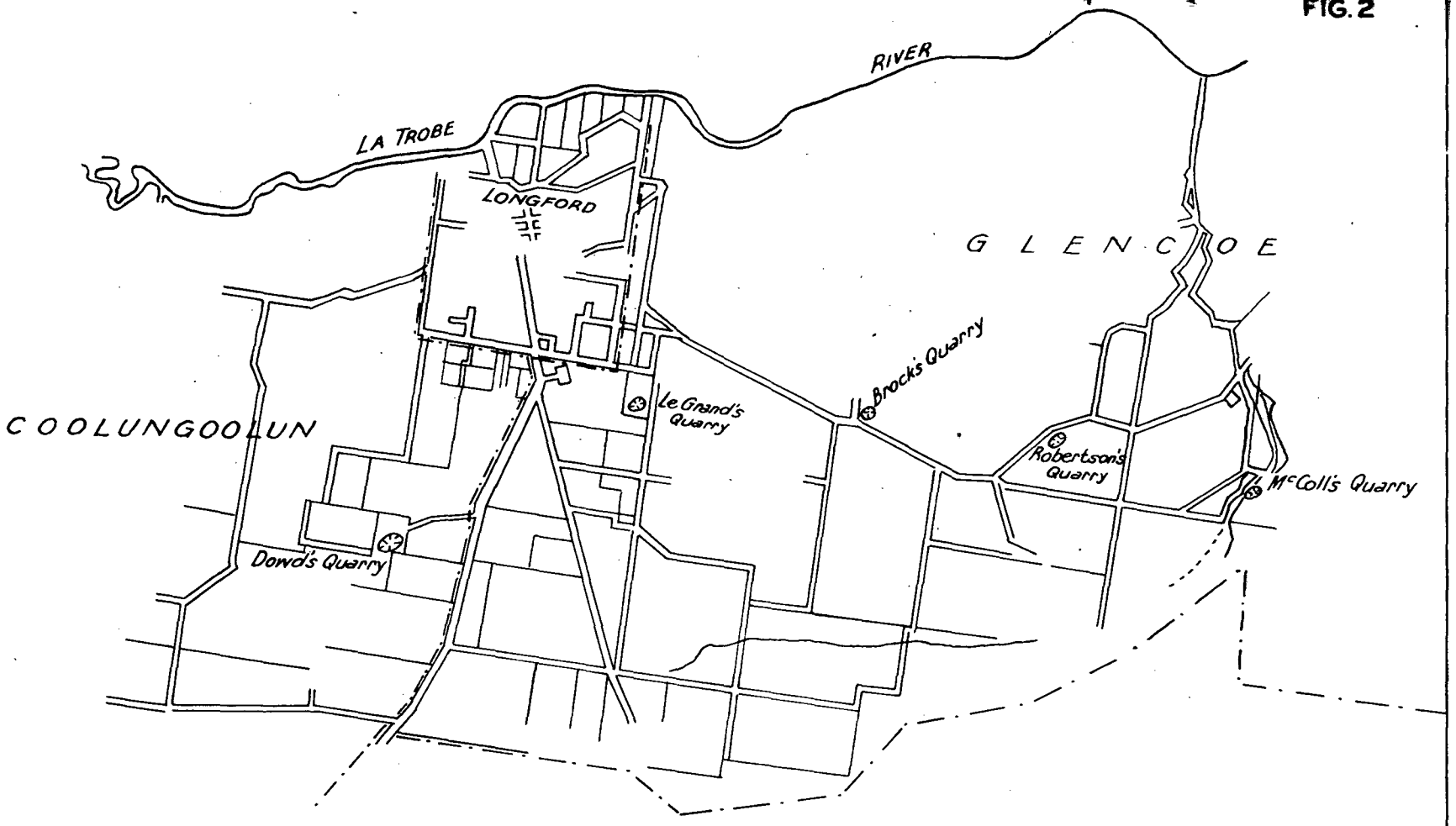
1122'6"-1124' - Hard, calcareous sandstone with Turritella aldingae.

1124-1138 feet - Brownish, micaceous, sandy marl with ovoid pellets of glauconite and a few small foraminifera.

1138'-1138'6" - Hard, calcareous sandstone.

1138'6"-1143' - Similar to 1124-1138 feet.

FIG. 2



— Plan —
— of —

Portion of Parishes Glencoe & Coolungoolun
Showing location of Dowd's, Brocks, Robertson's and Mc Coll's Quarries

Scale 1 Mile = 1 Inch.

1149-1150 feet - Greenish-grey, micaceous, sandy marl with abundant fine, angular quartz grains and ovoid pellets of brownish glauconite, also mica flakes.

1151 feet - Hard, grey to dark grey, calcareous, shelly (Turritella murrayana) sandstone with abundant glauconite, the darker portion containing oil.

1151'6" - Greenish, micaceous, sandy marl. Washings - chiefly fine, angular quartz grains and ovoid pellets of brown and green glauconite, also mica flakes.

1153-1158 feet - Fine, green sandstone with abundant ovoid pellets of green glauconite and a few foraminifera.

1158-1212 feet - Hard, green, glauconitic sandstone with mollusca chiefly indeterminate (Turritella murrayana).

1215-1229 feet - Pyritic and glauconitic sandstone.

1233 feet - Dense, fine-grained, greenish-grey sandstone with glauconite grains and pyrite.

Restricted Janjukian species of mollusca are rare in the Gippsland bores, but the foraminiferal assemblage is characteristic of the type locality at Torquay.

Balcombian Stage.

Overlying the Janjukian marls is a series of bryozoal limestones, marls and marly limestones referable to the Balcombian stage which in Sector IV, are 1,818 feet thick. These beds have been referred to as the "polyzoal series" but are now grouped under the heading of "Gippsland Limestone Formation", because of persistent characteristics. It is impossible to support Singleton's recent view (1941) that the Batesford (Lepidocyclina) horizon is a stage directly underlying the Balcombian. Evidence from borings in Gippsland is in favour of his earlier statement (1937) that it is a facies of the Balcombian. Sedimentation throughout this series of beds is practically uniform in all parts of Gippsland, with the species of bryozoa consistent and abundant, and the assemblage of smaller foraminifera persistent, the only distinct feature being the presence of Lepidocyclina and Cycloclypeus in the middle portion. Some species of foraminifera and bryozoa extend up to the overlying Mitchellian stage. The molluscan content varies in different sectors.

The Balcombian stage as developed in Gippsland is divided into three substages. In downward sequence these are:-

(iii) Bairnsdale.
(ii) Batesford.
(i) Longford.

(i) Longford Substage.

The term "Longford" is being applied to the beds which overlie the Janjukian marls and underlie the Lepidocyclina limestones and which have been referred to in reports on borings as "B1 stage". Singleton's comments (1941,p.75) on the relationship between the Janjukian and the Balcombian have already been quoted (p.4). The evidence for the creation of the new zone is based on the investigation of 50 bores and it is only recently that a surface section was

discovered which could be designated as the type locality. Both the lithological and palaeontological breaks between the Janjukian stage and the Longford substage are fairly distinct in Sectors I, II and III but in Sector IV where bores have been drilled in the deepest portion of the basin, there is little change in lithology, while the faunal break is equally indefinite, typical Janjukian foraminifera such as Cyclammina, persisting up to the Batesford substage.

The type locality for the Longford substage is Dowd's Quarry, south of Sale (Fig.2). The quarry is situated in the Ph. Coolungoolun on the east bank of Boggy Creek, west of Allotment 8, Section A, half a mile west of the road from Longford to Yarram, and about 2 miles south of Longford, where the road turns west to Rosedale. An excellent series of alternating hard limestones and friable, bryozoal marls showing a dip of about 15° to the west with a strike of N60° east is exposed in the quarry which has a vertical face about 50 feet high. Owing to the sheer face of the section, systematic collecting is difficult. As far as possible samples were taken from critical points such as the lowest bed exposed in the central portion (the eastern part being covered with detritus) and the topmost bed at the western end. Friable material was also sampled between various hard bands at the western and central portions.

(a) The lowest bed exposed is a greyish, friable marl composed almost entirely of spicules of the sponge Ecionema newberyi. Small foraminifera principally rotaline forms are also present. Eponides scabriculus and Anomalina nonionoides are the commonest forms while two other species rather rare in Gippsland are namely Cassidulinoides chapmani, described from Rocky Point, Torquay (possibly from an horizon equivalent to the Longford substage) and Tubulogenerina mooraboolensis, described from beds in the Moorabool Valley near Geelong, are also recorded. Bryozoa are not well developed in the basal samples, cyclostomatous species being typical. The pelecypod, Chlamys foulcheri, is fairly common. Ostracoda are numerous.

The faunal assemblage in the lower marls is as follows:-

FORAMINIFERA - Cyclammina rotundata, Clavulinoides szaboi var. victoriensis Bolivina robusta, B. victoriana, Cassidulina subglobosa, C. laevigata, Tubulogenerina mooraboolensis, Cassidulinoides chapmani, Ehrembergina serrata, Lagena orbignyana, L. striata, L. gracillima, Nodosaria sp.(1), N. raphanus, Dentalina emaciata, D. obliqua, D. soluta, D. fissicostata, Vaginulina legumen, Glandulina laevigata, Lenticulina cultrata, L. sp.(1), Guttulina irregularis, G. lactea, G. problema, Globulina gibba, Sigmoidella elegantissima, Pyrulina fusiformis, Globigerinoides trilobus, Pullenia quinqueloba, Sphaeroidina bulloides, Siphonina australis, Cibicides lobatulus, C. sp. (2), C. ungerianus, Heronallenia lingulata, Anomalina ammonoides, A. glabrata, A. nonionoides, Eponides scabriculus, Notorotalia howchini, Elphidium crespinae, E. parri.

SPONGIDA - Ecionema newberyi.

ECHINODERMA - Goniocidaris pentaspinosa, Steriocidaris australiae.

BRYOZOA - Cellepora coronopus, Crisia acropora, Idmonea trigona, I. milneana, I. incurva, Hornera frondiculata, H. tuberculata, Mecynoecia proboscidea, Filisparsa orakeiensis.

BRACHIOPODA - Murravia catinuliformis.

PELECYPODA - Chlamys foulcheri, C. praecursor, Ctenamusium atkinsoni.

OSTRACODA - Bairdia amygdaloides, B.subdeltoidea, Macrocypris decora, Bythocythere keblei, Cythere scutigera, C.dictyon, C.lactea, C.flexicostata, C.sp.(1), Cytheropteron fenestratum, Alatacythere praeantarcticum, Krithe producta, Cytherella lata.

CIRRIPEDIA - Balanus sp.

(b) The highest exposed beds are at the west end of the quarry and consist of yellowish, bryozoal marls. Foraminifera which include Eponides scabriculus, Gypsina howchini and Operculina victoriensis, are not as common as in the lower marls.

The faunal assemblage is as follows:-

FORAMINIFERA - Dorothia parri, Gandryina rugosa, Clavulinoides szaboi var. victoriensis, Cassidulina subglobosa, Nodosaria raphanus, Lenticulina articulata, Sigmoidella elegantissima, S.kagaensis, Cibicides sp.(2), C.ungerianus, Anomalina nonionoides, Carpenteria rotaliformis, Gypsina howchini, G.globulus, Eponides repandus, E.scabriculus, Elphidium parri, E.crespinae, Operculina victoriensis.

ANTHOZOA - Mopsea tenisoni, M.sp.(1).

ECHINODERMA - Psammechinus woodsi, Goniocidaris pentaspinosa.

BRYOZOA - Canda inermis, Cellaria contigua, C.depressa, C.gracilis, C.rigida var. perampla, Melicerita angustiloba, Macropora crassatina, M.clarkei, Crateropora patula, Omoiosia elongata, Vincularia gigantea, Hincksina geminata, Didymosella larvalis, Tubiporella elevata, Porina gracilis, P.vertebralis, Schizomavella marginata, Hiantopora liversidgei, Schizoporella orbiculifera, S.burlingtonensis, S.granulata, Corbulipora cf.ornata, Lepralia obliqua, L.bairnsdalei, Tetraplaria australis, Escharoides erectus, Porella baculina, P.denticulata, Petraliella corrugata, P.bi-incisa, Buffonellodes profunda, Conescharellina philippinensis, Cellepora fossa, Lekythopora hystrix, Gephyrophora bilamellaria, Hippomenella abdita, Dakaria crassocirca, Ramphonotus hisorius, Smittinella tatei, S.porrecta, Smittina elongata, Adeonellopsis clavata, Retepora beaniana, R.submmersa, Spiropora verticillata, Idmonea geminata, I.milneana, I.incurva, Hornera frondiculata, H.tuberculata, Entalophora longipora, Hetepora pisiformis.

BRACHIOPODA - Stethothyris insolita.

PELECYPODA - Chlamys foulcheri.

OSTRACODA - Bairdia subdeltoidea, Macrocypris decora.

It is apparent that affinities, based not only on the abundance of bryozoa but on the foraminiferal assemblage, are with the Balcombian stage rather than with the underlying Janjukian. The upper portion closely resembles the overlying Batesford substage, in the presence of Gypsina howchini, a species characteristic of the Lepidocyclina horizon and Operculina victoriensis which ranges into the basal portion of the Bairnsdale substage. Relationship with the underlying Janjukian is shown by the occurrence of Cyclammina rotundata, which is characteristic of, but not restricted to, the Janjukian marls.

In support of the faunal characteristics of the type surface section, a "standard subsurface section" is described from No.9 Bore, Ph.Colquhoun which is situated in Allotment 13, township of Cunninghame, about three miles east of Lakes Entrance and has an elevation of 7 feet above sea level. It was drilled with a rotary plant between January and April, 1941 and was cored throughout. The

portion of the bore which is being designated as the standard section for the Longford substage lies between the depths of 708 feet and 935 feet. This thickness of 227 feet is about the average proved by borings in the Phs. of Colquhoun and Bumberrah in Sector I.

The lithology ranges from bryozoal marls to marly limestones varying from white to grey and greenish-grey in colour. Grains of glauconite and fine, angular quartz are occasionally present. The predominant fossils are bryozoa, most of the species making their first appearance in the Longford substage. Foraminifera are fairly numerous and although the substage is the lowest horizon for many of the species none is definitely restricted to it. The forms are characteristically Balcombian, with a few typical Janjukian species occurring sparingly in the basal portion of the section. Cidaroid spines and small brachiopoda are occasionally present but molluscan shells and ostracoda are poorly represented.

The faunal list is as follows:-

FORAMINIFERA - Quinqueloculina vulgaris, Bdelloidina aggregata, Textularia fistulosa, Dorothia parri, Gaudryina collinsi, G.(Sipho-gaudryina) victoriana, Clavulinoides szaboi var.victoriensis, Reuss-ella spinulosa, Cassidulina subglobosa, Lagena marginata, L.orbignyana, L.sulcata, Nodosaria vertebralis, Dentalina obliqua, D.emaciata, D.mucronata, D.soluta, Vaginulina legumen, Marginulina glabra, Lentic-ulina articulata, L.cultrata, L.gibba, L. sp.(1), L.rotulata, Glandul-ina laevigata, Guttulina irregularis, G. cf.yabei, G.problema, G.lactea, Globulina gibba, Sigmomorphina vaughani, Sigmoidella eleg-antissima, Lingulina metungensis, Globigerina bulloides, Sphaeroidina bulloides, Pullenia quinqueloba, Gypsina globulus, G. howchini, Planorbulinella plana, P.inaequilateralis, Adervulina inhaerens, Hofkerina semiornata, Carpenteria rotaliformis, Spirillina vivipara, Heronallenia linguiata, H.wilsoni, Patellina corrugata, Anomalina ammonoides, A.nonionoides, Siphonina australis, Pulvinulinella tenui-marginata, Eponides repandus, E.concentricus, Epistomina elegans, Notorotalia howchini, Astrononion australe, Elphidium chapmani, E.crespinae, E.howchini, E.pseudoinflatum, Amphistegina lessonii, Operculina victoriensis.

SPONGIDA - Ecionema newberyi, Bactronella australis.

ANTHOZOA - Mopsea tenisoni.

ECHINODERMA - Plates and spines of cidaroids including Goniocid-aris prunispinosa.

BRYOZOA - Melicerita angustiloba, Cellaria contigua, C.australis, C.rigida var. perampla, C.gracilis, Ellisinidra profunda, Macropora clarkei, Schizoporella orbiculifera, Nellia oculata, Tubucellaria cereoides, Escharoides erectus, Hippomonella abdita, Adeonellopsis clavata, Porina gracilis, P.vertebralis, Porella baculina, Lepralia continua, Hiantopora liversidgei, Chaperia cylindriformis, Smittim-ella tatei, Retepora beaniana, Crisia acropora, Idmonea milneana, I.trigona, Entalophora longipora, Mecynoecia proboscidea, Mesonea hochstetteriana, Hornera tuberculata, H.striata, Lichenopora radiata.

BRACHIOPODA - Stethothyris insolita, Magellania garibaldiana, Murravia flindersi, Cryptopora acutirostrum, Aldingia sp., Tere-bratalia tatcana.

PELECYPODA - Chlamys foulcheri, Ostrea sp., Macrocallista sp.

OSTRACODA - Bairdia subdeltoidea, Cytheropteron batesfordiense, C.fenestratum.

The above assemblage of foraminifera, together with the per-sistent occurrence of species of bryozoa from 935 feet through to the

Bairnsdale substage and basal Mitchellian again indicates affinities with the Balcombian stage. Species characteristic of the Batesford substage include Gypsina howchini at 840 feet, Planorbulinella plana at 800 feet, P.inaequilateralis at 794 feet, all of which do not appear above this substage. Operculina victoriensis which ranges up to the base of the Bairnsdale substage, is recorded at 845 feet.

(ii) Batesford Substage.

Prior to the publication of the Holland's Landing report in 1941, all reports made by this Branch referred to the Batesford substage as Lower Miocene in age. The position of the Lepidocyclinae in the stratigraphic sequence in Gippsland has been discussed in Part 4. Not only is the species of Lepidocyclina in the area distinct from Batesford and Hamilton, but other foraminiferal species which are associated with the genus at those localities play an important part.

One of the commonest forms at the type locality for the Batesford substage is Calcarina verriculata Parr, which is fairly common at Hamilton and Flinders but is exceedingly rare in Gippsland, where it has been recorded from one bore (No.4, Ph.Colquhoun), in the cliff sections near Orbost and in quarry sections in the Ph.Glencoe. Hofkerina semiornata, one of the most characteristic foraminifera at Hamilton and in Gippsland, is not known from Batesford. The position of Austrotrillina howchini has already been discussed.

No striking lithological break is apparent between the Longford, Batesford and Bairnsdale substages, the beds consisting of bryozoal marls, limestones and marly limestones ranging from grey to greenish-grey in colour. Several surface sections are available in Sectors I, II and III, some of the quarry sections in Sector II being very rich in Lepidocyclinae.

The palaeontological distinction for the Batesford substage is based on the presence of a certain foraminiferal assemblage including the restricted genus Lepidocyclina and restricted species of Cycloclypeus, together with Planorbulinella inaequilateralis, P.plana, Gypsina howchini, Hofkerina semiornata, Calcarina verriculata, and Austrotrillina howchini (absent from Batesford but associated with Lepidocyclina at Hamilton and Skinner's Section, Mitchell River). Persistent accessory forms are Carpenteria rotaliformis, C.proteiformis, Amphistegina lessonii and Operculina victoriensis. This assemblage has been previously dealt with by the author (1936) but was referred to the Lower Miocene.

The Batesford substage in Gippsland is represented by the zone of Lepidocyclina (Trybliolepidina) gippslandica, which dominates the foraminiferal assemblage in all bores and outcrops. The thickness of the zone varies considerably, being 127 feet in No.11 Bore, Ph. Colquhoun and 857 feet in No.2 Bore, Ph.Glencoe. It can be subdivided into two zonules already mentioned.

(1) The lower or zonule of Cycloclypeus victoriensis var. gippslandica, is present in all sectors, in association with numerous Lepidocyclinae. It is extremely limited in vertical extent in bores. Cycloclypeus is rarely recorded from more than ten feet of core samples in any bore. Associated with these two genera are the typical forms listed above.

Surface sections are to be found in the Ph.Glencoe, and along the Mitchell River, above Bairnsdale. In deep borings, in Sector IV, the typical Janjukian genus Cyclammina ranges through the Longford into the Batesford substage, where it is found with Lepidocyclina. In Sector II, Lepidocyclina and other characteristic foraminifera are associated with a rich assemblage of Balcombian species of mollusca. This feature is illustrated at Skinner's section, Ph.Wuk Wuk and in certain bores. Some Balcombian species in this sector range up to the Mitchellian stage where they occur with Kalimnan species of foraminifera, bryozoa and mollusca.

(2) The upper or zonule of Hofkerina semiornata is of much greater thickness than the lower one and is characterised by the occurrence of other typical foraminifera such as Gypsina howchini, Planorbulinella inaequilateralis and P.plana, together with a few specimens of Lepidocyclina, the last occurrence, in the upward sequence, of one of this assemblage indicating the uppermost limits of the Batesford substage in bores. It is recorded from numerous bores and is exposed in quarry sections in the Ph. Glencoe and in cliffs along the Mitchell River and near Orbost. Bryozoa dominates the fauna.

These two zonules are represented in two quarries in the Ph. Glencoe, the lower in Brock's quarry and the upper in McColl's a short distance away.

(a) The zonule of Cycloclypeus victoriensis var. gippslandica is described from Brock's Quarry, Ph.Glencoe, about 1½ miles east of Longford along the Seaspray Road (Fig.2). The sediments consist of cream to whitish, bryozoal limestones containing Cycloclypeus, abundant Lepidocyclinae and numerous tests of Amphistegina. Samples were taken from various parts of the quarry, the fossil assemblage being uniform throughout. The fossil fauna is listed below.

FORAMINIFERA - Dorothia parri, Textularia fistulosa, T.carinata, Gaudryina rugosa, Listerella communis, Clavulinoides szaboi var. victoriensis, Bolivina limbata, Reussella spinulosa, Ehrembergina serrata, Cassidulina subglobosa, Lagena orbignyana, Dentalina consobrina, D.obliqua, Lenticulina articulata, L.rotulata, L.calcar, L.mamilligera, Glandulina laevigata, Sigmoidella elegantissima, S.kagaensis, Sigmomorphina haeusleri, Guttulina regina, G.irregularis, Globigerinoides trilobus, Sphaeroidina bulloides, Pullenia sphaeroides, Cibicidella variabilis, Anomalina glabrata, Heronallenia lingulata, H.wilsoni, Discorbis allomorphinoides, Gypsina howchini, G.globulus, Siphoninoides echinatus, Cibicides victoriensis, C. sp., Carpenteria proteiformis, Eponides scabriculus, E.repandus, Siphonina australis, Hofkerina semiornata, Planorbulinella inaequilateralis, P. plana, Operculina victoriensis, Amphistegina lessonii, Elphidium crespinae, E.pseudoinflatum, Cycloclypeus victoriensis var. gippslandica, Lepidocyclina (Trybliolepidina) gippslandica.

ECHINODERMA - Steriocidaris australiae, Goniocidaris pruni-spinosa, Psammechinus woodsi.

BRYOZOA - Strophipora harveyi, Cellaria enormis, C.divaricata, C.gracilis, Amphiblestrum grande, A.robustum, Acanthodesia simplex, Membranipora porcellana, M.striata var., Ellisinidra pyriformis, Stamnocella fusiformis, Hincksina geminata, Macropora clarkei, M.cribrilifera, Membraniporella tenuicosta, Figularia orbicula, Cribrilina cornuta, C.terminata, C.terminata var. coronata, Cellepora fossa, C.coronopus, Conescharellina cancellata, C.philippinensis, Tubucellaria cereoides, Tubiporella magnirostris, T.elevata,

Meliœerita angustiloba, Thalamoporella gracilis, Steganoporella magnilabris, Tremopora radicifera, Nellia oculata, Chaperia cylindriformis, Corbulipora sp., Schizoporella alata, S.burlingtonensis, Schizolavella, phymatopora, Buffonellodes profunda, Porella baculina, P.centralis var. laevigata, P.denticulata, P.rhomboidalis, Crateropora patula, Costazia producta, Escharoides erectus, Didymosella larvalis, Hiantopora liversidgei, Lepralia quadrata, L.filiformis, Caberea grandis, Ditaxipora internodia, Smittina praeclara, S.bisinuata, S.elongata, Smittinella tatei, Schizoporella strictifissa, Gigantopora cribraria, Tetraplaria australis, Phylactella porosa, Craspedozoum elongatum, Petraliella corrugata, Hippomenella rugosa, H.abdita, Porina gracilis, Lekythopora hystrix, Retepora beaniana, Crisia acropora, Entalophora longipora, Idmonea milneana, Hornera tuberculata, H.frondiculata, Lichenopora radiata, L.australis, Pachystomaria parvipunctata, Plagioecia sp.

BRACHIOPODA - Murravia flindersi, Cryptopora acutirostrum.

PELECYPODA - Chlamys praecursor, Dimya dissimilis.

OSTRACODA - Bairdia amygdaloides, B.subdeltoidea, Bythocypris reniformis, Macrocypris sp., Aglaia clavata, Cythere sp.nov., C.rastromarginata, C.sorrentae, C.flexicostata, Krithe eggeri, Xestoleberis variegata, Cytheropterom batesfordiense, Loxoconcha australis, Cytherella sp.1.

(b) The zonule of Hofkerina semiornata is represented in McColl's Quarry which is situated on the east side of Boundary Creek in Allotment H, Ph.Glencoe, and is 4 miles east of Longford and about 3 miles east of Brock's (Fig.2). The sediments consist of hard and soft bands of ferruginous bryozoal limestone and marly limestone, which apparently strike north-west and south-east, with a dip to the north-east. The quarry face is about 20 feet high. Samples were taken wherever friable material could be obtained, and examination of these shows the fossil content to be consistent throughout. At the top of the quarry, bryozoa are well preserved, with Cellepora coronopus abundant. A general list of fossils is as follows -

FORAMINIFERA - Dorothia parri, Bolivina victoriana, B.dilatata, B.lobata var., Trifarina bradyi, Cassidulinoides chapmani, Tubulogemerina mooraboolensis, Reussella spinulosa, Cassidulina subglobosa, Lagena hexagona, L.sulcata, L.globosa, Nodosaria raphanus, Dentalina obliqua, D.soluta, Parafrondicularia sp.nov., Lenticulina crepidula, L.rotulata, Sigmoidella kagaensis, S.elegantissima, Guttulina problema, G.(Sigmoidina) silvestrii, Uvigerina tenuistriata, Globigerina bulloides, Globigerinoides trilobus, Sherbornina sp.nov., Anomalina ammonoides, A.glabrata, Cancris auricula, Heronallenia wilsoni, H. lingulata, Cibicides victoriensis, C.sp.(2), Pulvinulinella tenuimarginata, Carpenteria rotaliformis, Planorbulinella inaequilateralis, P.plana, Siphonina australis, Eponides scabriculus, Elphidium parri, E.pseudoinflatum, E.crassatum, Amphistegina lessonii, Operculina victoriensis, Gypsina howchini, G.globulus, Acervulina inhaerens.

ANTHOZOA - Mopsea tenisoni, M.sp.

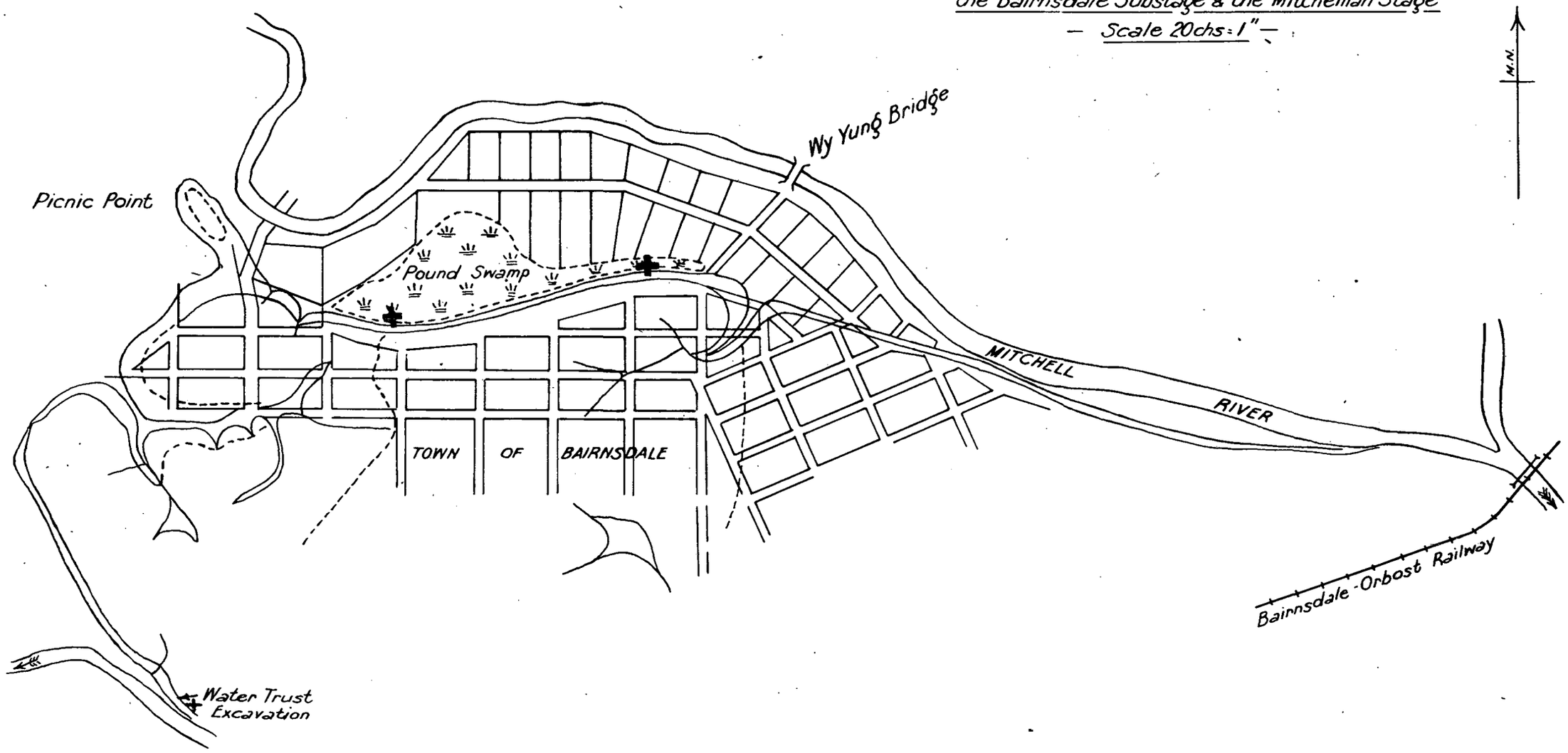
VERMES - Ditrupa cornea var. wormbetiensis.

ECHINODERMA - Goniocidaris pentaspinosa, G.prunispinosa, Steriocidaris australiae.

BRYOZOA - Canda inermis, Cellaria australis, C.contigua, C.rigida, C.rigida var. perampla, C.depressa, Melicerita angustiloba, M. acutimarginata, Macropora clarkei, Vincularia gigantea, Tremopora staminis, Corbulipora ornata, Cellepora tridenticulata, Porina gracilis,

FIG. 3

— Plan —
— of —
Portion of Parish of Bairnsdale
— Showing —
Location of the Type Localities of
the Bairnsdale Substage & the Mitchellian Stage
— Scale 20chs = 1" —



Porina vertebralis, P.cribraria, Metroperiella transversa, Bulbipora areolata, Smittina elongata, S.reticulata, Micropora carinata, Chiastosella porosa, Porella tuberosa, Buffonellodes baculina, Retepora fissa, R. subimmersa, Mecynoecia proboscidea, Idmonea trigona, I. incurva, Diastopora discoidea, Hetepora pisiformis, Filisparsa orakeiensis, together with all species recorded from Brock's.

BRACHIOPODA - Murravia catinuliformis, M.flindersi, Bouchardia sp., Stethothyris insolita, Thecidium australe.

PELECYPODA - Chlamys cf. polymorphoides, C.praecursor, Dimya dissimilis, Serripecten yahliensis.

OSTRACODA - Bairdia amygdaloides, B.subdeltoidea, Macrocypris decora, Bythocypris tumefacta, Bythocythere keblei, Cythere dictyon, C.scutigera, C.rastromarginata, C.melobesioides, C.caudispinosa, C.flexicostata, C.canaliculata, C.sp.4, C.sorrentae, Loxoconcha avellana, Krithe eggeri, Cytheropteron batesfordiense, C.fenestratum, C.praeantarcticum, Xestoleberis variegata, Cytherella lata.

Amongst the distinctive foraminifera is a new species of Sherbornina, the only other record being near Orbost, where it occurs in beds belonging to the same zone as those in McColl's Quarry.

(iii) Bairnsdale Substage.

The term "Bairnsdale substage" is applied to the bryozoal, shelly limestones and marly limestones which immediately overlie the Lepidocyclina horizon in all surface and subsurface sections. Characteristic foraminiferal species of the Batesford substage such as Planorbulinella plana, Gypsina howchini, Hofkerina semiornata and Lepidocyclina do not range above that substage, but Amphistegina and Operculina persist into the basal beds of the Bairnsdale substage. Typical small Balcombian species appear throughout.

In all exposures of this substage, as along the banks of the Tambo and Nicholson Rivers and along the Prince's Highway to Orbost, the upper portion appears everywhere as a horizontally bedded limestone which abounds in large echinoidea, brachiopoda and pelecypoda. This bed is underlain by bryozoal limestones, in which large pelecypoda such as Hinnites corioensis, Spondylus baileyanus and Serripectem yahliensis so abundant in the upper portion, occur sparingly.

In 1875, Howitt applied the term "Bairnsdale limestone" to cliff sections near Bairnsdale, regarding the age as Miocene. Dennant (1891) postulated an Eocene age for these beds on the basis of correlation with a fauna from Muddy Creek, Hamilton, then regarded as Eocene. McCoy (1874) referred them to the Middle Miocene, an age confirmed by present investigations.

The cliff section at Pound Swamp, Bairnsdale, on the south side of the Mitchell River, just beyond the Wy Yung Road turn-off is designated as the type section (Fig.3). The cliff is 74 feet high, and about half a mile long. It consists of an upper bed of ferruginous, fossiliferous limestone, containing large echinoids and bivalve shells and lower bed of friable, bryozoal limestone, in which macrofossils are scarce. Dennant (1891) lists one foraminifer, two echinoids, one bryozoan, five brachiopoda, eleven pelecypoda and two gasteropoda from the section. A collection of fossils was made by the writer in company with Mr.J.Easton of the Victorian Mines Department in 1932. The section was re-visited in April, 1941, when the lower bryozoal bed was also systematically sampled.

A faunal description of the type section is listed below and includes only specimens collected in recent years.

(a) Upper bed of hard, ferruginous, fossiliferous limestone. Fossils are difficult to extract owing to the hardness of the rock.

ANTHOZOA - Flabellum gambierense, Placotrochus sp.

ECHINODERMA - Clypeaster gippslandicus (common), Phyllacanthus duncani.

BRYOZOA - Cellepora fossa.

BRACHIOPODA - Magellania garibaldiana, Stethothyris insolita, Magadinella woodsiana.

PELECYPODA - Spondylus pseudoradulus (common), S.baileyanas (c), Chlamys meringae (c), Hinnites corioensis (c), Serripecten yahliensis, S.yahliensis var.semilaevis (a), Ostrea arenicola (common and large), Cucullaea corioensis, Glycymeris sp., Venericardia spinulosa, Myodora sp.

GASTEROPODA - Turritella conspicabilis, Calliostoma sp.

(b) Lower bed of friable, cream to ochreous coloured, bryozoal limestone. Washed samples are composed almost entirely of bryozoa, with Retepora the commonest genus. Foraminifera and ostracoda are also present but no forms are well preserved.

FORAMINIFERA - Textularia gramen, Verneuilina triquetra, Gaudryina rugosa, Bolivina dilatata, B.victoriana, Lagena apiculata, L.favosopunctata, L.sulcata, Siphonodosaria scalaris, Nodosaria costulata, Dentalina obliqua, Lenticulina rotulata, Glandulina laevigata, Sigmoidella elegantissima, S.kagaensis, Gypsina globulus, Discorbis australis, Cancris auricula, C.philippinensis, Heronallenia lingulata, Siphonina australis, Cibicides ungerianus, C.lobatulus, C.sp.(2), Anomalina glabrata, Eponides concentricus, E.repandus, Notorotalia howchini, Nonion victoriense, Elphidium chapmani, E.crispum, E.pseudonodosum.

ANTHOZOA - Mopsea tenisoni.

BRYOZOA - Cellaria rigida, C.rigida var. perampla, C.gracilis, C.contigua, Macropora clarkei, Conescharellina philippinensis, C.cancellata, Hiantopora liversidgei, Tubiporella magnirostris, Cribrilina terminata, Chaperia cylindriformis, Cellepora fossa, Lepralia bairnsdalei, Metroperiella transversa, Exochella granulata, Smittina elongata, Smittinella tatei, Peristomella praestans, Schizoporella bombycina, Retepora beaniana, R.schnapperensis, R.fissa, Crisia acropora, Idmonea trigona, I.milneana, Hornera striata, Mesonea hochstetteriana, Lichenopora radiata, Liripora fasciculata.

OSTRACODA - Bairdia subdeltoidea, Bythocypris tumefacta, Cythere demissa, C.dictyom, C.flexicostata, C.lactea, C.sorrentae, Loxoconcha australis.

The faunal assemblage in the lower bed of the section is typical of that found in all borings except in those towards the western portion of Sector II, in which numerous small Balcombian species of mollusca are prominent in a bryozoal marl. Several other foraminiferal forms are characteristic of the substage as found in borings. Amphistegina and Operculina, which are present in the Longford, and common in the Batesford, disappear in the basal beds of the Bairnsdale. The bryozoal species are similar to the majority of forms

Porina vertebralis, P.cribraria, Metroperiella transversa, Bulbipora areolata, Smittina elongata, S.reticulata, Micropora carinata, Chiastosella porosa, Porella tuberosa, Buffonellodes baculina, Retepora fissa, R. subimmersa, Mecynoecia proboscidea, Idmonea trigona, I. incurva, Diastopora discoidea, Hetepora pisiformis, Filisparsa orakeiensis, together with all species recorded from Brock's.

BRACHIOPODA - Murravia catinuliformis, M.flindersi, Bouchardia sp., Stethothyris insolita, Thecidium australe.

PELECYPODA - Chlamys cf. polymorphoides, C.praecursor, Dimya dissimilis, Serripecten yahliensis.

OSTRACODA - Bairdia amygdaloides, B.subdeltoidea, Macrocypris decora, Bythocypris tumefacta, Bythocythere keblei, Cythere dictyon, C.scutigera, C.rastromarginata, C.melobesioides, C.caudispinosa, C.flexicostata, C.canaliculata, C.sp.4, C.sorrentae, Loxoconcha avellana, Krithe eggeri, Cytheropteron batesfordiense, C.ffemestratum, C.praeantarcticum, Xestoleberis variegata, Cytherella lata.

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In all exposures of this substage, as along the banks of the Tambo and Nicholson Rivers and along the Prince's Highway to Orbost, the upper portion appears everywhere as a horizontally bedded limestone which abounds in large echinoidea, brachiopoda and pelecypoda. This bed is underlain by bryozoal limestones, in which large pelecypoda such as Hinnites corioensis, Spondylus baileyanus and Serripectem yahliensis so abundant in the upper portion, occur sparingly.

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along the stairway and directly behind the station, sampled, this portion representing the base of the stage. Here, bryozoal marls were found to overlie the Bairnsdale substage of the Balcombian. The contact with the overlying Kalimnan is not available owing to denudation, but the presence of several small Kalimnan mollusca and a few typical bryozoa suggest that the full section is not much thicker than that already exposed.

(a) Two beds were sampled in this lower portion:-

i. Lower bed, just above that containing large bivalves typical of the type locality for the Bairnsdale substage, exposed at Pound Swamp, not far to the north, and below a fine shell band. It consisted of ochreous marl containing brown glauconite which has replaced many organisms, angular quartz grains, foraminifera, a few bryozoa and numerous ostracoda.

FORAMINIFERA - Triloculina tricarinata, Sigmoilina schlumbergeri, Textularia carinata, Bolivina robusta, B.aff.limbata, Lagena striata, L.sulcata, Siphonodosaria scalaris, Dentalina sp., Rectobolivima bifrons var. striatula, Guttulina problema, Pyrulina fusiformis, Sigmoidella elegantissima, Discorbis australis, D.orbicularis, Cibicides lobatulus, C.ungerianus, Anomalina sp., Planulina kalimmensis, Siphonima australis, Nonion victoriense, Elphidium crispum.

VERMES - Ditrupa cornea var. wormbetiensis.

ANTHOZOA - Mopsea tenisoni.

ECHINODERMA - Goniocidaris pentaspinosa.

BRYOZOA - Cellaria australis, C.rigida, C.divaricata, C.depressa, Melicerita acutimarginata, Porina gracilis, Porella rhomboidalis, Conescharellina philippinensis, Adeonellopsis clavata, Idmonea milneana, I.contorta, Hornera frondiculata, H.tuberculata.

OSTRACODA - Bairdia subdeltoidea, Macrocypris decora, M.tumida, Aglaia clavata, Paradoxostoma cf. ensiformis, Cythere dictyon, C.demissa, C.canaliculata, C.scutigera, C.militaris, Bythocythere arenosa, Cytherideis laevata, Loxoconcha australis, Xestoleberis variegata, Cytherella lata, C.punctata, Alatacythere praeantarcticum.

CIRRIPEDIA - Balanus amphitrite var. acuta.

ii. Upper bed, along and abowe fine shell band. It consisted of ochreous, shelly marl with foraminifera common but species few, bryozoa scarce and poorly preserved, small mollusca and numerous ostracoda.

FORAMINIFERA - Quinqueloculina vulgaris, Triloculima schreibersiana, T.tricarinata, Sigmoilina sigmoidea, Reophax sp., Bolivinita cf. quadrilatera, Bolivina sp.1, B.robusta, Bulimina echinata, Lagena gracillima, L.favosopunctata, L.laevis, L.striata, L.apiculata, L.sulcata, Dentalina obliqua, D.emaciata, D. cf. obliqua, D.soluta, Rectobolivina bifroms var. striatula, Glandulima laevigata, Uvigerina cf. pigmea, Globigerina bulloides, Planulinoides biconcavus, Cibicides ungerianus, Planulina kalimmensis, Notorotalia cf. clathrata, Epistomina elegans, Astrononion australe, Nonion victoriense, Elphidium crispum, E. cf. parri, E. cf.verriculatum.

VERMES - Ditrupa cornea var. wormbetiemsis.

ANTHOZOA - Mopsea tenisoni.

BRYOZOA - Cellaria rigida, C.rigida var.perampla, C.divaricata, Melicerita angustiloba, Selenaria maculata, S.concinna, Otionella cupola, Thalamoporella gracilis, Conescharellina philippinensis, Idmonea incurva, Liripora superposita.

PELECYPODA - Nuculana woodsi, Neotrigonia acuticostata, Lepton trigonale, Lissarca rubricata, Cuna polita, C.radiata, Venericardia spinulosa, Clausinella subroborata, Lima bassi.

GASTEROPODA - Turritella acinella, T.conspicabilis, Cerithiopsis woolnoughi, Cylichnella sp.

OSTRACODA - Bairdia amygdaloides, Macrocypris decora, M.tumida, Bythocypris tumefacta, Cythere militaris, C.scutigera, C.scabrocuneata, C.canaliculata, C.demissa, C. sp.nov., Cytherideis laevata, Xestoleberis variegata, X.margaritea, Loxoconcha australis, Bythocythere arenosa, Alatacythere praeantarcticum.

CIRRIPEDIA - Balanus amphitrite var. acuta.

The above descriptions include a foraminiferal assemblage different from that in the underlying Balcombian, species typical of the overlying Kalimnan being present as well as some new species of Bolivina which seem to be fairly restricted to this new stage. Amongst the bryozoa, Balcombian species are present in the lower portion but give way to Kalimnan species such as Selenaria in the upper. Small molluscan shells of Kalimnan species occur in the upper portion while ostracoda are common throughout.

(b) The beds representing the upper portion of the stage, consist of hard, ferruginous, fossiliferous, marly limestone containing numerous casts and moulds of molluscan shells referable to Kalimnan and Balcombian species. The fossils present are:-

ANTHOZOA - Flabellum gippslandicum.

BRYOZOA - Cellepora biradiata.

BRACHIOPODA - Stethothyris insolita.

PELECYPODA - Spondylus baileyanus, Pteria (Meleagrina) crassicardia, Hinnites corioensis, Ostrea arenicola, Panope orbita, Pinna sp., Anomia tatei, Glycymeris subtrigonalis, Limopsis beaumariensis, Arca (Barbatia) cf.simulans, Dosinia johnstoni, Aloidis (Notocorbula) pyxidata, Venericardia spinulosa, Meretrix cf. eburnea, Semele krausei, Callanaitis cainozoicus, Cuspidaria sp.nov., Cucullaea corioemsis.

GASTEROPODA - Conus ligatus, Conus spp., Sigapatella crassa, Cypraea aff.subsidua, Trivia avellanoides, Murex aff.asteriscus, Cymatium annectans, Polinices substolida, Emarginula transenna, Antiphalium muelleri, Tylospira coronata.

CIRRIPEDIA - Balanus amphitrite var. acuta.

It will be shown in the description of a subsurface section for the stage, that similar conditions exist in the upper part of the stage in which numerous mollusca flourished.

The description of the subsurface section from No.11 Bore, Ph. Colquhoun, is given in detail so that the complete sequence from Kalimnan down to Balcombian can be illustrated.

This bore, with an elevation of 19 feet above sea level, is situated in Allotment 123A, Ph. Colquhoun and is the most northerly Government bore in this part of the Lakes Entrance area. The transition beds were systematically collected from and studied on the bore site. The Mitchellian stage was penetrated at 195 feet, the bore passing from the fine, shelly sandstone of the Kalimnan into greenish, shelly marls containing abundant quartz and glauconite grains, small pebbles of a greenish rock, foraminifera, numerous bryozoa and worn fragments of molluscan shells. This bed passes downwards into greenish-grey to grey shelly marl, the majority of the shells being preserved as whitish casts and moulds. The shells are unusually large and numerous, the mixed assemblage of Kalimnan and Balcombian species persisting throughout. The shelly and glauconitic facies disappears at 294 feet, at which depth is the topmost limit of the Balcombian.

A detailed description of the section, in downward sequence, is as follows:-

Greenish-grey, shelly marl with abundant glauconite grains, pebbles, foraminifera, bryozoa (more numerous than in the overlying Kalimnan), mollusca and ostracoda, extend from 195 feet down to 238 feet.

FORAMINIFERA - Pyrgo bulloides, P.depressa, Quinqueloculina ammophila, Q.vulgaris, Q.seminulum, Triloculina schreibersiana, T. tricarinata, Spiroloculina dispansa, Sigmoilina schlumbergeri, Cornuspira foliacea, Listerella communis, Bolivina aff.limbatum, Lagena gracillima, L.sulcata, Dentalina obliqua, Lenticulina cultrata, Glandulina laevigata, Guttulina regina, Uvigerina cf.pigmea, Globigerina bulloides, Globigerinoides trilobus, Orbulina universa, Discorbis australis, Planulina kalimnensis, Planulinoides biconcavus, Cibicides ungerianus, C.victoriensis, C.lobatulus, Anomalina sp.1, Notorotalia cf.clathrata, Epistomina elegans, Astrononion australe, Elphidium imperatrix.

ANTHOZOA - Notophyllia variolaris, Flabellum victoriae.

BRYOZOA - Cellaria depressa, C.divaricata, C.rigida var.perampla, C.australis, C.laticella, Melicerita angustiloba, M.acutimargimata, Thalamoporella gracilis, Crateropora patula, Tubucellaria margimata, Selenaria maculata, S.concinna, Lunulites parvicella, L.canaliculata, Dakaria crassocirca, Peristomella praestans, Porella denticulata, Conescharellina philippinensis, Adeonellopsis mucronata, Scuticella lata, Crisia acropora, Idmonea contorta, Hornera tuberculata, Mesonea hochstetteriana.

PELECYPODA - Anomia tatei, Chlamys meringae, Neotrigonia howitti, Nuculana woodsi, Cardita kalimnae, Venericardia compacta, V.gippslandica, V.subcompacta, V.spinulosa, Clausinella subroborata, Lissarca cincturata, Lepton trigonale, Cuna polita, C.concentrica, C.particula, Salaputium commune, Limopsis beaumariensis, Cucullaea corioensis var. praelonga, Mactra howchiniana, Myodora corrugata, Divaricella dentata, Glycymeris subtrigonalis, Dosinia cf. johnstoni.

GASTEROPODA - Turritella conspicabilis, T.acricula, Conus ligatus, Ancilla ligata, Cymatium annectans, Eglisia triplicata, Natica hamiltonensis, Pyramidella polita, Cyclostrema inscriptum, Phos liraecostatus, Bathytoma pritchardi, fragment of large Cypraea, cf.C.eximia, Cerithiella trigemmata, Laetifautor bicarinatus, Marginella kalimnae.

OSTRACODA - Bairdia subdeltoidea, B.amygdaloides, Macrocypris decora, Monoceratina arenosa, Cythere dictyon, C.scutigera, Xestoleebris variegata, Alatacythere praeantarcticum, Krithe producta, Cytherella lata.

CIRRIPEDIA - Balanus amphitrite var. acuta.

From 238 feet down to 294 feet, the beds pass from brownish-green, shelly marl to grey, shelly marl, in which the macro-fossils appear as whitish casts with the glauconite content gradually disappearing towards the base of the section. Bryozoa are the dominating fossils. Mollusca are represented chiefly by large specimens of pelecypoda. As many of the foraminiferal (excluding some miliolines) and bryozoal species (except Lunulites and Selenaria) are recorded under 195 to 238 feet, only additional forms will be listed.

FORAMINIFERA - Pyrgo elongata, Massilina lapidigera, Triloculina trigonula, Ammobaculites reophaciformis, Reophax sp., Textularia carinata, T.fistulosa, Dorothia gibbosa, Gaudryina rugosa, G.(Pseudogaudryina) crespinae, Bolivina nobilis, B.robusta, B.alata, B.sp.nov., Virgulina schreibersiana, Robertina sp., Bulimina echinata, Lagena hexagona, L.marginata, L.striata, Siphonodosaria scalaris, Dentalina emaciata, Marginulina glabra, Lenticulina crepidula, L.gibba, L.sp.(1), Guttulina irregularis, G.lactea, G.problema, Globorotalia canariensis, Cancris auricula, C.philippinensis, Cibicides lobatulus, Cibicidella variabilis, Discorbis tuberculata var. australiensis, Anomalina glabrata, Gypsina globulus, Gyroidina soldanii, Eponides repandus, Notorotalia howchini, Nonion victoriense, Elphidium crispum, E.pseudonodosum.

ANTHOZOA - Notophyllia variolaris, Mopsea tenisoni.

ECHINODERMA - Phyllacanthus duncani.

BRYOZOA - Scutella ventricosa, S.nobilis, Costaticella latifrons, C.benecostata, Scrupocellaria crenulata, Canda inermis, Menipea alternata, Caberea grandis, Cellaria rigida, C.rigida var. perampla, C.rigida var. venusta, Macropora clarkei, Membranipora delicatula, Tremopora staminis, T.radicifera, Ellisinidra pyriformis, Tubucellaria cereoides, Cellepora fossa, C.coronopus, Conescharellina cancellata, Lekythopora hystrix, Cribrilina terminata, C.terminata var. coronata, Hiantopora monoceras, H.liversidgei, Chiastosella gabrieli, Buffonellodes profunda, Hippomenella rectilineata, H.abdita, H.rugosa, Schizoporella alata, S.bombycina, S.orbiculifera, S.graysoni, S.lata, Lepralia spatulata, L.filiformis, L.perforata, L.continua, Porella rhomboidalis, P.tuberosa, Floridinella depressa, Smittina elongata, S.bisinuata, S.reticulata var. nitida, S.reticulata var. calceola, Porina gracilis, Didymosella larvalis, Arachnopusia linearis, Metroperiella transversa, Petraliella corrugata, Rhynchopora longirostris, Retepora beaniana, R.fissa, Entalophora longipora, Idmonea trigona, I.milneana, Hornera foliacea, Lichenopora radiata, Liripora superposita.

BRACHIOPODA - Stethothyris insolita.

PELECYPODA - Ostrea arenicola, Chlamys sturtianus, C.antiaustralis, Pteria (Meleagrina) crassicardia, Spondylus pseudoradulus, S.baileyanus, Lima (Limatula) jeffreysiana, Lima bassi, Clausinella allporti, Catelysia propinqua, Salaputium abbreviatum, Aloidis (Notocorbula) coxi, Dosinia johnstoni.

SCAPHOPODA - Dentalium mantelli.

GASTEROPODA - Cylichnella exigua, Emarginula transenna, Tylospira coronata, Vermicularia sp., Cypraea sp., Calliostoma sp., Astele sp.

OSTRACODA - Bythocypris tumefacta, Loxoconcha australis, Cytherella lata, C.subtruncata.

The faunal assemblage present from 294 feet up to 238 feet illustrates the relationship of the Mitchellian to the subjacent Balcombian. Amongst the foraminifera, certain of the Textularidae characteristic of the Balcombian persist. The bryozoal species are typically Balcombian. The large pelecypoda are such as found im the Bairnsdale substage. From 238 feet up to 198 feet, species typical of the supradjacent Kalimnan appear. The Textularidae give way to the Miliolidae; Selenaria and Lunulites, characteristic of the Kalimnan bryozoa, are intermingled with numerous Balcombian species; whilst Kalimnan mollusca make an early appearance in the Mitchelliam.

Kalimnan Stage

The sediments of the Kalimnan stage consist of friable, greenish-grey, shelly sandstone and grey, sandy marl, the marly condition being apparent towards the base of the section. They contain a characteristic foraminiferal, bryozoal and molluscan assemblage. The lithological break between the Mitchellian and the Kalimnan is fairly sharp, but the faunal one is gradual, the base of the latter being recognised by the sudden disappearance of bryozoa.

The chief points of recognition of the Kalimnan are - (a) the fairly sudden change in lithology from the underlying Balcombiam, a more sandy facies being prominent; (b) a characteristic foraminiferal assemblage; (c) the comparative scarcity of bryozoa with the presence of typical species; (d) a rich molluscan fauna, with typical restricted species.

The stage has its type section at Jemmy's Point, Lakes Entrance and it is only in Sector I that it is typically represented. Although it is recorded from numerous bores in Sectors II, III and IV, the mollusca are never so richly developed as in that sector. In view of the location of the type section, which is just above the site of No.1 Government Bore, Ph. Colquhoun, an excellent opportunity is given for a close study of the sequence of the Kalimnan deposits. Singletom (1941) has described the section in which he distinguishes am upper and a lower zone. The former is recorded only from outcrops and with one possible exception, is restricted to Sector I. The latter appears in both subsurface and surface sections.

(a) The lower zone (zone of Planulina kalimnensis) is characterised by friable, greenish-grey, fossiliferous sandstone in bores and by yellowish sandstone and hard, gritty limestones in surface sections. Foraminifera are moderately common, the abundance of specimens varying in different bores. Typical species include Quinqueloculina ammophila, Massilina lapidigera, Flintina intermedia, Bolivina alata, Rectobolivina bifrons var. striatula, Cancris philippinensis, Planulina kalimnensis, Nonion victoriense, Astrononiom australe and Elphidium imperatrix. In some bores in Sector I, the assemblage is dominated by large miliolines. Corals are not common, representative forms being Notophyllia variolaris, Placotrochus deltoideus, Sphenotrochus alatus and Trematotrochus clarkii. Joints of Mopsea tenisoni are frequently present. Bryozoa are practically restricted to the genera Cellaria, Conescharellina, Cellepora, Lunulites and Selenaria. Brachiopoda are poorly represented, the most persistent form being Stethothyris insoli[illegible].

Singleton has listed characteristic species from this zone, but in bores many smaller forms are represented. Amongst the pelecypoda are Anomia tatei, Neotrigonia howittii, Panope orbita, Eucrassatella kingicoloides, Clausinella subroborata, Catelysia propinqua, Aloidis (Notocorbula) coxi, Venericardia gippslandica,

Glycymeris subtrigonalis and Limopsis beaumariensis, which is more prominent in the basal portion of the section. N.howitti is not common in bores, and when present, occurs in the upper portion.

Amongst the gasteropoda are Ancilla orycta, Olivella nymphalis, Bathytoma pritchardi, Turritella conspicabilis, T.acinella, Tylospira coronata, Marginella kalimnae, Cylichnella cuneopsis, Phos gregsoni, Terebra catenifera and Natica hamiltonensis. Turritella is exceedingly common both in bores in all sectors and outcrops in Sector I. T.acinella is an abundant small species, while T.conspicabilis varies considerably in size. Forms such as Bankivia howitti, Liopyrga quadricingulata and Nassarius crassigranosus, which are typical of the upper zone, are rare in bore sections. Ostracoda are fairly common and are usually thin-shelled, the following species being present - Bairdia subdeltoidea, Aglaia clavata, Macrocypris tumida, Cythere dictyon, C.scutigera, Krithe producta, and Cytherella lata. Balanus amphitrite var. acuta is typical.

(b) The upper zone (zone of Nonion victoriense) consists of a coarse, sandy bed containing numerous large molluscan shells such as are found in the top "shell band" at the type locality at Jemmy's Point. This zone is only a few feet thick and outcrops are restricted to Sector I. A characteristic molluscan assemblage is present, but species are not numerous, considering the abundance of specimens. Pelecypoda include Neotrigonia howitti, Nucula kalimnae, Nuculana crassa, Eucrassatella kingicoloides, and Clausinella subroborata. Representative gasteropoda are Nassarius crassigranosus, Bankivia howitti, Polinices cunninghamensis, Tylospira coronata, and Liopyrga quadricingulata. Foraminiferal species are not numerous, Streblus beccarii and Nonion victoriense being the commonest forms. Bryozoa are rare. Thin-shelled ostracoda are typical.

The thickness of the stage as exposed at the type locality is about 40 feet, but if the section of proved Kalimnan in No.1 Government Bore, Ph.Colquhoun is taken into consideration, the thickness is approximately 180 feet. Only the lower zone is represented in bore sections, where the thickness of the sediments is comparatively uniform. Richly fossiliferous beds 180 feet thick were proved in No.1 Bore, Ph.Bumberrah (Pt.Addis) and 189 feet in No.6 Bore, Ph. Colquhoun, 160 feet in No.8 Bore, Ph.Glencoe, and 240 feet in No.1 Bore, Ph.Seacombe.

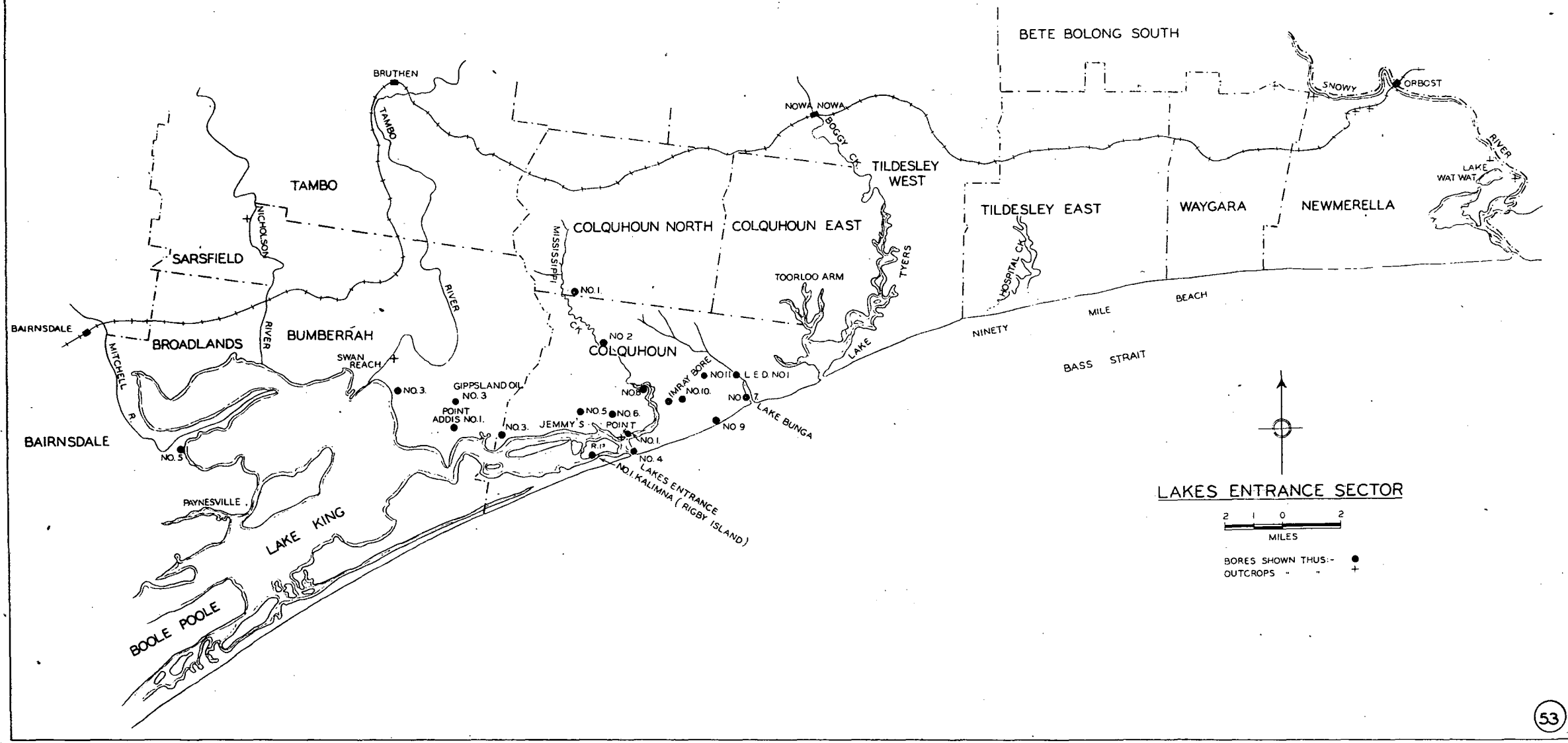
Post Kalimnan Beds.

Overlying the marine Tertiaries throughout Gippsland is a series of torrent gravels and sands which, in some sectors is 400 feet thick. Some of the sands in No.4 Bore, Ph.Colquhoun (Sector I) and in No.1 Bore, Ph.Dulungalong (Sector II) contain an assemblage of recent species of small foraminifera and molluscan shells. In the absence of any zonal fossils it seems advisable to refer to these sands and gravels simply as Post Kalimnan.

6. DETAILED STUDY OF THE BORES AND OUTCROPS.

In this section, the bores examined are enumerated, together with the varying limits of stratigraphic horizons. In the tabulation of bores the first depth recorded indicates the first fossiliferous sample received for examination and the last depth, the last sample. The bores are listed as far as possible in a definite geographical order and the stratigraphic horizons for convenience, in a descending sequence. The thicknesses of Post Kalimnan sands are not indicated.

FIG. 4.


BETE BOLONG SOUTH
BRUTHEN
TAMBO
NOWA NOWA
BOGGY CK.
TILDESLEY WEST
SNOWY
ORBOST
RIVER
LAKE WAT WAT
TAMBO
NICHOLSON
SARSFIELD
COLQUHOUN NORTH
COLQUHOUN EAST
TILDESLEY EAST
WAYGARA
NEWMERELLA
MISSISSIPPI CK.
TOORLOO ARM
TYERS
HOSPITAL CK.
NO. 1
NO. 2
COLQUHOUN
BAIRNSDALE
BROADLANDS
BUMBERRAH
MITCHELL R.
RIVER
SWAN REACH
NO. 3.
GIPPSLAND OIL NO. 3
POINT ADDIS NO. 1.
NO. 3.
JEMMY'S POINT
NO. 5
NO. 6.
NO. 8
IMRAY BORE
NO. 10.
NO. 11
L. E. D. NO. 1
NO. 7
LAKE BUNGA
NO. 9
NO. 1.
R. 13
NO. 4
LAKES ENTRANCE
NO. 1. KALIMNA (RIGBY ISLAND)
NO. 5
BAIRNSDALE
PAYNESVILLE
LAKE KING
BOOLE POOLE
LAKE
NINETY MILE BEACH
BASS STRAIT
LAKES ENTRANCE SECTOR
2 1 0 2
MILES
BORES SHOWN THUS:-
OUTCROPS " "

A stratigraphical section of a typical bore from each sector is illustrated at the end of this review (Fig.6).

I. Lakes Entrance Sector.

The cores of 19 bores, involving 24,574 feet of drilling and material from several outcrops have been examined, the stratigraphic sequence from Kalimnan down to Anglesean being proved in 13 bores. The geographical order in which the bores are listed, is approximately east to west.

The eastern limit of the sector is near Orbost where cliff sections are available along the Snowy River. The western boundary is marked by No.5 Bore, Bairnsdale (Eagle Point). The northern boundary extends along the junction of the granite and the exposures of bryozoal limestones in the Parishes of Tildesley East, North and East Colquhoun, then to the cliff sections along the Tambo and Nicholson Rivers (Fig.4).

The most easterly bores examined were No.1 Lakes Entrance Development Company and No.7 Government Bore(Lake Bunga)Ph. Colquhoun.

The elevation above sea level of most bores does not exceed 200 feet, the main exception being Gippsland Oil No.3 Bore, which had an elevation of 255 feet. Eleven bores were drilled to bedrock.

Beds belonging to the Kalimnan, Mitchellian and Balcombian stages are exposed throughout the sector.

PALAEOZOIC

Bedrock of palaeozoic age is recorded from eleven bores, granite forming the basement in seven of these and metamorphic rocks in four. The contact of the granite with the Balcombian bryozoal limestones is exposed in a quarry at the head of Mississippi Creek, Ph.North Colquhoun.

TERTIARY

Anglesean Stage

In Sector I this stage is represented by a thin series of sand & and sandstones, sometimes sideritic, which overlie the basement rocks. The bed reaches a maximum thickness of 61 feet in No.6 Bore, Ph.Colquhoun, where a flow of artesian water was encountered. Small foraminifera and bryozoal fragments are frequently recorded, the former including the zonal Janjukian species Vaginulina gippslandica and the Balcombian form, Amphistegina. Numerous fish remains, including neural spines, vertebrae, otoliths, scales and teeth of Carcharias victoriae, C.(Priodon) aculeatus, Heterodontus coleridgensis, Lamna apiculata and Isurus desorii, are present in No.1 Government Bore, Ph.Colquhoun and in No.3 Bore, Gippsland Oil, Ph. Bumberrah.

Janjukian Stage

This stage is represented by two lithological units, constituting the Lakes Entrance Formation, (i) a lower one consisting of glauconitic sandstone and (ii) an upper one of micaceous, foraminiferal marls.

LIMITING DEPTHS OF STRATIGRAPHICAL STAGES IN BORES IN SECTOR I. Table 2.

Bore	Stage	Kalimnan	Mitchellian	Balcombian			Janjukian	Anglesean	Bedrock
	Substage			Bairnsdale	Batesford	Longford			
Parish of North Colquhoun No.1 Government Bore (Mississippi Creek) S.L. 100'		-	-	54'-358'	382'	370'-659'	-	-	-
Parish of Colquhoun No.2 Government Bore S.L. 60'		110'-120'	120'-170'	180'-450'	510'	520'-740'	745'-926'	930'-940'	974' (granite)
No.1 Bore, Lakes Entrance Development Co. (L.Bunga) S.L. 9'		102'	120'-200'	200'-473'	489'-603'	613'-823'	833'-1100' G.S.1084'-1100'	1210'	1215' (metamorphic)
No.7 Government Bore (Lake Bunga) S.L. 5'		20'-60'	70'-150'	150'-470'	480'-670'	680'-870'	880'-1220' G.S.1184'-1220'	-	1221' (metamorphic)
No.9 Government Bore S.L. 10'		12'-94'	94'-167'	167'-530'	538'-700'	700'-920'	920'-1226' G.S.1186'-1226'	1226'-1242'	1242' (Hornfels)
No.10 Government Bore S.L. 140'		-	-	-	-	-	1020'-1291'6" G.S.1255'-1291'6"	1291'6"-1332'	1362'5"-1381'10" (granite)
Imray Well (Austral Oil) S.L. 135'		60'6"-215'6"	215'6"-274'	274'-630'	650'-770'	770'-1030'	1030'-1274'6" G.S.1255'-1274'6"	-	-
No.11 Government Bore S.L. 190'		96'-195'	195'-294	294'-607'	607'-734'	734'-926'	926'-1233'6" G.S.1149'-1233'6"	1233'6"-1238'	1238' (granite)
No.8 Government Bore (North Arm) S.L. 6'		40'-65'	65'-125'	125'-465'	465'-608'	608'-810'	810'-1094' G.S.1049'-1094'	1094'-1155'	1155'-1165' (granite)
No.1 Government Bore (Lakes Entrance) S.L. 9'		20'-140'	150'-220'	240'-720'	730'-840'	850'-1090'	1100'-1372'6" G.S.1331'-1372'6"	1372'6" - 1396'	1404'6" (granite)
No.4 Government Bore (Pilot Station) S.L. 15'		100'-160'	174'	184'-798'	799'-908'	909'-1140'	1150'-1441' G.S.1429'-1441'	1441'-1498'	1508'6" (granite)
No.1 Bore, Rigby Island (Kalimna Oil Co.) S.L. 36'		30'-95'	100'-160'	160'-680'	685'-890'	898'-1122'	1160'-1410' G.S.1387'6"-1410'	1427'	1476' (metamorphic)
No.6 Government Bore (Kalimna) S.L. 175'		117'-306'	306'-315'	315'-772'	775'-890'	895'-1115'	1120'-1425' G.S.1401'-1425'	1425'-1457'	1457' (granite)
No.5 Government Bore (Meringa Creek) S.L. 20'		80'-120'	130'-190'	200'-700'	710'-890'	900'-990'	1000'-1249' G.S.1228'-1249'	-	-
No.3 Government Bore (Nungurner) S.L. 15'		100'-198'	198'-283'	283'-706'	706'-919'	919'-1112'	1114'-1451' G.S.1431'-1451'	-	-
Parish of Bumberrah No.1 Bore, Pt.Addis Co. (Metung) S.L. 21'		60'-240'	240'-285'	285'-690'	700'-873'	875'-1110'	1115'-1409' G.S.?1396'-1409'	1421'-1429'	-
No.3 Government Bore S.L. 51' (not examined in detail)		73'-140'	-	150' +	640'-710'	-	?930'-1226'6" G.S.1226'6"	-	-
Gippsland Oil Bore No.3 S.L. 225'		218'-390'	425'	530'-830'	846'-980'	1030'-1105'	1141'6"-1423' G.S.1380'-1423'	1425'-1461'	-
Parish of Bairnsdale No.5 Government Bore (Eagle Point) S.L. 10'		120'-290'	300'-310'	320'-750'	760'-950'	960'-1220'	1230'-1540' G.S. 1540'	1541'	-

x G.S. - Glauconitic sandstone.

(i)The glauconitic sandstone as such is restricted to the Lakes Entrance Sector where it has been proved to be oil-bearing over an area of about 4 square miles. It consists of quartz grains coated with glauconite, brown limonitic ovoid pellets cemented together with glauconite and occasional casts of molluscan shells referable to typical Janjukian species. The commonest form is Turritella aldingae. In No.10 Bore, numerous Ostrea shells are present.

The average thickness of the glauconitic sandstone is about 30 feet, although in No.2 Bore, Lakes Entrance Development Co., 60 feet were recorded at 1210 feet. Its known limits from east to west are about 20 miles. On the eastern boundary, it is recorded from Lakes Entrance Development No.1 Bore (Lake Bunga) at 1084 feet and from No.7 Government Bore (Lake Bunga) at 1184 feet, but it is absent in Gobden's Bore a little further east. To the west it occurs in No.1 Government Bore, Ph.Bumberrah, just east of the Tambo River, at 1194 feet. A hard, grey, glauconitic and pyritic sandstone about 1 foot thick in No.5 Bore, Ph.Bairnsdale (Eagle Point), the most westerly bore im Sector I, suggests the last remnants of the glauconitic sandstone in that direction. Its known northerly extent from Lakes Entrance is about 3 miles, but its limits in that direction are not known. It is not recorded from No.1 Bore, Ph. North Colquhoun, nor from No.2 Government Bore, Ph. Colquhoun, but is present in No.1 Bore, South Australian Oil Company and in No.11 Bore, Ph.Colquhoun. The extent to the south-west has not been proved. It is somewhere in the area between No.1 Bore, Rigby Island in which it is recorded at 1387'6" and No.1 Bore, Ph.Boole Poole (Sperm Whale Head) in which it is absent, this latter bore marking the eastern limit of Sector IV.

The formation of glauconite is a slow process and takes place under moderately shallow water conditions at about 50 fathoms, in which molluscan shells and fishes can flourish. Such remains are found in the glauconitic sandstone at Lakes Entrance. Conditions of sedimentation in this area appear to have been similar to those which pertain at the present day in Monterey Bay (Galliher,1935) where the basement rock is granite as is the case in seven bores im Sector I. The glauconite is the result of decomposition of biotite which has its origin in the nearby basement rocks. Deposition of the sandstone must have been very slow so as to permit the alteration of the biotite to glauconite, with the necessary replacement of organisms. Pyrite, the decomposition of which is important im the production of glauconite, is a common component of the sandstone.

(ii) The glauconitic sandstone passes upward into fine, greenish to brown, sandy, micaceous marls, containing grains of brown and green glauconite in the basal portion. Fossils are rare but typical of the stage. A characteristic feature of this sandy facies throughout the sector is the presence of several bands of hard concretionary, shelly, calcareous sandstone, which are uniform in lithology but vary in number in different bores. Ten are recorded from No.7 Bore, and eleven from No.8 Bore, Ph.Colquhoun, both im the eastern portion of the sector; three are recorded from the Metung Bore, Ph.Bumberrah, in the west. The relative position of the bands in the sequence is shown in the description of the "standard section" from No.11 Bore in Part 5. This sandy content is gradually replaced in t he upward sequence by brownish to grey, micaceous, foraminiferal marls known in the field as the "micaceous series".

The fossil assemblage in the micaceous marls is, for the most part, consistent in all bores. Foraminifera are abundant, bryozoa few, and mollusca varying in abundance. A contrast to this uniformity is found in No.11 Bore, where bryozoa and mollusca are commom. Unfortunately, many mollusca, frequently represented by large

specimens, have been too crushed during deposition for specific determination.

The foraminiferal assemblage in the micaceous marls is similar to that recorded from the type Janjukian locality, with the Miliolidae, Lagenidae, Polymorphinidae and Globigerinidae being particularly well represented. Species restricted to the Janjukian in Gippsland are rare and include Victoriella plecte and Lamarckina glencoensis, Vaginulina gippslandica which is present in nearly all bores and is typical of the stage, does not range above the Janjukian but is present in the underlying Anglesean. Cyclammina, although typical, is found ranging up into the Balcombian in No.3 Bore, Ph. Colquhoun. The occurrence of L.glencoensis and V.plecte is much rarer. L.glencoensis is recorded from only four bores in the Ph. Colquhoun, the Imray Well at 1060-1070 feet, in No.3 Bore at 1200 feet, in No.9 Bore, at 920 feet and in No.11 Bore at 926-951 feet. V.plecte appears in No.2 Government Bore at 745-775 feet, in No.3 at 1296 feet, in No.1 Bore, Rigby Island at 1170 feet, in the Metung Bore at 1180 feet and in No.5 Bore, Ph.Bairnsdale at 1430 feet. Amongst the more characteristic but not restricted species, are Cibicides sp.1, Gyroidina soldanii, Elphidium crassatum and E.crespinae.

Mopsea joints are common throughout, but bryozoa,frequently replaced by pyrites,are comparatively rare. Porina gracilis, Bracebridgia emendata, Aspidostoma airensis, and Adeonellopsis obliqua are amongst the commoner species. Molluscan shells, chiefly gastercpoda, are fairly numerous but usually crushed. Fragments of large Cypraeas are common in No.11 Bore. Recorded species include Venericardia gracilicostata, Limopsis chapmani, Turritella aldingae, T.murrayana, Collonia parvula, Triforis wilkinsoni, Rissoina stevensiana, Astralium aster, Murex polyphyllus, Marginella wemtworthi and Buchozia hemicthone.

Balcombian Stage

Bryozoal marls, limestones and marly limestones constitute the lithology of the Balcombian stage in Sector I. The three substages, the Longford, Batesford and Bairnsdale, are typically developed. The stratigraphical break between the underlying Janjukian and Balcombian is usually distinct, the brownish, micaceous marls of the Janjukian being in striking contrast to the bryozoal, marly limestones of the Balcombian. Surface sections are available, principally along the northern and eastern boundaries of the sector.

(i) Longford Substage. The standard section for this substage is taken from No.9 Bore, Ph.Colquhoun and is described in detail on p.17. It is only necessary here to consider variations which occur elsewhere in the sector. The sediments consist of bryozoal marls and marly limestones, the average thickness being about 220 feet. They are unusually marly and shelly towards the base of No.11 Bore. The shallowest depth at which the substage is met in borings, is 370 feet in No.1 Bore, Ph.North Colquhoun (Mississippi Creek). This bore ceased in hard, calcareous sandstone, probably representing the base of the Longford substage. The greatest depth from which it is recorded is 1010 feet in No.5 Government Bore (Maringa Creek). In the most westerly bore, No.5, Ph.Bairnsdale (Eagle Point), the limits for the substage are 950 feet down to 1220 feet. These facts can better be illustrated by making reference to Table 2. In No.11 Bore, unusual conditions exist between 856'6" and 858 feet, where a dark greenish-yellow marl with the appearance of a glauconitic rock contains large molluscan shells, partially decomposed, (Eotrigonia semiundulata, Serripecten yahliensis var. semilaevis). All fossils

are stained greenish-yellow. Bryozoa are typically prominent whilst amongst the foraminifera is the rare form Sherbonina atkinsoni. The foraminiferal assemblage for the Longford substage in Sector I is as described from the type section but a higher percentage of deeper water forms is present in the basal portion, where species are numerous and persistent.

The zonal Janjukian forms Cyclammina and Ammodiscus occur im the basal portion of the Longford substage in No.6 Bore, Ph.Colquhoum (Kalimna). In the same bore at 1,029 feet and in No.5 Bore at 808 feet, an assemblage of deeper water forms is present in which Cassidulina subglobosa, Lagena orbignyana, L.marginata, Vaginulina legumen, Globigerinoides trilobus and Heronallenia lingulata are very common, whilst in No.6 Bore, the washings of a greenish-grey, bryozoal marl at 975 feet consist almost entirely of small foraminifera, a condition unique in the Gippsland area. The most prominent genera are Bolivina, Cassidulina, Lagena, Dentalina, Globigerina, Anomalina, Cibicides and the rare form Tubulogenerina mooraboolensis, the only other record of this species in Sector I being from the Batesford substage in No.11 Bore.

Other foraminifera which are moderately common in the Longford substage are Carpenteria rotaliformis and Elphidium crespinae, the latter species being abundant in certain b ores. Hofkerina semiornata is present in No.11 Bore. Planorbulinella plana and P.inaequilateralis occur not only in the standard section but also im Bores No.3 (Nungurner), No.6 (Kalimna) and No.11, Ph.Colquhoun. Operculina does not appear until the upper beds of the substage, where it is associated with Amphistegina, which makes an early appearance in this sector in the Janjukian.

Sponges are represented by Bactronella australis and spicules of Ecionema newberyi, Mopsea joints are numerous. Bryozoa dominate the faunal assemblage. Spines of Goniocidaris prunispinosa and G.pentaspinosa and the small brachiopod shells, Murravia catinuliformis, M.flindersi and Aldingia sp. are usually present. At 839-840 feet in No.9 Bore, a yellowish-greem, bryozoal marl occurs in which are numerous fragments of brachiopod shells including Magellania garibaldiana, Stethothyris insolita and Terebratalia tateana. Molluscan shells are rare in the majority of bores, Chlamys praecursor and Dimya dissimilis being the most persistent. They are unusually common in No.11 Bore but are fragile and difficult to secure for examination. Ostracoda although not well represented in the type section vary in number in different bores. The species include Cythere caudispinosa and Cytheropteron batesfordiense.

(ii) Batesford Substage. This substage is represented by the zone of L.(T.)gippslandica. There is no break in sedimentation between the Longford and the Batesford substages, the lithology being bryozoal marls and marly limestones often greenish in colour. In some bores, as in Nos.9 and 11, Ph.Colquhoun, grey to dark grey, bryozoal marls frequently bedded, with bryozoa appearing as white decomposed casts along the bedding planes, alternate with marly limestones.

In No.11 Bore, masses of Cellepora coronopus are almost entirely replaced by bright green glauconite, which also infills foraminiferal tests, especially the Lepidocyclinae. The restricted foraminifera, Lepidocyclina and Cycloclypeus, and other typical Batesford forms, Gypsina howchini, Hofkerina semiornata, Planorbulinella plana and P.inaequilateralis are well represented. Carpenteria proteiformis, C.rotaliformis, Amphistegina and Operculina are consistent accessories. Fossils other than foraminifera and bryozoa are poorly represented. Spicules of Ecionema newberyi, cidaroid spines and small brachiopoda (Murravia flindersi and Cryptopora acutirostrum)

are occasionally present, but mollusca are rare, Chlamys murrayanus being recorded from No.9 Bore. Ostracoda include Cytheropterom batesfordiense and C.fenestratum.

The thickness of the Batesford sediments shows some variation. In No.1 Government Bore, Ph.North Colquhoun, it is recorded from one depth only, 382 feet, and in No.2 Government Bore, Ph.Colquhoun, at 510 feet, no samples being available in this bore between 450 and 510 feet, to indicate any thickness. But these two bores are near the northern limit of the area, in proximity to the basement rocks where a thinning out of beds is to be expected. 109 feet of sediments are recorded from the Pilot Station Bore, 213 feet from the Nungurner Bore and 290 feet from the Maringa Creek Bore.

The lower and upper zonules are present in all bores, the sediments being slightly more marly in the former. No outcrops referable to the lower zonule are yet known in the sector but certain ferruginous, bryozoal marls near Orbost are included in the upper one.

The localities are -

Parish of Newmerella.

Near Cumming's property on the Bete Bolong Road.
Cliff at T.Paton's gate, N. of allotment 7 of B.

(a) The zonule of Cycloclypeus victoriensis var. gippslandica varies in thickness, but the actual occurrence of Cycloclypeus is limited to about 10 feet. Both A and B forms of L.(T.)gippslandica are always present, sometimes occurring through more than 100 feet of sediments. The apparent absence of Cycloclypeus in some bores is due to the gaps between the depths at which samples were collected, the very limited zone occurring in those gaps. Where personal collections have been made, the form is found to be well represented. Cycloclypeus is abundant in No.8 Bore, Ph.Colquhoun (North Arm) between 560 and 572 feet. It is also found in the following bores in the Ph.Colquhoun, No.3 at 891-893 feet, No.4 at 855-860 feet, No.6 at 887 feet, No.7 at 620 feet, No.9 at 614 feet, No.11 at 699 to 704 feet, and in No.3 Bore, Ph.Bumberrah at 710 feet. The only bore in Sector I. in which Cyclammina is recorded with Lepidocyclina is No.5, Ph.Colquhoun at a depth of 1,000 feet.

(b) The zonule of Hofkerina semiornata contains Lepidocyclina (sometimes L.(T.) batesfordiensis) or one of the typical associated foraminifera and is considerably thicker than (a). Calcarina verriculata, characteristic of the Lepidocyclina facies at Batesford, occurs only in the Pilot Station Bore at 779 feet and in the surface sections near Orbost, where a new species of Sherbonina is also recorded. Two other foraminiferal species rather rare in Gippsland, namely Cassidulinoides chapmani and Tubulogenerina mooraboolensis, are present in No.11 Bore, Ph.Colquhoun, at the depths of 683 feet and 665 feet respectively. The former is also found in the section at Paton's property near Orbost.

In No.6 Bore, Ph.Colquhoun at 790 feet and in No.9 Bore at 557 feet there is a rich development of species other than the usual assemblage of this substage, including Dentalina consobrina Siphonodosaria sp., Lingulina metungensis, Vaginulina sp. and Lenticulina rotulata.

(iii) Bairnsdale Substage. Whitish and grey to greenish-grey, bryozoal limestones and marly limestones, so characteristic of the Longford and Batesford substages, persist through the Bairnsdale, the limestone facies being more strongly developed in some bores. Bryozoa still dominate the fauna, foraminifera being only moderately common, the number varying with the marly nature of the sediments. This

fact is especially well illustrated in the Rigby Island (Kalimna Oil Bore), where large and well preserved tests of Lenticulinae and Epomides repandus are common at 200 and 250 feet. The foraminiferal assemblage for this substage has been listed under the description of the type section, but in bores, arenaceous forms such as Textularia and Gaudryina are persistent. Amphistegina and Operculina, which never occur above the basal portion of the substage, are not as common in it in Sector I as in Sectors II, III and IV, the former not being recorded in samples examined from the Metung Bore, the Rigby Island Bore nor the Imray Well.

Bryozoal species are similar to those listed under the type section. Macro-fossils such as Serripecten yahliensis and the variety semilaevis, Hinnites corioensis and Spondylus baileyanus are scarce in most bores, but are fairly numerous in Bores Nos. 9 and 11 Ph. Colquhoun.

Several outcrops of Bairnsdale rocks which include localities near Orbost, are available in Sector I for examination. The localities are -

Parish of Newmerella.

Bete Bolong Road cutting.
Railway cutting at Newmerella (Chapman 1926).
Newmerella railway bridge on Prince's Highway.
Lock End and Devil's Backbone, towards the mouth of the Snowy River.

Parish of Tildesly East.

Hospital Creek on Prince's Highway.

Parish of East Colquhoun.

Toorloo Arm, Prince's Highway; also along old road.

Parish of North Colquhoun.

Contact between granite and bryozoal limestone in quarry at head of the Tram Track, Mississippi Creek.

Parish of Tambo.

Tambo River cliffs above Swan Reach.
Nicholson River cliffs above Prince's Highway.

Parish of Sarsfield.

Cliff west side of Nicholson River in Allotment 10.

The two zones are well illustrated in Sector I. The lower zone is represented chiefly in bores, with outcrops near Orbost and near the head of Mississippi Creek. Bryozoa dominate the faunal assemblage. In bores, Operculina and Amphistegina are recorded up to about 100 feet above the last appearance of Lepidocyclina or one of the typically associated Batesford forms. Molluscan shells such as Hinnites corioensis, Serripecten yahliensis, with its variety semilaevis and Spondylus baileyanus, are scarce. A beautifully preserved large left valve of S. yahliensis escaped damage from the drill in the Rigby Island Bore at 500 feet.

The contact between the bryozoal limestone and the granite is exposed in the quarry near the head of Mississippi Creek. The limestone immediately in contact with the granite is friable and highly ferruginous, much of the bryozoa being replaced with dark red limonitic material. A short distance from the contact the limestone is

cream to pale ochreous coloured, and contains fragments of brachiopoda (Stethothyris insolita) and mollusca (Spondylus pseudoradulus).

The upper zone is present in bores, and is typically developed in cliff sections around Orbost, at Toorloo Arm (Prince's Highway) and along the banks of the Tambo and Nicholson Rivers. The echinoid, Clypeaster gippslandicus, the brachiopod, Magellania grandis, and the pelecypoda listed from the lower zone, are very common in the ferruginous, bryozoal limestones of these cliffs. C.gippslandicus is scarce in bores, but one of the large pelecypoda is usually present.

Mitchellian Stage

The transition beds between the Balcombian and Kalimnan are present in all bores except No.1, Ph.North Colquhoun, the first sample taken at 54 feet being in the Bairnsdale substage. The beds are greenish-grey marls with decomposed remains of molluscan shells, chiefly bivalves, and of species which are typical of the overlying Kalimnam, whilst washed samples prove the abundance of bryozoa. The foraminiferal assemblage contains typical Kalimnan species including Rectobolivina bifrons var. striatula, Cancris philippinensis and Planulina kalimnensis. A description of the Mitchellian as developed in the Gippsland bores, is given from No.11 Bore, Ph.Colquhoun under the general survey of the stage in Part 5. As lithological and palaeontological features are almost identical in all bores in Sector II, no further remarks are necessary.

Outcrops referable to the Mitchellian stage are rare in Sector I. They include the following localities:-

Parish of Bumberrah.

Road cutting along east bank of Tambo River, below Swam Reach.

Parish of Newmerella.

Devil's Backbone, along Snowy River.

The probability that outcrops occur near Toorloo Arm, Prince's Highway is suggested by the mollusca present in blocks of ferruginous limestone along the roadside.

Kalimnan Stage

Beds belonging to the Kalimnan stage are recorded from all bores in Sector I except one, namely No.1, Ph.North Colquhoun, and outcrops are numerous. The upper and lower zones are exposed at the type locality at Jemmy's Point and have been discussed in Part 5. No bore in the sector passed through the upper zone.

(1) The lower zone is recorded from all bores in Sector I (except No.1, Ph.North Colquhoun) and the following outcrops -

Parish of Tildesley West.

Lake Tyers.

Parish of Colquhoun.

Lake Bunga.
Prince's Highway east of Bunga.
Jemmy's Point, Lakes Entrance (base of section).
Road Cutting at turn-off to Golf Links.

Hunter's Point, west bank of North Arm.
Along Tram Track, Mississippi Creek.
Ritchie's Cutting, Mississippi Creek.
Maringa Creek.
Nyerimalang.

The elevation above sea level of the top of this shell band in the Lakes Entrance area is about 40 feet. It can be traced for about 10 miles east from Nungurner, on the northern shore of Lake King (Reeve's Channel) to Maringa Creek then to North Arm, Cunningham Arm, Lake Bunga and Lake Tyers.

The lithology of all surface sections in the Ph. Colquhoun is friable, ochreous sandstone with occasional limestone concretions. The sandstones are present in all bores, the glauconite content becoming more pronounced towards the base of the stage. Not only the abundance of shells but the number of species varies considerably in different bores and outcrops. In localities around and to the west of Lakes Entrance the upper portion of the lower zone contains numerous large molluscan shells such as Eucrassatella kingicoloides, Neotrigonia howitti, Cancellaria wannonensis and Tylospira coronata. This typical Jemmy's Point facies with large shells appears in only one bore, No.11, Ph. Colquhoun, where large shells are very common down to 162 feet. Anomia tatei occurs abundantly at 164-172 feet and Dosinia johnstoni at 163 feet, the pelecypoda occurring in bands practically devoid of large gasteropoda. T. coronata, rare in bores, is fairly common at 142 to 156 feet, whilst Turritella conspicabilis is abundant from 156 feet down to 162 feet. A. tatei and T. conspicabilis are also prominent in the sectiom on the Prince's Highway east of Bunga and at Hunter's Point, and T. coronata at Lake Bunga and Nyerimalang.

Bores east and north of Lakes Entrance (except No.11 Bore) are not highly fossiliferous but in those to the south and west, as the Kalimna Oil Bore, Rigby Island, and the Metung Bore, and Gippsland Oil Bore No.3 in the Ph. Bumberrah, small and well preserved mollusca are abundant. Species recorded from bores include Nuculana woodsi, Glycymeris subtrigonalis, Limopsis beaumariensis (these two species being more prominent towards the base of the section), Aloidis (Notocorbula) ephamilla, Venericardia gippslandica (abundant in the Gippsland Oil Bore No.3 and in the section on Prince's Highway), Clausinella subroborata and Catelysia propinqua, Turritella conspicabilis, T. acinella, Marginella kalimnae, Olivella nymphalis, Ancilla ligata, Phos gregsoni, Terebra catinifera, Typhis (Cephonochelus) rugicostatus and Natica hamiltonensis. In material recently collected from the Kalimnan beds in the Lakes Entrance Shaft, several beautiful specimens of species which have been previously recorded only from the Balcombian stage, have been collected. They include Cypraea consobrina McCoy and Fulgoraria ancilloides (Tate).

As regards the other groups of fossils, the foraminifera are the most valuable for zonal purposes, with the bryozoa to a minor degree. As with the mollusca, the foraminifera vary considerably in abundance in bores. In all surface and subsurface sections the dominant forms are Nonion victoriense, Streblus beccarii and Rectobolivina bifrons var. striatula. In No.11 Bore, Ph. Colquhoun, S. beccarii and N. victoriense are by far the commonest species. The Miliolidae are also unusually well developed in that bore and in the Kalimna Oil Bore, Rigby Island, the tests of Massilina lapidigera, Quinqueloculina vulgaris, Pyrgo bulloides, Flintina intermedia and Triloculina tricarinata being large and abundant. There is little variation in the associated species, which include Quinqueloculina ammophila, Planulina kalimnensis, Cancris philippimensis, Astrononion australiae and Elphidium imperatrix.

Bryozoal species are few but typical and include Cellaria rigida var. perampla, C. divaricata, Selenaria maculata, Lunulites canaliculata and Thalamoporella gracilis. Corals are not common. Ostracoda are numerous and thin shelled, many forms not previously recorded, being present in No.11 Bore, Ph. Colquhoun. Persistent species are Bairdia amygdaloides, B. subdeltoidea, Macrocypris decora, Cythere scutigera and Cytherella lata.

(2) The upper zone is represented by a thin band of friable sandstone containing abundant large molluscan shells. It is restricted to Sector I, there being one possible exception at Gelliondale, South Gippsland where Kalimnan sands, containing numerous specimens of Nuculana crassa and Liopyrga quadricingulata overlie the brown coal. The foraminifera, S. beccarii and N. victoriense are very common at Jemmy's Point. Pelecypoda include Nucula kalimnae, Nuculana crassa, Neotrigonia howitti and Clausinella subroborata and gasteropoda Bankivia howitti, Liopyrga quadricingulata and Nassarius crassigranosus.

Post Kalimnan Beds.

The Kalimnan stage is overlain by sands which are chiefly unfossiliferous. Shallow-water foraminifer (Streblus beccarii) and recent molluscan shells such as Modiolus sp., Assimania tasmanica, Glycymeris striatularis and Polinices conicus are present in No.4 Bore, Ph. Colquhoun (Pilot Station) between 10 and 90 feet.

A summary of the stratigraphic features in Sector I is as follows -

(a) The Lakes Entrance Sector is bounded on the east near Orbost by fossiliferous limestone cliffs belonging to the Bairnsdale and Batesford substages, with Lepidocyclina in the latter. Similar cliffs along the Tambo River above Swan Reach, along the Nicholson River and at Sarsfield make the northern and north-western boundaries. The western limit is to be found in No.5 Bore, Ph. Bairnsdale.

(b) Post Kalimnan sands cover the whole area.

(c) The Kalimnan stage with the type section at Jemmy's Point, Lakes Entrance, is present in all bores but one, and in numerous outcrops extending from Nyerimalang to Lake Tyers. It is divided into two zones -

(1) Upper zone including the topmost band of molluscan shells at the type section. Species are few but specimens abundant. Outcrops limited to Sector I and to certain localities around Lakes Entrance.

(2) Lower zone consisting of friable sandstone containing glauconite and an assemblage of large molluscan shells in outcrops around Lakes Entrance, from Nyerimalang east to Lake Tyers, and of smaller forms in bores. The maximum thickness of 198 feet is recorded from No.6 Bore, Ph. Colquhoun.

(d) The Mitchellian stage is represented by greenish-grey marls containing glauconite and a mixed assemblage of Kalimnan and Balcombian species of foraminifera, bryozoa, and molluscan shells, the bryozoal content being richer than in the overlying Kalimnan. It is typically developed in subsurface sections. The upper beds are exposed in the road cutting along the east bank of the Tambo River below Swan Reach, while blocks of shelly, ferruginous limestone suggest the occurrence of the stage along the Prince's Highway near Toorloo Arm and at Devil's Backbone near Orbost.

(e) The Balcombian stage is comprised of bryozoal limestones, marls and marly limestones.

(1) The Bairnsdale substage is present in all bores and in cliff sections along the Tambo and Nicholson Rivers, in road cuttings between Toorloo Arm and Orbost and in a quarry at the head of Mississippi Creek.

(i) Upper zone is recorded in bores and in the cliff sections and road cuttings as listed above, in which the sediments are horizontally bedded and contain a rich assemblage of the large echinoid, Clypeaster gippslandicus (rare in bores), large brachiopoda, Magellania grandis, and pelecypoda, Hinnites corioensis, Spondylus baileyanus and Serripectem yahliensis. The shelly facies is followed in downward sequence by bryozoal, marly limestones containing only large fossils.

(ii) Lower zone is recorded from bore sections and one outcrop. Operculina and Amphistegina appear in bores (downward sequence) at about 100 feet above the first occurrence of Lepidocyclina or other typical Batesford foraminifera. S.yahliensis occurs throughout.

(2) The Batesford substage with its restricted foraminifera, Lepidocyclina and Cycloclypeus, is present in all bores. Molluscan shells are rare.

(i) Upper zonule with whitish, bryozoal limestones is fairly thick. Lepidocyclina is associated with typical foraminifera. Molluscan shells are rare. Outcrops, containing Sherbonina sp. nov., are recorded near Orbost.

(ii) Lower zonule with bryozoal marls and marly limestones, frequently greenish in colour and containing Lepidocyclina and numerous Cycloclypeus, is rarely more then 10 feet thick. No outcrops are known.

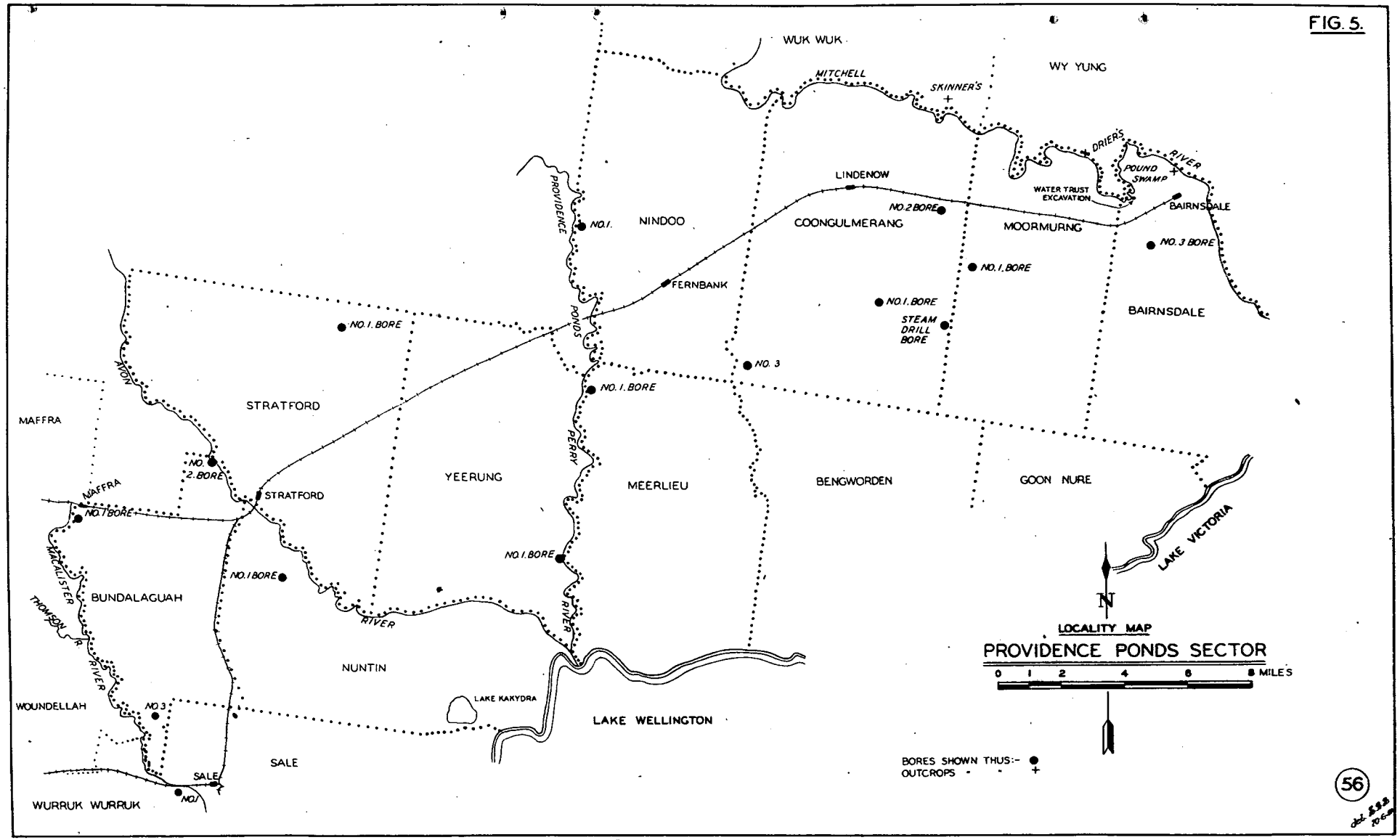
(3) The Longford substage is present in all bores and a standard section is described from No.9 Bore, Ph.Colquhoun. Molluscan shells are rare, but many Balcombian species of bryozoa, make their first appearance and persist upwards to the Mitchellian.

(f) The Janjukian stage is recorded only from bores. Two lithological units are represented.

(i) Upper one of brownish-grey, micaceous marls containing a typical foraminiferal assemblage, including Cyclammina incisa, Vaginulina gippslandica and Victoriella plecte and small molluscan shells, including Turritella aldingae (with fragments of other large forms in No.11 Bore). The marls pass into sandy marls in which fossils are rare and in which several bands of hard, shelly, calcareous sandstone up to 10 inches thick are intercalated. Glauconite grains are common at base.

(ii) Lower one of glauconitic sandstone which is oil-bearing over an area of 4 square miles, and has a thickness varying from 30 to 60 feet. Large shells are present but most foraminifera have been replaced with glauconite.

FIG. 5.


WUK WUK
WY YUNG
MITCHELL
SKINNER'S
DRIER'S
POUND SWAMP
RIVER
WATER TRUST EXCAVATION
LINDENOW
NO.2 BORE
BAIRNSDALE
NO.3 BORE
NO.1.BORE
PROVIDENCE
NO.1.
NINDOO
COONGULMERANG
MOORMURNG
FERNBANK
NO.1.BORE
STEAM DRILL BORE
BAIRNSDALE
NO.1. BORE
PONDS
NO.3
NO.1. BORE
AVON
STRATFORD
MAFFRA
NO. 2. BORE
PERRY
YEERUNG
MEERLIEU
BENGWORDEN
GOON NURE
STRATFORD
MAFFRA
NO.1 BORE
LAKE VICTORIA
NO.1 BORE
NO.1 BORE
MACALISTER
THOMSON R.
BUNDALAGUAH
RIVER
RIVER
NUNTIN
WOUNDELLAH
NO.3
LAKE KAKYDRA
LAKE WELLINGTON
SALE
SALE
NO.1
WURRUK WURRUK
N
LOCALITY MAP
PROVIDENCE PONDS SECTOR
0 1 2 4 6 8 MILES
BORES SHOWN THUS:-
OUTCROPS

(g) The Anglesean stage is represented by sands and sideritic sandstone. The sands are artesian water-bearing. Numerous fish remains occur in No.1 Government Bore, Ph. Colquhoun and in No.3 Gippsland Oil Bore, Ph. Bumberrah.

(h) Granite and metamorphic rocks of Palaeozoic age form the basement rock in bores. Granite is seen in contact with bryozoal limestones belonging to the Bairnsdale substage at the head of Mississippi Creek.

(i) No.1 Government Bore, Ph. North Colquhoun and No.2 Government Bore, Ph. Colquhoun show a shallowing of the Tertiary basin in a northerly direction towards the outcropping basement rocks.

(j) The deepest portion of the basin is in the vicinity of Lakes Entrance as proved by the Pilot Station and Nungurner Bores, the glauconitic sandstone being met with at 1,429 feet in the former and 1,431 feet in the latter.

(k) The thickness of most of the stratigraphic horizons is fairly consistent in all bores.

II. Providence Ponds Sector.

Cores of 19 bores, from 17,405 feet of drilling and material from numerous cliff sections have been examined. The geographical order in which the bores are listed is approximately east to west. Drilling operations have been carried out over an extensive area, from No.3 Bore, Ph. Bairnsdale (Cobbler's Creek) on the east to No.1 Bore, Ph. Stratford, Nos.1, 2 and 3 Bores, Ph. Bundalaguah and No.1 Bore, Ph. Wurruk Wurruk on the west. Unfortunately the evidence derived from the investigation of these bores must necessarily be incomplete, as only one, No.1 Bore, Ph. Wurruk Wurruk, was carried to bedrock. Those bores drilled in the eastern portion of the sector are comparatively shallow but there is a considerable deepening of the basin towards the south-west (Fig.5).

The entire area is covered with sands and torrent gravels.

Material from numerous outcrops in the vicinity of Bairnsdale and along the Mitchell River, was collected by Mr. J. Easton, Dr. W.V. Ludbrook and by Mr. E.A. Rudd of Oil Search Ltd. Several sections were examined by the writer.

JURASSIC

Only one bore, namely No.1 Bore, Ph. Wurruk Wurruk, near Sale, was drilled through to bedrock. Felspathic sandstones of Jurassic age were met with at 3,158 feet.

TERTIARY

Anglesean Stage

Palaeontological information regarding the Anglesean stage in Sector II is incomplete. Of the seven bores which penetrate the Yallourn formation, only one, No.1, Ph. Wurruk Wurruk, passed through the sands and brown coal to bedrock.

LIMITING DEPTHS OF STRATIGRAPHICAL STAGES IN BORES IN SECTOR II. Table 3.

Bore	Stage	Kalimnan	Mitchellian	Balcombian			Janjukian	Anglesean	Bedrock
	Substage			Bairnsdale	Batesford	Longford			
Parish of Bairnsdale									
No. 3 Bore S.L. 20'		20'-80'	90'-370'	370'-450'	460'-550'	560'-790'	800'-860'	866'	-
Parish of Moormurng									
No. 1 Bore S.L. 175'		210'-350'	360'-500'	507'-578'	590'-635'	645'-940'	950'-988'6"	1001'-1021'	-
Parish of Coongulmereng									
No.1 Bore (Oil Search) S.L. 185'		240'-320'	330'-550'	560'-780'	790'-830'	840'-930'	-	-	-
No.2 Bore (Oil Search) S.L. 152'		64'-98'	110'-239'	256'-299'	310'	325'-597'	606'-624'	640'	-
No.3 Bore (Govt.) (Tom's Creek) S.L. 110'		300'-348'	348'-578'	578'-651'	651'-813'	813'-1051'	1051'-1200'	-	-
No.3 Bore (Oil Search) (Bravo)		182'-282'	-	-	-	-	-	-	-
No.4 Bore (Oil Search) (Bravo)		205'-306'	-	-	-	-	-	-	-
Steam Drill S.L. 184'		294'-356'	364'-436'	444'-806'	814'-946'	954'-1330'	1332'-1446'	-	-
Parish of Nindoo									
No.1 Bore S.L. 201'		-	-	82'-138'	147'-208'	210'-452'	475'-530'	-	-
Parish of Yeeruhg									
No.1 Bore S.L. 27'		380'-505'	-	551'-990'	1000'-1240'	1250'-1340'	-	-	
Parish of Meerlieu									
No.1 Bore S.L. 102'		-	260'-515'	522'-590'	600'-720'	730'-999'	1005'-1200'	-	-
Parish of Nuntin									
No.1 Bore S.L. 41'		-	-	666'-846'	852'-909'	920'-1338'	1345'-1452'	-	-
Parish of Stratford									
No.1 Bore S.L. 298'		-	-	-	-	220'-480'	489'-500'	510'-561'	
Parish of Bundalaguah									
No.1 Bore S.L. 72'		-	-	-	-	-	-	64'-575'	
No.2 Bore S.L. 70'		-	-	-	-	-	610'-650'	-	-
No.3 Bore S.L. 21'		-	-	-	-	-	-	250'-552'	-
Parish of Wurruk Wurruk									
No.1 Bore S.L. 30'		-	690'-798'	804'-1065'	1065'-1248'	1248'-1804'	1804'-2276'	2276'-3124'	Jurassic 3124'-3214'

x Two borings in the Parish of Wy Yung ceased in Post Kalimnan sands.

The transition from the Anglesean to the Janjukian is not well defined in this sector. In the Wurruk Wurruk Bore conditions throughout the whole section are unusually sandy. The break between the two stages is taken at 2,274 feet just below a glauconitic marl containing numerous foraminifera, while in No.1 Bore, Ph.Stratford it is marked by a narrow pyritic band. Foraminifera including such species as Vaginulina gippslandica, Cyclammina rotundata, Cibicides sp.(1), Eponides scabriculus are present, but not commonly, in the sands in the Wurruk Wurruk Bore between 2,274 and 2,995 feet. No organisms occur in the sands in No.1 Bore, Ph.Bundalaguah between 64 and 575 feet. Their absence suggests that the bore may be situated just beyond the margin of marine influence which appears in similar sands in No.1 Bore, Ph.Stratford to the east. The thickness of the fossiliferous beds in the bores in the central portion of the sector, as in Phs. Meerlieu and Yeerung and in No.1 Bore, Ph.Nuntin, a little south-west, indicate that the Yallourn formation would not be encountered for some considerable depth.

Only one sample referable to the Anglesean was taken in each of three other bores namely, No.3, Ph.Bairnsdale (Cobbler's Creek) on the eastern boundary of the sector, at 866 feet, No.1 Bore, Ph. Moormurng at 1,001 feet (hard, lignitic band) and No.2 Bore, Ph. Coongulmerang (Oil Search Bore) at 640 feet. Impure lignite is recorded from No.1 Bore, Ph.Bundalaguah at 99 feet and then intermittently down to 358 feet. In the Wurruk Wurruk Bore a band of brown coal was 48 feet thick and another 21 feet, while an impure brown coal, with sand, extended from the depth of 2,516 feet down to 2,580 feet.

Janjukian Stage

The limiting depths of this stage are only available in five bores - No.3, Ph.Bairnsdale, No.1, Ph.Moormurng, No.2, Ph.Coongulmerang, No.1, Ph.Stratford and No.1, Ph.Wurruk Wurruk, while four bores did not reach the stage. No outcrops of Janjukian sediments are known in Sector II. The brownish, micaceous marls of the Lakes Entrance Sector are replaced by greyish, shelly marls, only slightly micaceous and are rich in foraminifera, especially Cyclammina. The thickness of these marls in Sector II is considerably less than in Sector I. Only 21 feet are proved in No.1 Bore, Ph.Stratford on the west, and 58 feet in No.2 Bore, Ph.Coongulmerang on the east, but 470 feet were recorded in No.1 Bore, Ph.Wurruk Wurruk.

The foraminiferal assemblage is similar to that recorded from the same horizon in Sector I with the Polymorphinidae and Miliolidae prominent. Restricted species include Vaginulina gippslandica, Victoriella plecte and Lamarckina glencoensis which are widely distributed in the bores. Operculina and Amphistegina make an early appearance in this sector, both forms being recorded from the Janjukian in No.1 Bore, Ph.Nindoo at 530 feet, and No.1, Ph.Moormurng at 986-995 feet. Sponge spicules (Ecionema newberyi) are fairly common. Corals are rare, Conosmilia anomala being recorded. Bryozoa are comparatively scarce, and cidaroid spines (Goniocidaris pentaspinosa) occur occasionally. Molluscan shells are common in the eastern portion and include Macrocallista tenuis, Protocardia hemimeris, Limopsis maccoyi, Turritella aldingae and Cymatium annectans. A hard, shelly sandstone is recorded at 982 feet at the base of the stage in the Moormurng Bore, in which the molluscan shells are in an unusually perfect state of preservation, the colour bands still being visible. Glauconitic marls, characteristic of the basal beds of the stage in Sectors III and IV, are poorly developed in Sector II.

Balcombian Stage

Conditions of sedimentation during the Balcombian in Sector II show considerable diversity from those in Sectors I, III and IV. Bryozoal, shelly and foraminiferal marls, representing an argillaceous facies predominate the Batesford substage in surface and subsurface sections. Similar conditions exist in the Bairnsdale substage in bores but surface sections are represented by moderately hard, shelly, ferruginous limestones. The sediments in the Longford substage, except in No.1 Bore, Ph.Nindoo, are not shelly, and sandy conditions are prominent in the western portion of the sector.

Excellent surface sections are available along the banks of the Mitchell River. The sequence from the Bairnsdale substage (Balcombian) up to the Mitchellian stage is exposed on the north bank, 25 chains north-west of Skinner's, and up to the Kalimnan near Underwood's and Drier's.

(i) Longford Substage. The sediments in this substage show considerable thickening in the bores in the central and south-western portions of the sector as compared with those in the eastern portion and in Sector I. In the south-west, a thickness of 556 feet has been proved in No.1 Bore, Ph.Wurruk Wurruk, more than 400 feet in No.1 Bore, Ph.Weerlieu and No.1 Bore, Ph.Nuntin in the central portion and 230 feet in No.3 Bore, Ph.Bairnsdale to the east. They consist of grey, bryozoal marls and marly limestones, frequently hard and containing foraminifera which vary considerably in abundance. Species more typical of the overlying Batesford, such as Hofkerina semiornata, Planorbulinella plana and Gypsina howchini, appear towards the top of the substage, whilst Amphistegina and Operculina occur spasmodically. Numerous small foraminifera are present as in the Yeerung Bore at 1,250 feet and 1,260 feet. Cassidulina chapmani is recorded at 370 feet in the Nindoo Bore and Ammodiscus and Cyclammina from 1,248 feet down to 1,804 feet in the Wurruk Wurruk Bore. Mollusca are fairly common in the Nindoo Bore from 250 down to 440 feet, typical Balcombian species such as Turritella aldingae, Eulimella nitidula, Etrema pseudoelegans, Cerithiella trigemmata, Murex polyphyllus, Trophon halli, Uromitra paucicostata and Ataxocerithium concatenatum being recorded. They are rare in the Wurruk Wurruk Bore.

(ii) Batesford Substage. The main feature of this substage in Sector II, is the fossiliferous marls containing a rich assemblage of foraminifera, bryozoa, mollusca and ostracoda, exposed in the section at Skinner's, Ph.Wuk Wuk, on the north bank of the Mitchell River and represented by 40 feet of sediments in No.1 Bore, Ph. Coongulmerang, 240 feet in No.1 Bore, Ph.Yeerung, and 243 feet in No.1 Bore, Ph.Nuntin.

Outcrops referable to the substage are recorded from the following localities along the Mitchell River -

Parish of Wuk Wuk.

Skinner's section, S.W. corner of Allot.29 Al.

Parish of Wy Yung.

Bridge at Boggy Creek.

Parish of Moormurng.

North cliff east of Hillside Bridge.
Near Hillside Bridge.

(a) The lower zonule with Lepidocyclina and Cycloclypeus, is unusually well developed in parts of Sector II. The above genera are associated with a rich molluscan assemblage at Skinner's, but conditions of sedimentation as revealed by boring, are normal, molluscan shells being very scarce. Lepidocyclina is common at Skinner's and in the Yeerung Bore at 1,190, 1,200 and 1,240 feet and is recorded from the North Cliff east of Hillside Bridge. Cycloclypeus is present at Skinner's, also in No.1 Bore, Ph.Nindoo at 120 feet, in Steam Drill, Ph.Coongulmerang at 914-916 feet and in the Wurruk Wurruk Bore at 1,154-1,158 feet. The genus is not widely distributed in this sector, but this absence may be only apparent, due to insufficient collecting of samples at critical depths. Austrotrillina howchini is found at Skinner's, this being the only record of the species in Gippsland. Planorbulinella inaequilateralis, Gypsina howchini and Hofkerina semiornata, the accessory forms Amphistegina, Operculina and Carpenteria and numerous small foraminifera are also present in that section. Species, including Cassidulinoides chapmani, are abundant in this zonule in the Nindoo Bore at 190 feet.

Conocyathus scrobiculatus is amongst the few corals recorded. Bryozoa are very abundant, the species including those already listed from the Longford substage. Cidaroid spines are represented by Phyllacanthus duncani and brachiopoda by Stethothyris insolita. Numerous typical Balcombian species of mollusca are recorded from Skinner's. Similar species are common from 180 to 208 feet in the Nindoo Bore, which is situated a few miles south of the Mitchell River. Ostracoda are well distributed.

Hard, grey, shelly, bryozoal limestones are the main constituents of the Batesford substage in the Meerlieu Bore. Small pelecypoda such as Dimya dissimilis and Ctenamusium atkinsoni are recognisable.

(b) The upper zonule is represented by grey, bryozoal marls with abundant foraminifera, including Lepidocyclina and associated species. The rare Miocene species Tubulogenerina mooraboolensis is recorded from No.3 Bore, Ph.Bairnsdale at 470 feet and No.1 Bore, Ph.Yeerung at 1,080 feet. Brachiopoda, including Murravia triangularis, occur occasionally. Mollusca are present in Bores Nos.1, Phs. Meerlieu and Nuntin.

(iii) Bairnsdale Substage. This substage is developed not only in borings but also in cliff sections along the Mitchell River. The type locality for the substage has been selected from this sector and has been described fully in Part 5. All surface sections consist of moderately hard, ferruginous, shelly, marly limestones, many fossils being preserved as casts. The characteristic fossils are Clypeaster gippslandicus, Hinnites corioensis, Serripecten yahliensis with its variety semilaevis, Spondylus pseudoradulus and S.baileyanus.

Localities referable to the Bairnsdale are as follows:-

Parish of Bairnsdale.

Pound Swamp (type locality).
Picnic Point.

Parish of Wy Yung.

Top of cutting, west of Myrtle Point Homestead.
Lower bank of Boggy Creek, 5 chains N.E. of bridge.
Bluff at Boggy Creek.
Drier's Cliff, S.W. corner Allot.15 A.
Portion of section at Underwood's.

Parish of Wuk Wuk,

North bank, Mitchell River, Allot.29 A2, 25 chs.N.W. of Skinner's. 1 mile W. of Skinner's, towards Saunders' Bluff.

All borings, except two shallow ones in the Ph.Wuk Wuk, are on the south side of the Mitchell River, where there is a facies change from the ferruginous, shelly limestones of the north bank to moderately hard, bryozoal, shelly limestones and friable marls. Sediments in this substage are moderately thick in borings in the eastern portion of the sector, 266 feet being recorded from No.3 Government Bore, Ph.Coongulmerang. They gradually increase in thickness towards the central and south-western portions where 439 feet are present in No.1 Bore, Ph.Yeerung. The substage is met with in the Nindoo Bore at the depth of 82 feet, the first sample to be examined, and No.1 Bore, Ph.Nuntin, a few miles to the south, at 666 feet.

The bryozoal, marly limestones are comparatively shelly when compared with those in Sector I. In bores Nos.1, Phs. Nuntin and Nindoo, the marly lithology is pronounced, with the result that foraminifera especially Miliolines, and ostracoda are very common. Operculina and Amphistegina are present in the basal part of the substage in all bores. Marginopora vertebralis and Pavonina triformis, two rare forms in Gippsland, are recorded from the Wurruk Wurruk Bore at 797-798 feet. Cassidulinoides chapmani occurs at 912 feet. Spicules of the sponge Hexionema newberyi, are conspicuous in the Meerlieu Bore at 560 and 580 feet. Bryozoa are common but frequently encrusted. Mollusca are fairly numerous though not always well preserved. Species include Pronucula morundiana, Ctenamusium atkinsoni, Venericardia spimulosa, Limopsis maccoyi, Eotrigonia semiundulata, Aloidis (Notocorbula) pyxidata, Turritella aldingae, Turris murndaliana, Buchozia hemithone, Filodrillia sterioides, Conomitra ligata, Volutilithes anticingulata and Cerithium apheles. The majority of these species have been recorded from the Janjukian, but their presence in the Balcombian further indicates the close relationship between the Janjukian and that stage. Ostracoda are represented by the Miocene form Cythere flexicostata and several long-ranging species.

Mitchellian Stage

Unusual features are present in the Mitchellian in bores im Sector II as well as in the underlying Balcombiam. The type locality for the stage is described from this sector.

Localities referable to the Mitchellian stage are in the vicinity of the Mitchell River.

Parish of Bairnsdale.

Water Trust Excavation (Type locality).
Rose Hill.

Parish of Wy Yung.

20 chains N.E. of Boggy Creek Bridge, near N.W.corner Allot.9B.
100 feet above river flats, Boggy Creek, Allot. 11B.
Quarry on cliff, E. of Underwood's Gully, S.E.corner Allot.22.
Top of section at Drier's.
Pit on road 14 chains E. of Boggy Creek Bridge.

In surface sections the sediments are represented by moderately hard, ferruginous, shelly limestones, with some bryozoa. Those proved by boring are shelly marls, the break between this stage and

the underlying Balcombian being fairly well marked by the presence of rather hard, marly limestones in that stage.

The Mitchellian stage can best be illustrated by referring specifically to the Meerlieu Bore, although the Wurruk Wurruk Bore contains almost as rich a fauna. The beds in the former are 265 feet thick, the first sample in the bore being taken at 260 feet. They consist of dark greenish-grey, friable, shelly marl which becomes micaceous and greyish in colour as the bore passes down. Foraminifera, Mopsea joints, bryozoa, molluscan shells and ostracoda are very numerous.

As regarding the foraminifera, the Miliolidae are well developed, beautiful specimens of Pyrgo bulloides, Quinqueloculina vulgaris, Triloculina tricarinata and Spiroloculina dispansa dominating the assemblage. Species typical of the Kalimnan include S. dispansa, Planulina kalimnensis, Discorbis australis, Nonion victoriense, Cancris philippinensis, and Astrononion australe. Characteristic Balcombian species are Heronallenia wilsoni, H. lingulata, Pavonina triformis, Cibicides victoriensis, and Carpenteria rotaliformis. The remaining species are long-ranging. Corals include Placotrochus deltoideus, Sphenotrochus alatus, Flabellum gambierense and Notophyllia variolaris, all forms ranging from Balcombian to Kalimnan. Mopsea joints are common. Bryozoa are well represented, species being referable to those already listed from this stage.

The molluscan fauna shows an intermingling of Balcombian and Kalimnan species, the former being in the majority. Most of the pelecypoda are ranging species as Nuculana woodsi, Glycymeris subtrigonalis, Limopsis beaumariensis, Salaputium commune and Vemericardia spinulosa. Restricted Miocene forms are Arca (Barbatia) consutilis, A. (Plagiarca) celleporacea, Limopsis morningtonensis, Ctenamusium atkinsoni and Eotrigonia semiundulata. The gasteropoda contain Janjukian and Balcombian forms including Daphnobela gracillima, Murex polyphyllus, M. amblyceras, M. lophoessus, Turritella aldingae, T. warburtoni, Phos tardicrescens, Cerithiella trigemmata, Conomitra ligata and Calliostoma semiornata, Buchozia hemiothone, Turris murndaliana. Species previously described from the Kalimnan are Cerithiopsis woolnoughi, Trophon (Enatimene) metungensis, and Typhis (Cyphonochelus) rugicostatus. The longer-ranging forms are Marginella wentworthi, M. micula, Ringicula tatei, Turritella conspicabilis and T. acinella. The chiton, Protochiton granulosus, is recorded from No. 3 Bore, Ph. Bairnsdale at 240 feet and another form, Afossochiton (Telechiton) dendus, from the Wurruk Wurruk Bore at 746 feet.

Most of the ostracoda range through the Middle Miocene to Recent, the restricted Miocene species being Cythere flexicostata, C. sorrentae, Krithe eggeri, and Cytheropteron batesfordense. Conditions similar to the above, but with fewer mollusca present, exist in No. 3 Bore, Ph. Bairnsdale, in No. 1 Bore, Ph. Moormurng and in bores in the Ph. Coongulmerang.

Kalimnan Stage

Only the lower zone of the Kalimnan is represented in Sector II. It is not recorded in bores west of No. 1 Bore, Ph. Yeerung but is present in No. 1 Bore, Ph. Wurruk Wurruk to the south-west. Outcrops occur around Bairnsdale and along the banks of the Mitchell River, above Bairnsdale, where moderately hard, ferruginous, fossiliferous limestones overlie similar rocks of the Mitchellian stage. The Kalimnan is represented in bores by friable, shelly sandstone containing typical foraminifera which are very numerous in the Cobbler's Creek and Coongulmerang bores. Tubes of the worm Ditrupa are

abundant in No.3 Bore, Ph.Coongulmerang. Corals are rare and bryozoa restricted to the usual few species. Molluscan shells are common and characteristic.

Post Kalimnan Beds.

The whole sector is covered with sands and torrent gravels, which are over 600 feet thick in the vicinity of No.1 Bore, Ph.Nuntim. They thin out towards the east in bores south of the Mitchell River, only 20 feet being recorded in Cobbler's Creek Bore near Bairnsdale. North of the Mitchell, in Ph.Wy Yung, 270 feet are present in No.1 Bore and 330 feet in No.2 Bore, neither bore penetrating the underlying marine sediments.

A summary of stratigraphic features in Sector II is as follows -

(a) Extensive Post Kalimnan sands and torrent gravels cover the entire area. Over 600 feet have been proved in the western bores, 20 feet in the eastern portion in bores just south of the Mitchell River, and over 300 feet on the north side of the river.

(b) The Kalimnan stage is present in nine bores and is represented by the lower zone. It is not recorded in the western part of the sector, but occurs in bores to the south-west. Exposures occur near Bairnsdale and along the Mitchell River banks. Ditrupa tubes are very common at the base of the section in the eastern bores.

(c) The Mitchellian stage has its type section at the Water Trust Excavation near Bairnsdale. The development of the stage is a feature of the central and western portions of the sector, the fossil assemblage being especially rich in the Meerlieu and Wurruk Wurruk bores. The admixture of Balcombian and Kalimnan species of foraminifera, bryozoa and mollusca shows a gradual increase of Balcombian forms towards the base of the section.

(d) The Balcombian stage also has distinctive characters.

(1) The Bairnsdale substage is represented by numerous outcrops of ferruginous, fossiliferous limestones along the banks of the Mitchell River, the type locality being described from Pound Swamp, Bairnsdale. Bryozoal limestones are a feature of the bores. They are frequently shelly and contain species which range upwards from the Janjukian.

(2) The Batesford substage is characterised in the lower zonule by the association of Lepidocyclina, Cycloclypeus and Austrotrillina with abundant bryozoa and mollusca, at Skinner's section, Mitchell River. The molluscan species are typically Balcombian, but many of the forms are recorded in the Janjukian. The two zones are present in bores.

(3) The Longford substage is typical in all bores except No.1 Ph.Nindoo, in which mollusca are common.

(e) The Janjukian stage is rather thin in the eastern bores, but in the Wurruk Wurruk Bore, in the south-east corner of the sector, 472 feet have been proved. No bore in the central portion penetrated the stage. The marls are less micaceous than in Sector I, but the foraminiferal assemblage is characteristic. No outcrops are available.

(f) The Anglesean stage is penetrated in six bores. Its thickness has been proved in only one bore, viz. No.1, Ph.Wurruk Wurruk, in which 848 feet of lignitiferous sands and brown coal are recorded, below the

FIG.6

SALE

LAKE WELLINGTON

LATROBE RIVER

WURRUK WURRUK

LONGFORD

NO.8

GLENCOE

DULUNGALONG

LE GRAND'S QUARRY

NO.7

BROCK'S QUARRY

ROBERTSON'S

MC.COLL'S

DOWD'S QUARRY

NO.2

NO.5

NO.4

NO.3

NO.6

TEXLAND BORE

LAKE WELLINGTON OIL BORE

NO.2

COOLUNGOOLUN

GLENCOE SOUTH

TANJIL POINT ADDIS NO.2

NO.2

WULLA WULLOCK

LAKE REEVE

MERRIMAN'S

NO.15

NO.16

STRADBROKE

MONKEY CREEK

NO.14

CREEK

GIFFARD

NINETY MILE BEACH

BASS STRAIT

NO.3

MULLUNDUNG

DARRIMAN

NO.6

NO.5

WOODSIDE

— LOCALITY MAP —

MERRIMAN'S CREEK SECTOR

0 1 2 4 6 8

SCALE OF MILES

BORES SHOWN ●

OUTCROPS " +

depth of 2,276 feet. To the north-east, in No.1 Bore, Ph.Bundalaguah, the Anglesean is met with at the shallow depth of 64 feet and in the most easterly bore, No.3, Ph.Bairnsdale, at 1,001 feet.

(g) Only one bore was drilled through to bedrock of Jurassic age.

(h) Evidence points to a gradual deepening of the basin in a southerly direction from the Mitchell River in the Meerlieu, Yeerung and Nuntin (No.1) Bores, which are in the centre of the sector, with a shallowing to the east. The Kalimnan stage disappears in bores to the west, but is present in the Wurruk Wurruk Bore to the south-west.

III. Merriman's Creek Sector.

Cores from 19 bores, involving 19,315 feet of drilling and several quarry sections have been examined. The geographical order in which the bores are listed is approximately north and south. No bore examined was drilled to bedrock, but Jurassic sediments are recorded at 1,400 feet from the Tanjil-Pt. Addis No.1 Bore.

The sector includes bores and quarry sections south from Sale, from No.2 Bore, Ph.Glencoe down to No.6 Bore, Ph.Woodside and then south-east to the Lake Wellington Oil Bore, in the Ph.Glencoe (Fig.6). No.8 Bore, Ph.Glencoe and No.2 Bore, Ph.Wulla Wullock are included in this sector rather than in Sector IV. Both bores would have been deep, as indicated by the respective horizons at which drilling ceased. Operations were suspended at 1,406 feet in No.8 Bore, just after the upper zone of the Batesford substage was entered, and at 1,420 feet in No.2 Bore, in the lower zone. Neither bore was deep enough to prove the presence of the mixed assemblage of Batesford and Jamjukian forms, characteristic of the Batesford substage in Sector IV. No bore examined was drilled to bedrock whilst only eight reached the Anglesean sands. The flanking by marine beds, of the lignitiferous sands which extend from near the surface in No.6 Bore, Ph.Glencoe, to a greater depth in a westerly direction, suggests an east to west anticlinal structure, which has been termed the "Baragwanath Anticline".

An important feature of this sector is that no beds younger than the Bairnsdale substage are encountered in bores on the western boundary. These bores are Nos.2, 3, 4 and 5, Ph.Glencoe at the northern point and in No.15, Ph.Stradbroke and Nos.5 and 6, Ph.Woodside, towards the southern end. No.2 Bore, Ph.Glencoe commences in the Bairnsdale substage, No.5 Bore, Ph.Glencoe, No.15 Bore, Ph.Stradbroke and Bores Nos.5 and 6, Ph.Woodside in the Batesford substage, and Bores Nos.3 and 4, Ph.Glencoe in the Longford substage.

Anglesean Stage.

Lignitiferous sands and brown coals, referable to the Anglesean were penetrated in eight bores, the first sample from No.6 Bore, Ph.Glencoe being taken at the shallow depth of 30 feet. This bore is in the axis of the "Baragwanath Anticline". 1,457 feet of sediments were proved in No.2 Bore, Tanjil-Pt. Addis. Bands of brown coal are present in the deep bores, as the Lake Wellington Oil Bore (boring ceasing in coal at 2,217 feet), and in Tanjil-Pt.Addis No.2 Bore. Small foraminifera, such as Lagena orbignyana, Globigerina bulloides, Cibicides ungerianus, and Eponides scabriculus, and fragments of bryozoa are present in the three shallow Glencoe Bores, Nos. 3, 4 and 5, in the lignitic material immediately underlying dark green, glauconitic marls. Foraminifera are fairly numerous in

LIMITING DEPTHS OF STRATIGRAPHICAL STAGES IN BORES IN SECTOR III.

Table 4.

Bore	Stage	Kalimnan	Mitchellian	Balcombian			Janjukian	Anglesean	Bedrock
	Substage			Bairnsdale	Batesford	Longford			
Parish of Glencoe No.2 Bore	S.L. 144'	-	-	30'-87'	90'-947'	-	-	-	-
No.5 Bore	S.L. 180'	-	-	-	30'-90'	100'-380'	384'-505'	520'-532'	-
No.4 Bore	S.L. 205'	-	-	-	-	20'-190'	200'-270'	272'-340'	-
No.3 Bore	S.L. 236'	-	-	-	-	20'-96'	100'-210'	214'	-
No.6 Bore	S.L. 113'	-	-	-	-	-	-	30'-605'	-
No.7 Bore	S.L. 75'	140'-185'	186'-356'	360'-467'	477'-760'	770'-1259'(a)	1259'(b)-1380'	-	-
No.8 Bore	S.L. 10'	420'-580'	590'-700'	710'-1350'	1360'-1406'	-	-	-	-
Texland Oil Bore (Houghton)	S.L. 175'	-	-	-	250'-550'	580'-765'	775'-1010'	1085'	-
Lake Wellington Oil Bore	S.L. 175'	70'-230'	275'-450'	460'-503'	522'-712'	720'-915'	935'-1248'	1250'-2217'	-
Parish of Glencoe South No.2 Bore		180'-222'	-	-	500'-600'	610'-927'	-	-	-
Tanjil Pt. Addis No.1 (Water Bore)	S.L. 255'	175'-185'	-	-	-	-	-	-	-
Tanjil Pt. Addis No.2 Bore		176'-295'	300'-500'	500'-524'	524'-650'	716'-900'	968'-1203'	1303'-2760'	-
Parish of Wulla Wulleck No.2 Bore		320'-437'	450'-568'	580'-1060'	1070'-1420'	-	-	-	-
Parish of Stradbroke No.15 Bore (Merriman's Creek)		-	-	-	45'-80'	110'-410'	420'-570'	590'-640'	-
No.16 Bore (Merriman's Creek)		200'	260'-390'	400'-580'	590'-640'	650'-1260'	1270'-1476'	-	-
No.14 Bore (Monkey Creek)		130'-285'	295'-445'	455'-595'	605'-745'	755'-1505'	-	-	
Parish of Darriman No.3 Bore		62'-88'	88'-169'	179'-289'	299'-559'	569'-1069'	1079'-1207'	-	-
Parish of Woodside No.5 Bore		-	-	-	24'-87'	88'-312'	-	-	-
No.6 Bore		-	-	-	32'-131'	132'-137'	-	-	-

certain sandy beds in the Lake Wellington Bore and very common in the Tanjil-Pt.Addis Bore at 1682 and 1806 feet. Species typical of the Anglesean and overlying Janjukian include Cyclammina incisa. Balcombian forms are Carpenteria rotaliformis, Eponides scabriculus, Elphidium crespinae, Amphistegina lessonii and Operculina victoriensis. Long-ranging species include Cassidulina subglobosa, Lagena orbignyana, Globigerina bulloides, Globigerinoides trilobus, Cibicides ungerianus, Eponides repandus and Epistomina elegans. Sponge spicules (Ecionema newberyi) and fragments of bryozoa (Cellaria rigida var.perampla and Smittinella tatei) are occasionally present.

Janjukian Stage.

The Janjukian beds consist of grey marls which contain very little mica and are strongly glauconitic at the base of the section. A pyritic band marks the break between the Anglesean sands and the Janjukian marls in the Tanjil-Pt.Addis and Lake Wellington Oil Bores. The marls show a considerable variation in thickness in the seven bores which penetrated them, only 110 feet being recorded from No.3 Bore, Ph.Glencoe between the depths of 100 and 210 feet, with 150 feet in No.15 Bore, Ph.Stradbroke (these being in the western part of the sector), and 335 feet in No.2 Bore, Tanjil-Pt. Addis in the eastern portion.

Foraminifera are fairly abundant, the assemblage being consistent with that listed in Sector II. Cyclammina and Vaginulina gippslandica are persistent, but Lamarckina glencoensis is not so common. Victoriella plecte, always rare in Gippsland, is recorded at 200 feet in No.3 Bore, Ph.Glencoe, at 1,360 feet in No.16 Bore, Ph.Stradbroke, and at 1,110-1,120 feet in No.2 Bore, Tanjil-Pt.Addis. Spicules of the sponge, Ecionema, are fairly common, bryozoa and mollusca rare and ostracoda not numerous.

Balcombian Stage.

Sediments throughout this stage comprise bryozoal marls, limestones and marly limestones with bryozoa dominating the fossil fauna. Tubes of the worm, Ditrupa, are very abundant in the Bairnsdale and Lepidocyclinae in the Batesford substages.

(i) Longford Substage. The sediments referable to this substage, are friable to hard, bryozoal, marly limestones which occur in outcrops and bores, the thickness of the beds varying considerably in the latter. The type locality for the Longford substage is at Dowd's Quarry near Longford and south of Sale, a full description being given in Part 5. The only other known exposure is at Massey's Quarry, 3 miles south-west of Longford, Ph.Coolungoolum.

Only 76 feet of Longford beds are recorded in No.3 Bore, Ph. Glencoe, whilst in No.5 Bore, only 50 chains away, 280 feet are present, and in No.14 Bore, Ph.Stradbroke, still further south, 750 feet, boring ceasing in this substage at a depth of 1,505 feet. In No.8 Bore, Ph.Glencoe, to the east, the substage had not been reached at 1,406 feet nor in No.2, Ph.Wulla Wullock to the west, at 1,420 feet.

Foraminifera are not common; Amphistegina and Operculina are present in several bores. Sponge spicules are characteristic and bryozoa typically abundant. Cidaroid spines, brachiopoda and mollusca are occasionally present, but ostracoda are numerous.

(ii) Batesford Substage. The zone of L.(T.)gippslandica is represented by greenish-grey and cream coloured bryozoal limestones and marly limestones in bores and quarry sections, the latter being situated in the Ph.Glencoe. The type locality for the lower zonule is at Brock's Quarry, and for the upper one, McColl's Quarry, the fossil fauna of each being described in Part 5.

The sediments in the substage vary considerably in thickness. In No.2 Bore, Ph.Glencoe, 857 feet of marly limestones containing Lepidocyclina, were passed through before the boring ceased at 947 feet, this thickness being the greatest recorded for the substage in any bore in Gippsland. In No.5 Bore, 12½ chains to the south, only 60 feet of sediments are recorded, from 30 feet down to 90 feet.

Outcrops belonging to the Batesford substage are located in the Ph.Glencoe, namely at -

Le Grand's Quarry, south of Longford, Allot.42 } Lower zonule.
Brock's Quarry, south-east of Longford, Allot 28 }

McColl's Quarry, east side of Boundary Creek, Allot.H. } Upper zonule.
Robertson's Quarry, Port 2, Sec.A. }

(a) The lower zonule is characterised in borings and quarry sections by numerous well-preserved tests of Lepidocyclinae, associated with Cycloclypeus. Lepidocyclinae, including excellent preserved specimens of L.(T.)gippslandica, are abundant in No.15 Bore, Ph. Stradbroke between 45 and 80 feet and in No.5, Ph.Glencoe between 40 and 80 feet. The usual associated forms are invariably present. Amphistegina is abundant at Brock's, and Tubulogenerina mooraboolensis is recorded from No.15 Bore, Ph.Stradbroke. The sponge, Bactronella australis, is frequently present, as well as numerous spicules of Ecionema newberyi. Brachiopoda, echinoidea, and mollusca, though common in Le Grand's Quarry, are sparingly present in bores. Arachnoides (Monostychia) australis is recorded from Le Grand's Quarry and Chlamys murrayanus and Dimya dissimilis from No.16 Bore, Ph.Stradbroke.

Le Grand's and Brock's quarries, though fairly close to one another, show some striking differences in their foraminiferal content.

(1) The scarcity of Lepidocyclina in Le Grand's and its abundance in Brock's.

(2) The abundance of Cycloclypeus in Le Grand's and its scarcity in Brock's. In Le Grand's, the foraminiferal fauna is associated with an abundance of the ramose bryozoan, Cellepora coronopus. Deposition of beds in this quarry was apparently under conditions similar to coral reefs, for recent Cycloclypeus is closely associated with such conditions at the depth of 50 to 60 fathoms.

(3) The comparative dearth of Amphistegina in Le Grand's and its abundance in Brock's. Operculina shows a small increase in number at Le Grand's.

(4) The prolific occurrence of Cellepora coronopus as well as small membranaceous forms at Le Grand's. The smaller species dominate the fauna at Brock's.

(b) The upper zonule is characterised by hard to friable, bryozoal limestones and marly limestones, in which foraminifera are numerous, and corals, brachiopoda and mollusca present. Marly limestones are typical of the Stradbroke bores and of McColl's and Robertson's quarries.

Lepidocyclina is not common but typical foraminiferal species are also available as well as rare forms. Cassidulinoides chapmani, Sherbonina sp.nov. and Calcarina verriculata are recorded from McColl's and Robertson's, and T.mooraboolensis from the latter. This assemblage is also found in the Batesford outcrops near Orbost in Sector I.

Corals, including Flabellum victoriae, are common in the Stradbroke bores. Brachiopoda are persistent but not abundant, and include Murravia triangularis, M.flindersi and Terebratulina suessi. Mollusca such as Arca (Barbatia)celleporacea, Venericardia spinulosa, Turritella acricula, and Cerithiella trigemmata, are amongst the more persistent species, while Chama lamellifera and Protocardia antisemigranulata appear in No.7 Bore, Ph.Glencoe. Ostracoda, such as Cythere flexicostata and Cytheropteron batesfordiense, are fairly common.

(iii) Bairnsdale Substage. Hard to friable, bryozoal limestones and marly limestones, chiefly grey in colour and referable to this substage are recorded from nine bores. No outcrops are known. In bores, it is comparatively thin, being rarely more than 100 feet thick, the exceptions being No.8 Bore, Ph.Glencoe with 400 feet and No.2 Bore, Ph.Wulla Wullock with 470 feet.

Foraminifera are not common except in the Stradbroke bores. Operculina and Amphistegina disappear just above the base of the substage, the former being abundant at 400 feet in No.16 Bore, Ph.Stradbroke, as well as small molluscan shells.

Two important features are present in this substage in Sector III. The first is the record of the shallow, warm water foraminifer, Marginopora vertebralis, a species previously only recorded in the Victorian Tertiaries from the Mallee Bores, where it is associated with Batesford species. Its identification at 465 feet in No.14 Bore, Ph.Stradbroke, (where it is associated with Operculina), in the overlying Mitchellian in No.16 Bore in the same parish, and in the Bairnsdale substage in the Wurruk Wurruk Bore (Sector II), constitute the three records of the form in Gippsland.

The second feature is the prolific occurrence of the tubes of the worm Ditrupa cornea var.wormbetiensis, forming Ditrupa limestones in No.7 Bore, Ph.Glencoe at 412 and 440 feet. They are also numerous in No.8 Bore, between the depths of 720 and 1,150 feet.

Species of bryozoa are similar to those recorded in other sectors. Molluscan shells are moderately common but fragmentary, such species as Limopsis maccoyi, L.morningtonensis, Chlamys murrayanus, Arca (Barbatia) celleporacea and Ctenamusium atkinsoni being present in the Stradbroke bores. Ostracoda are common. A shark's tooth, Lamna bronni, is recorded at 575 feet in No.14 Bore, Ph.Stradbroke.

Mitchellian Stage.

Transition beds between the Balcombian and Kalimnan are present in nine bores and are between 100 and 200 feet thick. They consist of moderately hard, marly, shelly limestones, the fossils frequently appearing as whitish casts, and showing an admixture of Balcombian and Kalimnan species. The stage is best developed in No.7 Bore, Ph. Glencoe and in Nos.14 and 16, Ph.Stradbroke.

Foraminifera are fairly numerous, many species persisting from the Balcombian. Marginopora vertebralis is present in No.16 Bore, Ph.Stradbroke. Kalimnan species include Quinqueloculina

ammophila, Spiroloculina dispansa, Cancris philippinensis, and Discorbis australis. Ditrupa tubes are common especially in No.8 Bore, Ph.Glencoe at 660-690 feet. Bryozoa are very abundant, many typical Balcombian species making their last appearances. Molluscam shells are numerous, characteristic Kalimnan species as Limopsis beaumariensis and Clausinella subroborata intermingling with Balcombiam forms such as Cocculina gunyoungensis and Argobuccinum maccoyi. Afossochiton rostratus is recorded from No.14 Bore, Ph.Stradbroke.

Kalimnan Stage

This stage consists of friable, grey, micaceous sandstones containing the typical foraminiferal and molluscan assemblages of the lower zone. It has been proved in ten bores but no surface exposures are known. It is absent in bores which form the western boundary of the sector, i.e. Bores Nos.2, 3, 4 and 5, Ph.Glencoe, No.15 Bore, Ph.Stradbroke and Bores Nos.5 and 6, Ph.Woodside. Foraminifera are not as common as in Sectors I and II, but small mollusca are abundant. Species such as Nuculana crassa and Liopyrga quadricingulata, characteristic of the upper zone in Sector I, occur sparingly. Protochiton granulosus is recorded from No.2 Bore, Ph.Wulla Wullock at 418-420 feet. Species of bryozoa and ostracoda are typically Kalimnan.

Post Kalimnan Beds

The area is covered with Post Kalimnan sands. In the western portion of the sector, they are moderately thin, ranging from 20 feet in No.3 Bore, Ph.Glencoe to 45 feet in No.15 Bore, Ph.Stradbroke. 420 feet were proved in the eastern part in No.8 Bore, Ph. Glencoe. A band of lignitic material containing coarse pebbles is present in No.2 Bore, Ph.Wulla Wullock from 120 to 130 feet.

A summary of the stratigraphic features of the Merriman's Creek Sector is as follows:-

(a) Post Kalimnan sands are thin in the western portion and fairly thick towards the east. Ligneous conditions are present in No.2 Bore, Ph.Wulla Wullock.

(b) Kalimnan sediments, representing the lower zone, are well developed in bores in the eastern and central portion of the sector. They are not recorded from bores along the western boundary, and no outcrops are known.

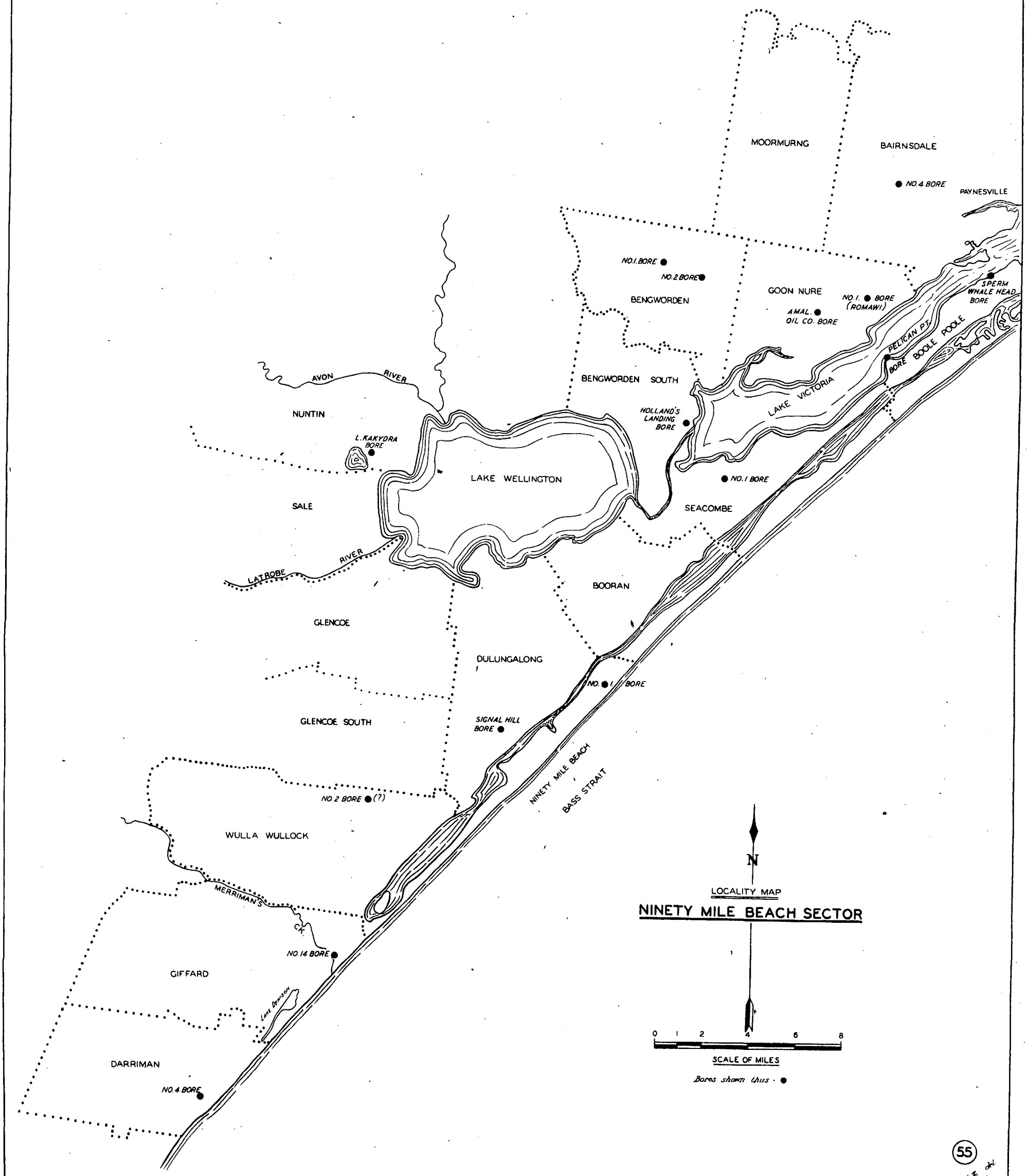
(c) The Mitchellian stage is typically present. Marginopora vertebralis is recorded from one bore and Ditrupa tubes are common.

(d) The Balcombian stage is well developed.

(1) The Bairnsdale substage is represented by fairly hard, bryozoal, marly limestones. Ditrupa tubes are very common and Marginopora vertebralis is also present.

(2) The zonules in the Batesford substage are described from this sector. The upper zonule, with its type section at McColl's Quarry, is 340 feet thick in No.2 Bore, Ph.Glencoe. The lower one, with its type section at Brock's Quarry, is exceptionally rich in Lepidocyclina and Cycloclypeus. The thickness of the substage varies considerably, from 35 feet in No.5 Bore, Ph.Glencoe, to 857 feet in No.2 Bore, 12½ chains to the north and 360 feet in No.2 Bore, Ph.Wulla Wullock, 8 miles to the south-east.

FIG. 7.


MOORMURNG
BAIRNSDALE
NO.4 BORE
PAYNESVILLE
NO.1 BORE
NO.2 BORE
BENGWORDEN
GOON NURE
NO.1 BORE (ROMAWI)
AMAL. OIL CO. BORE
SPERM WHALE HEAD BORE
PELICAN PT
BORE
BOOLE POOLE
AVON RIVER
NUNTIN
BENGWORDEN SOUTH
HOLLAND'S LANDING BORE
LAKE VICTORIA
L. KAKYDRA BORE
LAKE WELLINGTON
NO.1 BORE
SALE
SEACOMBE
LATROBE RIVER
BOORAN
GLENCOE
DULUNGALONG
NO.1 BORE
GLENCOE SOUTH
SIGNAL HILL BORE
NINETY MILE BEACH
BASS STRAIT
NO.2 BORE (?)
WULLA WULLOCK
MERRIMAN'S CK.
NO.14 BORE
GIFFARD
LAKE DENISON
DARRIMAN
NO.4 BORE
N
LOCALITY MAP
NINETY MILE BEACH SECTOR
0 1 2 4 6 8
SCALE OF MILES
Bores shown thus - ●

(3) The Longford substage with the type locality at Dowd's Quarry near Sale, is typical in all bores and is recorded from two quarry sections. It is thin in bores in the western area.

(e) The Janjukian marls vary considerably in thickness, the least thickness being in the western portion and the greatest in the south-eastern. The marls are strongly glauconitic and pyritic at base.

(f) The Anglesean stage is penetrated in eight bores, but the thickness of the stage is not proved in any bore examined. 1,357 feet were recorded from No.2 Bore, Tanjil-Pt.Addis. Brown coal is common, appearing immediately below the glauconitic and pyritic band in the western bores. Foraminifera are present in the sands.

(g) Bedrock was not reached in any bore examined, but sediments at 1,400 feet in No.1 Bore, Tanjil-Pt.Addis were considered to be Jurassic in age.

(h) The flanking of the Anglesean sands and brown coal by richly fossiliferous sediments on both sides of a line extending west from No.6 Bore, Ph.Glencoe, suggests the presence of an anticlinal axis, which is referred to as the "Baragwanath Anticline".

(i) The basin shows a considerable thickening of beds in a south-easterly direction.

IV. Ninety Mile Beach Sector.

Cores of 14 bores from 30,864 feet of drilling, have been examined. No outcrops are available. The geographical order in which the bores are listed is approximately east to west.

The bores in this sector are situated in an area adjacent to the Ninety Mile Beach, and extend west from No.1 Bore, Ph.Boole Poole (Sperm Whale Head) to No.4 Bore, Ph.Darriman, with an extension inland to No.2 Bore, Ph.Nuntin (Lake Kakydra) on the west side of Lake Wellington through to No.4 Bore, Ph.Bairnsdale on the west shores of Lake King. The exact eastern limit is not known, but it lies somewhere between the Sperm Whale Head Bore and No.1 Bore, Rigby Island near Lakes Entrance (Fig.7).

This sector contains the deepest bores yet to be drilled in Gippsland, No.1 Bore, Ph.Bengworden South (Holland's Landing) proving 3,524 feet of Tertiary beds, and No.1 Bore, Ph.Goom Nure (Romawi), 3,125 feet, both bores continuing into the Jurassic series. No.4 Bore, Ph.Bairnsdale is included in Sector IV because of certain features which suggest that it forms the north-eastern margin of the sector. As regards the inclusion of No.4 Bore, Ph.Darriman as the western limit, this is again based on the similarity of the beds in the Bairnsdale and Batesford substages, with the comparative scarcity of fossils other than bryozoa, together with the moderately hard mature of the marly limestones. This boring just penetrated the Batesford substage.

The incomplete records of the Romawi Bore are due to the large gaps between the depths of the samples forwarded for examination.

The two features of this sector are – (a) the great development of Middle Miocene marls and sands in certain bores, and (b) the mixed assemblage of Balcombian and Janjukian foraminiferal species in the Batesford and Longford substages.

LIMITING DEPTHS OF STRATIGRAPHICAL STAGES IN BORES IN SECTOR IV. Table 5.

Bore	Stage / Substage	Kalimnan	Mitchellian	Balcombian			Janjukian	Anglesean	Bedrock
				Bairnsdale	Batesford	Longford			
Parish of Bairnsdale No.4 Bore (Forge Creek)	S.L. 100'	240'-390'	400'-660'	670'-880'	890'-1150'	1160'-1370'	1380'-1410'	-	-
Parish of Bengworden No.1 Bore	S.L. 105'	425'-610'	610'-640'	650'-924'	-	-	-	-	-
No.2 Bore	S.L. 75'	374'6"-500'	505'-545'	555'-1080'	1087'	-	-	-	-
Parish of Boole Poole No.1 Bore (Sperm Whale Head)	S.L. 10'	190'-455'	477'-560'	570'-1210'	1230'-1530'	1554'-2088'	2107'-2565'	2570'-2962'	2966'-3110' Jurassic
Valve Oil Wells (Pelican Point)	S.L. 10'	352'-392'	-	1220'-1475'	1520'-1920'	1920'-2200'	2227'-2309'	-	-
Parish of Goon Nure No.1 Bore (Romawi)	S.L. 100'	500'	610'	704'-1135'	1235'	1342'-1846'	1966'-2580'	2632'-3125'	3158'-3244'6" Jurassic
Amalgamated Oil Wells (Old Goon Nure Bore)	S.L. 95'	-	-	-	1380'-1730'	1740'-2010'	2020'-2687'	2689'-2890'	-
Parish of Bengworden South No.1 Bore (Holland's Landing)	S.L. 10'	403'-562'	572'-735'	745'-1516'	1526'-1946'	1956'-2390'	2400'-3176'	3186'-3927'	3949'-4004' Jurassic
Parish of Seacombe No.1 Bore	S.L. 10'	380'-620'	630'-860'	870'-1570'	-	-	-	-	-
Parish of Dulungalong No.1 Bore	S.L. 10'	280'-580'	590'-720'	730'-1270'	1280'-1616'	-	-	-	-
Signal Hill Bore	S.L. 93'	300'-650'	-	742'-1129'	1573'-1630'	1639'-1781'	1822'-2237'	2240'-2295'	-
Parish of Nuntin No.2 Bore (Lake Kakydra)	S.L. 5'	510'-680'	680'-1035'	1050'-1665'	1670'-1709'	1720'-2336'	2337'-3020'	3025'-3506'	3513'-3560' Jurassic
Parish of Giffard No.14 Bore	S.L. 14'	216'-510'	520'-670'	680'-1358'	1365'-1600'	-	-	-	-
Parish of Darriman No.4 Bore	S.L. 10'	210'-410'	420'-565'	575'-1175'	1180'-1245'	-	-	-	-

The palaeontological review of the Holland's Landing Bore, recently published by the writer (1941) will be used as a basis in discussing the stratigraphic features of this sector. As stated earlier in this work, in view of evidence now available, it has been necessary to reconsider the age given to certain beds in that report.

JURASSIC

Four bores in Sector IV were drilled through to bedrock. Felspathic mudstones at the depth of 3,949 feet in the Holland's Landing Bore are regarded as Jurassic. Plant remains of that age, namely, Taeniopteris Daintreei, and Coneopteris hymenophylloides var. australica have been determined from the Sperm Whale Head Bore between 3,036 feet and 3,103 feet.

TERTIARY

Anglesean Stage.

A typical section of the lignitiferous sands and brown coals representing the Yallourn Formation has been described in Part 5, from the Lake Kakydra Bore, while a short account is available in the report on the Holland's Landing Bore. Anglesean sediments, 741 feet thick, have been proved in the latter bore, the topmost sample being recorded at 3,186 feet. The stage was met with at 3,025 feet in the Lake Kakydra Bore, about 15 miles to the west.

Of six bores which reached the Anglesean stage, four were carried to bedrock. Marine alternate with fluvio-lacustrine conditions throughout the stage, bands of brown coal up to 60 feet thick in the Sperm Whale Head Bore and 90 feet in the Lake Kakydra Bore occurring intermittently.

Foraminifera are common in the sands, the species being referable to some which become of zonal importance in the overlying Janjukian marls as well as those which range up into the Balcombian. The genus Cyclammina is characteristic of the Anglesean at the type locality at Anglesea. In the Gippsland bores it is found associated with the Janjukian forms C. rotundata, Vaginulina gippslandica and Ammodiscus sp. and the Balcombian species, Sigmomorphina chapmani, Cibicides sp.(1) and Amphistegina lessonii, this species being recorded from the Holland's Landing Bore at 3,549 feet. Many long-ranging forms make an early appearance in the Anglesean, including Pyrgo bulloides, Cassidulina subglobosa, Lagena striata, L. hexagona, Saracenaria italica, Globigerina bulloides, Pullenia quinqueloba and Eponides concentricus. Bryozoa, fragmentary molluscan shells and ostracoda are also represented. Fossil plants are rare and indeterminate. Cheirolepis cf. setosus is recorded from the Romawi Bore at 3,229 feet and Mollinedia sp. from Holland's Landing Bore at 3,828 feet.

Janjukian Stage.

It is in this stage that a marked difference in the lithology of the sediments from those in other sectors is apparent. The brownish, micaceous marls are replaced by grey to greenish-grey, fine-grained marls, frequently hardened and glauconitic and pyritic at base. The pyritic and glauconitic condition is more strongly developed in bores in the eastern portion of the sector, as in the Romawi and

Amalgamated Oil Bores, Ph. Goon Nure, where the presence of massive pyrite made drilling difficult. Pyrite gradually decreases in abundance upwards in the sequence, while glauconitic replacement of foraminifera becomes very common. This character in turn gradually disappears and marls become predominant.

Foraminifera, including typical zonal forms, are common and usually well preserved, but crushed specimens are frequent. Cyclammina is always common. Ammodiscus is characteristic of Sector IV, unusually large specimens occurring at 2,538 feet in the Holland's Landing Bore. Glomospira charoides is practically restricted to this sector. Victoriella plecte is recorded from the Amalgamated Oil Bore at Goon Nure at 2,436 feet and from Holland's Landing Bore at 2,975 feet. Lamarckina glencoensis is rare. Associated species have been listed from earlier sectors and are chiefly moderately deep-water forms. Species typical of the Balcombian are persistent in these deep bores. Amphistegina and Operculina are fairly common in the Romawi Bore, and Hofkerina semiornata is found at Holland's Landing. A unique assemblage of foraminifera is recorded from this bore between the depths of 2,938 and 2,898 feet. Associated with the usual numerous species of Miliolidae, Lagenidae, Globigerinidae, and Rotalidae, and Cyclammina, Ammodiscus and Glomospira, are the deep, cold-water forms, Hormosina sp., Tolypammina vagans and Hyperammina sp. These genera are exceedingly rare in the Victorian Tertiaries.

Balcombian Stage.

There is no apparent stratigraphical or lithological break between the Janjukian and Balcombian. Greenish-grey, fine-grained marls of the Janjukian still persist and the foraminiferal species represent a deeper-water facies than that usually found in the Balcombian, but the abundance of bryozoa indicates the presence of this stage. The Janjukian foraminiferal genus Cyclammina ranges as high as the Batesford substage in all bores and molluscan shells are scarce.

There is a very marked thickening of sediments in the Balcombian towards the centre of the sector. In No. 4 Bore, Ph. Bairnsdale, which marks the north-eastern boundary of the sector, they are only 720 feet thick; in the Sperm Whale Head Bore to the south of this bore, 1,518 feet; in the Holland's Landing Bore, in the central portion, 1,645 feet, and in the Lake Kakydra Bore to the north-west, 1,286 feet.

(i) Longford Substage. In the report on Holland's Landing Bore this substage has been referred to "B1 zone probably new". It is 434 feet thick in that bore and 458 feet in the Sperm Whale Head Bore. The lithology which is represented by bryozoal marls and marly limestones is consistent in all bores, the bryozoal content gradually increasing upwards in the section. Pyritic replacement of bryozoa and foraminifera is a constant feature. Typical Balcombian foraminifera are common, the Batesford species, Planorbulinella inaequilateralis, Hofkerina semiornata and Gypsina howchini, becoming prominent towards the top of the substage. Cyclammina is usually present. Sponge spicules are numerous. Bryozoa are not well preserved. Cidaroid spines, brachiopoda and ostracoda are occasionally present, but mollusca are very rare.

(ii) Batesford Substage. No lithological change is apparent as the Longford substage passes upwards into the Batesford. The presence of this substage is based entirely on palaeontological evidence, Lepidocyclina being the most important factor. Bryozoa are very numerous, sponge spicules common, Goniocidaris spines occasionally

present, and molluscan shells rare.

Both the lower and upper zonules are represented. The lower zone is typically thin. Cycloclypeus has been recorded from only two bores, both in the Ph.Dulungalong viz. in the Signal Hill Bore at 1,573 feet and in No.1 Government Bore at 1,590 feet. This apparent absence from other bores is possibly due to the lack of intensive collecting of material at the vital depths. As a result, recognition of the zonule is based on the abundance of Lepidocyclinae, with which are associated typical Batesford species, and in this sector, Cyclammina. The upper zone is thick, 300 feet being proved in No.1 Bore, Ph.Dulungalong. Lepidocyclina occurs spasmodically throughout.

(iii) Bairnsdale Substage. Grey, bryozoal marls and limestones, similar to those marking the upward passage of the Longford to the Batesford, are present as that substage passes upward into the Bairnsdale. Bryozoa still dominate the fossil fauna. Foraminifera are not numerous. Elphidium is a persistent genus, and Amphistegina and Operculina disappear early in the substage. The latter genus is unusually abundant in No.4 Bore, Ph.Darriman at 900 feet. Ditrupa tubes are characteristic of bores in the south-western portion, especially in No.14 Bore, Ph.Giffard at 1,256 feet and No.4 Bore, Ph. Darriman at 754 feet. The large pelecypoda of other sectors are practically absent.

Mitchellian Stage.

The transition from the Balcombian to the Mitchellian is marked by the incoming of mollusca, chiefly Kalimnan species, which appear as white casts and moulds in grey, bryozoal limestones. Fine quartz grains also become common. The bryozoal content decreases towards the top of the stage. Foraminifera are fairly numerous, typical Kalimnan species such as Planulina kalimnensis, Cancris philippimensis and Nonion victoriense mingling with characteristic Balcombian forms. Mollusca include Spondylus pseudoradulus, Limopsis beaumariensis, Neotrigonia acuticostata and Turritella acinella.

Kalimnan Stage.

Sediments belonging to the lower zone of the Kalimnan are present in all bores. They consist of friable, micaceous, shelly sandstone, containing a characteristic assemblage of foraminifera and mollusca, the latter not being as numerous as in other sectors. Friable sands containing many foraminifera together with shell fragments are a feature of Bores No.1, Phs.Seacombe and Dulungalong. Characteristic foraminifera are Flintina intermedia, Spiroloculina dispansa, Bolivina alata, Rectobolivina bifrons var.striatula, Planulina kalimnensis, Streblus beccarii, Astrononion australe, Nonion victoriense and Elphidium imperatrix. Bryozoa, mollusca and ostracoda are represented by the usual species.

Post Kalimnan Beds.

The occurrence of fossiliferous beds overlying the Kalimnan is unusual in the Gippsland region. They are recorded in this sector from No.1 Bore, Ph.Dulungalong between 10 and 60 feet, and consist of uncomsolidated, shelly, quartz sands containing numerous recent species of shallow water foraminifera, including Buliminoides williamsonianus, Streblus beccarii and Discorbis dimidiatus, several recent species of mollusca such as Glycymeris striatulus, Montacuta

sericea, Bittium diemeniensis, B.granarium, Monodonta constricta, Diala pagodula and Assiminia tasmanica, and thin-shelled ostracoda as Cythere canaliculata, C.melobesioides and Xestoleberis variegata.

Unfossiliferous sands are present in all bores, 500 feet being recorded from the Lake Kakydra Bore.

A summary of stratigraphic features in the Ninety Mile Beach Sector is as follows:-

(a) The whole area is covered with Post Kalimnan sands and torrent gravels, which are 500 feet thick in the Lake Kakydra Bore in the north-western portion. The sands in No.1 Bore, Ph.Dulungalong, from 10 to 60 feet contain recent shallow water species of foraminifera and mollusca.

(b) The Kalimnan stage is represented by the lower zone only. The depth at which the top of the zone is met in bores varies from 240 feet in the most northerly bore, No.4, Ph.Bairnsdale, to 403 feet in the central bore, No.1, Ph.Bengworden South, and 210 feet in the most westerly, No.4 Bore, Ph.Darriman. Mollusca are not as abundant as in other sectors. No outcrops are known.

(c) The Mitchellian stage is recognisable in nine bores. It is 330 feet thick in No.1 Bore, Ph.Seacombe.

(d) The Balcombian stage has two features. (i) Its great thickness when compared with other sectors, 1,645 feet being recorded in the Holland's Landing Bore. (ii) The comparatively uniform sedimentation from the Longford substage through to the Bairnsdale. No outcrops are known.

(1) The Bairnsdale substage contains few of the typical large molluscan shells, the only prominent fossil other than bryozoa being Ditrupa, which is abundant in the western bores.

(2) The Batesford substage is characterised by (a) the presence of Cyclammina with Lepidocyclina throughout the substage, the latter genus being less abundant than in other sectors; (b) the thickness of the upper zonule, which, in No.1 Bore, Ph.Dulungalong, is 300 feet.

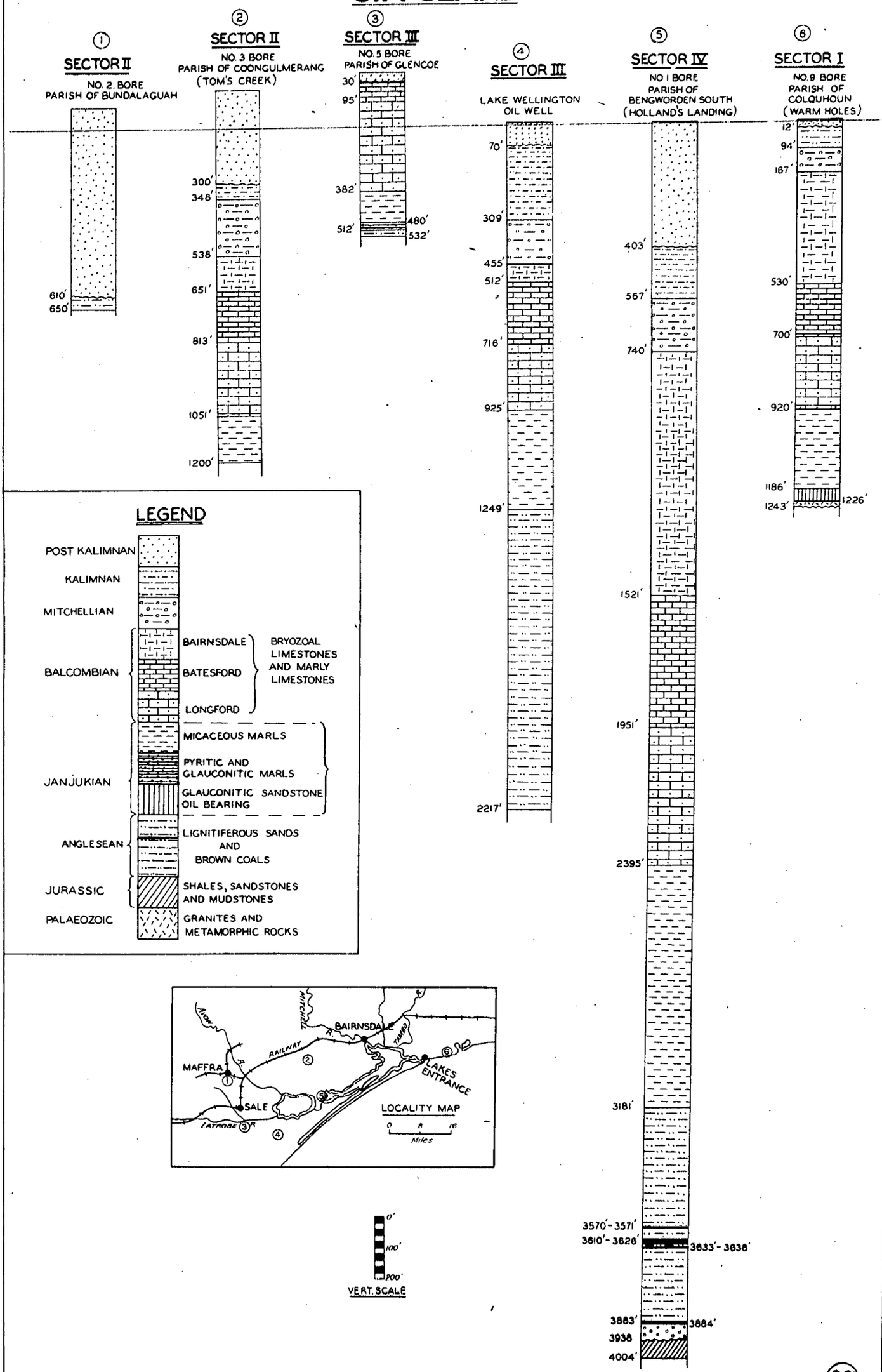
(3) The Longford substage is unusually thick, 630 feet being recorded from the Lake Kakydra Bore. Cyclammina occurs throughout.

(e) Because of the lithological similarity of the passage beds between the Balcombian and the Janjukian stages, the break is based entirely on palaeontological evidence. The Janjukian sediments are recorded 776 feet thick in the Holland's Landing Bore. Typical Balcombian foraminifera are associated with the usual Janjukian assemblage in all bores. Molluscan shells are extremely rare. No outcrops are known.

(f) The Anglesean stage is represented by lignitiferous sands containing foraminifera, interbedded with thick seams of brown coal, 90 feet of coal being recorded in the Lake Kakydra Bore). The sands show a thickening towards the centre of the sector in the Holland's Landing Bore, with a thinning-out to the north-west in the Lake Kakydra Bore and to the east in the Sperm Whale Head Bore. There is a considerable decrease in thickness in bores further east in Sector I.

TYPE BORE SECTIONS
GIPPSLAND

FIG. 8.



(g) Bedrock, reached in four bores, is of Jurassic age.

(h) Bores in this sector illustrate beyond doubt, the close relationship between the Janjukian and Balcombian stages. This is shown not only in the uniform sedimentation but also in the persistent occurrence of typical Janjukian foraminifera in the Balcombian and in the early appearance in the Janjukian of zonal Balcombian species. At the same time a palaeontological relationship is shown between the Anglesean and Janjukian based on the occurrence of certain foraminifera in both stages.

7. PALAEOECOLOGY OF THE FAUNAL ASSEMBLAGES.

Considerable attention is being paid in various parts of the world to the ecological aspect. Amongst the most recent studies of the foraminifera are those by Kleinpell in his "Miocene Stratigraphy of California" and T.Wayland Vaughan on the "Ecology of Modern Marine Organisms with Reference to Palaeogeography". An important feature is that temperature and nature of sea floor rather than depth affect the occurrence of foraminifera. Trask remarks (1939,p.428) that "As the texture of the sediments likewise is influenced by the movement of the water, the organic content is related to the texture. Sands contain relatively little and clays contain considerable organic matter". This view is supported by the study of the faunal content of the Tertiary sediments of Gippsland.

The foraminifera are the most important group in the fauna and will be considered in detail.

(a) Anglesean Stage. The brown coals and lignitiferous sands of this stage, as found in sub-surface sections were deposited under temperate climatic conditions. For a long time it has been believed that these beds were entirely of fluvio-lacustrine origin. Recent investigations have proved the presence of foraminifera, bryozoa and ostracoda in these sands, pointing to marine influence. Unfossiliferous sands are to be found in the region of Morwell and Yallourn, but foraminifera and ostracoda are present in the lignitiferous sands in bores at Mirboo North, where they overlie extensive deposits of bauxite. No marine forms are present in No.1 Bore, Ph.Bundalaguah on the western margin of Sector II. But to the north, in similar sands, in No.2 Bore, Ph.Bundalaguah and No.1 Bore, Ph.Stratford, numerous small foraminifera again indicate marine influence. Similar conditions are recorded in bores along the western boundary of the area under consideration, such as Bores, No.1, Ph.Wurruk Wurruk, Nos. 3, 4 and 5, Ph.Glencoe, No.14, Ph.Stradbroke, Nos.5 and 6, Ph.Woodside. In No.5 Bore, Ph.Glencoe, a bed of lignite immediately underlies the marine fossiliferous glauconitic marls and is followed by lignitiferous sands containing foraminifera.

The foraminifera range from deep, cold water forms of the boreal type to shallow water ones of the neritic type. The shelter-loving, moderately shallow water forms such as the miliolidae are absent and the pelagic family Globigerinidae is rare. Abyssal genera such as Cyclammina, Ammodiscus, Gyroidina and Cassidulina occur together with medium depth forms such as Lenticulina. As against these deep water forms, there is the occurrence of the sub-tropical to tropical genera Amphistegina and Operculina. The assemblage of foraminifera, in the Anglesean stage, shows affinities not only with that of the overlying Janjukian but with the stratigraphically still higher Balcombian.

(b) Janjukian Stage. The Janjukian marls indicate moderately deep, cool water conditions where deposition, which took place some

distance off shore, was rapid, currents gentle and the sea floor rather muddy. The foraminiferal assemblage in all sectors shows little variation in content but exhibits extreme ecological diversity in forms present. It includes the abyssal and boreal genera, Cyclammina, Ammodiscus and Gyroidina, together with the shallow water, shelter-loving Elphidium and the subtropical to tropical genera, Amphistegina, Operculina and Hofkerina. A feature of the foraminiferal content of cold water deposits is that species are few but specimens numerous. The scarcity of bryozoa is due to the muddy condition of the water and absence of currents. Molluscan shells, chiefly small species, are numerous in Sector I, are occasionally present in Sectors II and III and exceedingly rare in Sector IV. The mica content in Sector I is due to the proximity of the basement rocks, the sediments being deposited a short distance off-shore where currents were practically absent. As the sediments extend west the mica content diminishes, due to the greater distance from the rocks from which the mica was derived.

Arenaceous foraminifera such as Ammodiscus, Glomospira, Cyclammina, Ammobaculites, Clavulina and Listerella are fairly common in the Janjukian, the first two genera being more characteristic of the fine-grained marls of Sector IV. The presence of all these forms is governed by the clarity of the water and the character of the sea bottom. Cyclammina, Ammodiscus and Glomospira and the rare forms present in Sector IV, Tolypammina, Ammolagena and Hyperammina, are finely arenaceous genera typical of deep, cold water. Ammodiscus does range up to 20 fathoms and Hyperammina to 27 fathoms but the average depth is about 1,000 fathoms.

The Lagenidae which are common in the Janjukian, like temperate to cold waters, being most abundant between 50 and 500 fathoms, but range down to 3,000 fathoms. Vaginulina occurs down to 1,000 fathoms. The Polymorphinidae are very common in the Janjukian marls. They are mostly shallow-water forms but are recorded down to 2,000 fathoms. Genera such as Cibicides, Epistomina and Eponides range from shallow to deep waters. Warmer, shallower-water forms include Victoriella, Carpenteria and Lamarckina. The Globigerinidae are characteristic of open seas, but are not indicative of depth. Gyroidina, which is common in the marls, is definitely a deep water form, thriving below 300 fathoms. Elphidium, a persistent and sometimes a common genus in some bores, is a shallow-water, shelter-loving form. Cassidulina subglobosa is a "deep sea type".

The glauconitic sandstone facies of Sector I points to off-shore conditions where deposition was slow, and large molluscan shells could flourish. The foraminiferal assemblage, where determinable, is similar to that recorded from the overlying marls, the majority of the forms being replaced with glauconite. Large molluscan shells, including numerous specimens of Ostrea in No.10 Bore, Ph.Colquhoun, indicate the existence of a rocky sea-floor and moderate temperatures.

The distribution of typical foraminifera in the Janjukian marls indicates that the deposit was laid down near the edge of the continental shelf in cool water in which current action was gentle. This view is supported by the scarcity of bryozoa and mollusca in the sediments and applies more especially to the marls in Sectors II, III and IV. Slightly shallower-water conditions prevailed in Sector I where molluscan shells are moderately common.

(c) Balcombian Stage. In Sectors I, II and III, the sediments of this stage reveal a change in conditions, from the moderately deep, cool water of the Janjukian to the warm to subtropical and moderately shallow water of the Balcombian, which, even in Sector IV where the sediments are marly, is dominated by bryozoa, which thrive in clear, marine waters of temperate to tropical temperature in which adequate circulation is available.

(1) Longford Substage. In Sectors I, II and III, conditions during this substage are generally similar to those throughout the whole Balcombian stage. In Sector IV, the passage from the deeper, cool waters to the shallower warm ones, is more gradual. In Sector I, in Bores Nos. 5 and 6, Ph. Colquhoun, a definite departure from the comparatively stable conditions during this substage exists, considerable oscillation taking place from moderately shallow to deep water in which numerous small foraminifera such as Cassidulina, Bolivina, and Globigerina flourished. Shallower, warmer conditions prevailed towards the close of the Longford when larger foraminifera such as Operculina, Amphistegina and Carpenteria, begin to appear in some abundance. Mollusca are not common.

(2) Batesford Substage. Bathymetric conditions throughout this substage are tropical to subtropical. Bryozoal limestones and marly limestones are the chief lithological types. Foraminifera are fairly common and are represented by persistent species in the limestones, additional forms appearing in the more marly beds. The substage is characterised by the restricted occurrence of the orbitoidal genus, Lepidocyclina which is indicative of tropical to subtropical conditions. Orbitoids generally are shallow water forms, living in less than 100 fathoms with the temperature averaging about 15° C. Lepidocyclina is frequently associated with Cycloclypeus, another typical tropical genus, thriving in shallow warm water at the present day, and practically restricted to the Indopacific region. Other genera existing under similar conditions are Gypsina, Planorbulinella and Calcarina (rare in Gippsland), Carpenteria, Operculina and Amphistegina. The majority of associated species of smaller foraminifera are moderately shallow water forms. Amongst the rare ones are Bdelloidina, which likes warm water, Tubulogenerina, a genus not yet recorded living in the seas at the present time, and Cassidulinoides, which enjoys sandy conditions. A persistent shallow warm water genus is Elphidium.

In the Ninety Mile Beach Sector, the shallow, warm water forms Lepidocyclina and Cycloclypeus, are associated with the cold, deep water, or boreal to abyssal genus, Cyclammina. The persistence of this latter form may be due to the continuance of the more marly lithology of the sediments. A similar association is found in California, where Kleinpell suggests that the intermingling "is probably attributable to bathymetric conditions".

The association in Skinner's outcrop, of numerous foraminifera including Lepidocyclina and Cycloclypeus, with a rich bryozoal and molluscan assemblage may be due, according to Singleton, "to an argillaceous facies of the Batesfordian". It is evident from conditions of sedimentation in bores that mollusca do not thrive in bryozoal limestones.

(3) Bairnsdale Substage. Subtropical, with moderately shallow water conditions, still persisted during this substage. Foraminifera are not very numerous but typical Balcombian forms are present. In the majority of borings, the normal moderately, warm, shallow water conditions of the Longford and Batesford substages persist in the Bairnsdale. The foraminifera show little variation from those in the lower substages, but Amphistegina and Operculina disappear early. This indicates the advent of slightly deeper water conditions, for bryozoa, which dominate the fauna, thrive in moderately deep water where there is adequate circulation.

(c) Mitchellian Stage. This stage represents passage beds which contain mixed assemblages of Kalimnan and Balcombian species of foraminifera and mollusca, Balcombian bryozoa, quartz and glauconite grains. The sediments were deposited somewhere near a shore-line along which moderately shallow, warm water and partially open sea conditions permitted the growth of bryozoa. At the same time the environment was favourable for the development of shallow-water foraminifera and molluscan shells such as flourished in the overlying Kalimnan. An argillaceous facies is recorded from bores im Sector II, which are in the vicinity of the Mitchell and Thomson Rivers, with a special development in Bores No.1, Phs.Meerlieu and Wurruk Wurruk, where foraminifera and mollusca of Balcombian and Kalimnan species intermingle im profusion. The change from these conditions to those characterising the Kalimnan must have been rather sudden, as shown by the abrupt disappearance of the majority of bryozoal species.

(d) Kalimnan Stage. Warm, littoral to sub-littoral and fairly sheltered conditions prevailed in Kalimnan times, during which shallow-water foraminifera and mollusca flourished. The foraminifera include such genera as Bolivina, Rectobolivina, Discorbis, Notorotalia, Streblus and Nonion. Miliolines are fairly common especially in the Kalimna Oil Bore, Rigby Island, and are indicative of sheltered conditions. Deeper water forms such as the Lagenidae and Polymorphinidae are sparingly represented.

(e) Post Kalimnan Beds. Terrestrial conditions were predominamt in Post Kalimnan times in Gippsland. Oscillation, from terrestrial to marine conditions, is shown in two bores, namely, No.4 Bore, Ph. Colquhoun (Pilot Station) and No.1 Bore, Ph.Dulúngalong, where shallow-water and estuarine foraminifera are recorded as well as small shells with similar affinities.

The main conclusion to be drawn from the above considerations is that there are four distinct foraminiferal assemblages characteristic of the four stages as represented in Gippsland.

(1) The deep cool water assemblage represented by extreme "ecological diversity" and characteristic of quiet sedimentation which prevailed in Janjukian times. Several species are recorded earlier in this section from the underlying Anglesean stage.

(2) The moderately shallow, temperate to subtropical assemblage associated with bryozoa and characteristic of the Balcombian stage. The assemblage includes the restricted zonal genus Lepidocyclina in the Batesford substage and other genera which are found living around coral reefs at the present day.

(3) The mixed assemblage of Balcombian and Kalimnan foraminiferal species in the Mitchellian.

(4) The sub-littoral to littoral assemblage of the Kalimnan.

Amongst the groups of fossils other than the foraminifera, the most important is the bryozoa. They are represented by only a few characteristic species in the Janjukian, their absence being due to the quiet sedimentation and muddy condition of the sea bottom at the time of deposition of the beds. They occur in profusion in the Balcombian, the moderately shallow-water in which there was adequate movement and the moderate to sub-tropical temperature being especially suitable for their development. These conditions were partially present in Mitchellian times but the change to shallow, littoral conditions in the Kalimnan stage caused the sudden disappearance of the majority of species.

Remains of worm tubes generally, give no indication as to conditions of environment, but it seems that Ditrupa, which is so abundant in the bryozoal limestones in the upper portion of the Balcombian (Bairnsdale substage) in bores in Sectors III and IV, flourishes in moderately shallow warm water. It does not appear in the cooler and deeper water of Janjukian times.

Echinoidea and brachiopoda are not common in the Gippsland Tertiaries. The Janjukian seas were too cool and deep for these groups to thrive. They are only occasionally present in the Balcombian bryozoal limestones, the greatest development being in the Bairnsdale substage in Sectors I and II. Shallow, muddy waters in fairly protected embayments were present along the northern and eastern boundaries of the basin towards the close of the Middle Miocene (Balcombian). Such conditions were ideal for the development of large echinoids, brachiopods and pelecypods such as are found in the Snowy River cliffs near Orbost on the eastern boundary and in the cliffs along the Tambo, Nicholson and Mitchell Rivers on the northern boundary. Such accumulations of large fossils include the echinoid Clypeaster gippslandicus, the brachiopod, Magellania grandis and the pelecypoda Hinnites corioensis, Serripecten yahliensis, and heavy valves of Ostrea. Magellania thrives in muddy water not more than 100 feet deep .

Mollusca are not abundant in the Gippsland Tertiaries, except in the Kalimnan deposits and the argillaceous facies of the Mitchellian stage in the Meerlieu and Wurruk Wurruk bores, in the Batesford substage at Skinner's Section and in the Bairnsdale substage in the cliff sections around Bairnsdale and along the Princes Highway east of Lakes Entrance through to Orbost. Small forms are present in the Janjukian but the sediments were deposited too far off-shore for the development of many large species. This is especially the case in Sector IV, in which molluscan shells are very scarce. The majority are recorded from Sector I where deposition was fairly close to the shoreline. Their comparative absence in the bryozoal limestones is due to the clear water and rather strong currents, the shell beds in the Skinner's Section and in the Meerlieu Bore representing quieter waters and more argillaceous conditions. Large pelecypoda such as Ostrea and Serripecten which dominate the fauna in the cliff sections referable to the Bairnsdale substage, are particularly adaptable to shallow and muddy water conditions.

The warm, sub-littoral to littoral and sheltered conditions as prevailed in Kalimnan times were ideal for the development of mollusca. The lowest portion of the stage, as shown in bores, is represented by a sub-littoral facies in which small species of mollusca are abundant in fine, marly sandstone. Conditions of deposition in the middle portion of the stage as indicated in the lower part of the section at Jemmy's Point, Maringa Creek and certain localities along the Princes Highway, where large pelecypoda such as Eucrassatella kingicoloides and Neotrigonia howitti and gasteropoda as Turritella conspicabilis abound, were slightly further in-shore. Conditions were distinctly littoral and sheltered at the time of deposition of the topmost bed at Jemmy's Point, in which a prolific number of large and small molluscan shells including Nuculana crassa and Polinices cunninghamensis occur in a coarse friable sandstone, and in which there is almost a complete absence of bryozoa.

8. CORRELATION OF THE GIPPSLAND TERTIARIES WITH OTHER OCCURRENCES IN SOUTH-EASTERN AUSTRALIA.

The present correlation will be extended beyond Victoria into south-eastern South Australia. Under the scheme of stratigraphic

sequence postulated in this work, it is necessary to make certain alterations in the correlation table put forward by Singleton (1941).

(a) Kalimnan Stage. The fauna of the Kalimnan is uniform in all its occurrences in Victoria, but the very rich, shelly, sandy bed as found at Jemmy's Point and elsewhere in Sector I, does not appear to have its equivalent beyond this sector. All outcrops, except that at Gelliondale in South Gippsland, are referable to the lower zone. The foraminifer, Fabularia howchini, which is found in the shelly beds at Muddy Creek, Hamilton, Western Victoria, has not been recorded from Gippsland. The upper portions of the Mallee bores also belong to this zone. It seems that most of the section at Beaumaris is basal Kalimnan. The exact relationship between the Victorian Kalimnan and the Lower Pliocene beds of South Australia has not been determined.

(b) Mitchellian Stage. This stage with its mixed Kalimnan and Balcombian fossil assemblage, is limited in its occurrence outside the Gippsland basin. Surface sections do not appear to be available but subsurface correlation can be made with those beds between the depths of 741 and 746 feet in the Sorrento Bore and with certain portions of the Mallee Bores, Western Victoria, where Marginopora vertebralis is associated with Kalimnan mollusca and Balcombian bryozoa as in the Gippsland bores.

(c) Balcombian Stage. Extensive deposits of Balcombian sediments are recorded both in surface and subsurface sections outside Gippsland. The deposits are present in bores in Western Victoria, as in the Glaxo Bore, Port Fairy, in the Nelson, Portland and Mallee Bores and in eastern South Australia near Mt. Gambier and in the Hundred of Caroline.

(1) The bryozoal limestones of the Bairnsdale substage can be correlated with those on the western shore of Corio Bay in which Hinnites corioensis and Clypeaster gippslandicus are typical fossils. The latter form is comparatively rare in localities west of Bairnsdale. Other outcrops referable to this substage are the bryozoal limestones west of Geelong, at Muddy Creek, Hamilton, and the fossiliferous ironstone at Green Gully, Keilor; the bryozoal limestones in the upper portion of the Caroline Bore, South Australia are also included here. Marginopora vertebralis is recorded in certain Mallee bores under circumstances similar to those in Gippsland.

(2) The Batesford substage is characterised in Gippsland by the zone of Lepidocyclina (Tryblioleipidina) gippslandica. This species is replaced, in abundance, in southern-central and western Victoria by L. (T.) howchini, which is present in the bryozoal marls in the Tyabb bores, Victoria Golf Club Bore at Cheltenham, and the Water Bore, Lara near Geelong, and in the limestones at Clifton Bank, Hamilton and the Hamilton Bore. Austrotrillina howchini is present at Skinner's in Gippsland and Clifton Bank, Hamilton as well as in some of the Mallee bores. Singleton states that "only at Skinner's on the Mitchell River near Bairnsdale are Lepidocyclinae associated with Trillina howchini and a molluscan fauna of Balcombian affinities". Actually the type locality for that form is Clifton Bank, from which Lepidocyclinae and mollusca are recorded. Marginopora vertebralis is associated with A. howchini in the Mallee bores, but is present only in the Bairnsdale substage and Mitchellian stage in Gippsland.

(3) Outcrops referable to the Longford substage are apparently not numerous outside Gippsland. Rocky Point, Torquay, with its abundant Cassidulinoides chapmani belongs here, and it is certainly represented in the Glaxo and Portland bores.

(d) The Janjukian stage is fairly widespread in central-southern Victoria, where it has been determined primarily on the mollusca. In Gippsland the correlation has to be based on the foraminifera, as mollusca are comparatively rare except in Sector I. Outstanding forms are Cyclammina incisa, C. rotundata, Victoriella plecte and Vaginulina gippslandica. Victoriella is recorded not only from marls at Torquay (type locality) but from bryozoal limestones at Karwarren, from bryozoal marls in several of the Dartmoor bores in Western Victoria, where it appears commonly just above the lignitiferous sands, and in the Portland Bore; and in the bryozoal limestones at the top of the Nelson Bore (from 390 to 465 feet) and in Knight's Dome, No.1 Bore, Mt. Gambier, South Australia. Janjukian sediments are recorded down to 80 feet in the latter bore and down to 963 feet in the former. An important factor shown by this correlation is, that the strongly bryozoal character of the Balcombian, is also a feature of many Janjukian deposits. This point further supports the contention that the Janjukian beds are closely related to the Balcombian and are not older than Middle Miocene.

Glauconitic sandstone occurs at the base of the Janjukian in bores not only in Gippsland but in Western Victoria, as in the Nelson Bore, but up to the present only that in the Lakes Entrance bores has proved to be oil-bearing.

(e) The extensive deposits of lignitiferous sands and brown coals proved by boring in Gippsland and referred to the Anglesean are not typical of the type section at Anglesea, where Cyclammina is the characteristic foraminifer. A definite correlation with that stage can be made with more than 3,500 feet of lignitiferous sands proved up to the present in the Nelson Bore, Western Victoria. Cyclammina is common throughout but other Janjukian and Balcombian species found throughout the Gippsland beds are absent. No brown coal was present at Nelson but deposits occur at Moorlands in South Australia to the north-west of Nelson. Similar sands occur in numerous shallow bores at Dartmoor, Victoria and in No.1 Bore, Knight's Dome, near Mt. Gambier, South Australia.

9. CORRELATION OF THE GIPPSLAND TERTIARIES, WITH OCCURRENCES BEYOND SOUTH-EASTERN AUSTRALIA.

Correlations of the marine Victorian Tertiary beds with areas beyond South-Eastern Australia can only be satisfactorily carried out with regard to the Balcombian, because of the presence in this stage of the restricted orbitoidal foraminiferal genus Lepidocyclina accompanied by Cycloclypeus. Most of the zoning of the Tertiaries in the Indo-Pacific region is based on the occurrence of certain restricted genera of the larger foraminifera. It is not possible to make comparison of horizons in which the foraminifera are chiefly long-ranging species, (as is the case in the majority of the Victorian Tertiary sediments) because such forms will persist under suitable conditions. But the presence of the restricted genus Lepidocyclina, together with Austrotrillina howchini, Marginopora vertebralis, Amphistegina and Operculina does form a basis for correlation with deposits in Western Australia, Papua, New Guinea and the Netherlands East Indies. No attempt is made to carry it to New Zealand as little is known of the sub-generic character of the Lepidocyclinae in that region.

The age of the Lepidocyclina horizon in Victoria has already been discussed. It is sufficient to state here that it is equivalent to the "f2-f3" stage of the Netherlands East Indies. Unfortunately such typical Miocene genera as Miogypsina and Flosculinella have not yet been recorded from the Victorian beds.

The genus Cycloclypeus in Victoria has been discussed by the writer (1941) who determined the species present as new, at the same time indicating that its affinities are with C.indopacificus Tan, a species also characteristic of the "f2-f3" stage. It has been shown that Austrotrillina howchini, previously considered typical of "e" stage, has its type locality in the Lepidocyclina beds at Hamilton which are Upper Middle Miocene in age. This form is associated with Marginopora vertebralis in Gippsland in the Stradbroke and Wurruk Wurruk bores in the Bairnsdale substage of the Balcombian (Upper Middle Miocene) and in the Mitchellian stage (Upper Miocene) in the Mallee bores in north-west Victoria, and in limestones at Ooldea on the Transcontinental Railway, in North-West Australia, Papua, New Guinea and the Netherlands East Indies. The genera, Amphistegina and Operculina, although found living at the present time in tropical seas, are typically Middle to Upper Miocene not only in Gippsland but elsewhere in the Indo-Pacific region. Calcarina verriculata, so abundant at Batesford, Hamilton and Flinders and rare in Gippsland, is fairly common in the friable limestones of Upper Miocene age in Papua (communication from Dr.Glaessner). Gypsina howchini has been recorded recently from Middle Miocene ("f2") limestones in North-West Australia.

Singleton has correlated the Lepidocyclina horizon in Victoria with limestones containing L.murrayana and L.verbeeki from Cape Range, North-West Australia. Unfortunately this comparison is based on erroneous specific and subgeneric determination of the Lepidocyclinae in Victoria. L.murrayana is a eulepidine and typical of stage "e" or Lower Miocene. Neither the species nor subgenus is recorded from Victoria. L.verbeeki is also absent.

He also correlates the Austrotrillina-and Flosculinella-bearing limestones of Cape Range and Rough Range with an horizon higher than the Batesford substage. These beds, which contain Tryblio-lepidina, appear to be stratigraphically equivalent to, or slightly lower than that substage.

Finlay and Marwick (1940) have suggested a correlation of the New Zealand Tertiaries with Victoria. The comparison, as in Singleton's case, is based on the subgeneric determination of the Victorian Lepidocyclina as Nephrolepidina, instead of Trybliolepidina, and until this matter is clarified it is unwise to attempt any correlation.

No attempt is made to correlate the Janjukian stage with any beds beyond South-Eastern Australia. As regards the Kalimnan and Balcombian faunal assemblages, the Gippsland or the Victorian forms in general show few affinities with outside areas except those of South Australia. The Western Australian assemblage is decidedly Indo-Pacific, the majority of the molluscan species being identical with those recorded from elsewhere in that region. The same applies to the foraminifera of Miocene and Eocene age in Western Australia.

As regards New Zealand, some of the foraminiferal species recorded from the Kalimnan of Gippsland are present in similar deposits in that country. Finlay and Marwick quote Rectobolivina striatula Cushman, which they record from the Uppermost Miocene "a horizon doubtfully recognised in Australia". This species is recorded from the Mitchellian (Upper Miocene) as well as the overlying Kalimnan.

No further correlation of the Victorian Tertiaries with the zones of the Indo-Pacific region can be attempted because of the absence of many of the larger zonal foraminifera from Victoria.

10. REMARKS ON THE DISTRIBUTION OF FOSSIL SPECIES IN GIPPSLAND.

The appended comprehensive list of fossils from Gippsland has been compiled entirely from material accumulated in the Commonwealth Palaeontological Collection at Canberra. The list contains 1,280 fossils, including 405 foraminifera, 307 bryozoa, 402 mollusca and 72 ostracoda. The investigation of surface and subsurface samples has involved the handling and determination of thousands of specimens, and prior to the compilation of this list, many of the early determinations have been checked and the nomenclature partially revised. The foraminifera, sponges, corals, worms, echinoids, bryozoa, brachiopoda, mollusca, ostracoda and fish remains have been exhaustively examined. The distribution of foraminiferal species shows that certain assemblages are characteristic of certain stages. Actual restricted species are few, although several have a limited range. No restricted form has as yet been found in the Anglesean stage. Certain species which have their earliest record in that stage, range through the Janjukian up to the Mitchellian, whilst others pass through the Kalimnan and are found living in recent seas. Amongst those with a short, restricted range is Vaginulina gippslandica, which is not recorded above the Janjukian. Those with a longer range include Hofkerina semiornata, Eponides scabriculus and Cyclammina incisa, which are not found above the Batesford substage of the Balcombian; Cassidulinoides chapmani, Amphistegina lessonii and Operculina victoriensis, which do not appear above the basal portion of the Bairnsdale substage; Cibicides victoriensis, C. sp.1, and Pulvinulinella tenuimarginata which range through to the basal Mitchellian. These forms, which range through the Balcombian, form an assemblage characteristic of that stage.

Species restricted to the Janjukian are Ammolagena clavata, Glomospira charoides, Hyperammina sp., Hormosina sp. and Victoriella plecte. The general assemblage includes numerous polymorphinidae, many species ranging through to the Balcombian, short ranging species as Lamarckina glencoensis and Massilina torquayensis, which disappear early in the Longford substage of the Balcombian, Sigmomorphina chapmani, Spirillina limbata var. tuberculolimbata and S. pectinimarginata which are found as high as the Batesford substage, and Guttulina (Sigmoidina) silvestrii and Tubulogenerina mooraboolensis which range up to the Bairnsdale substage and Cerobertina dehiscens and Lenticulina sp.1 are recorded up to the basal Mitchellian.

The Janjukian assemblage includes numerous polymorphinidae. In the Balcombian, certain species are restricted not only to the stage, but to definite substages within it. Sherbonina atkinsoni has not been recorded out of the Longford substage, while Lepidocyclina (Tryblioclepidina) batesfordensis, L. (T.) gippslandica, L. (T.) howchini, Cycloclypeus victoriensis var. gippslandica, Austrotrillina howchini and Sherbonina sp.nov., are restricted to the Batesford substage.

Species not restricted to a substage but definitely of zonal importance in the Balcombian are Calcarina verriculata, Gypsina howchini, Planorbulinella inaequilateralis and P. plana which are found only in the Longford and Batesford substages; Carpenteria proteiformis, Vaginulina sp. cf. linearis, from the Longford to the Bairnsdale; Crespinella umbonifera and Reussella ensiformis from the Batesford to the Bairnsdale and Frondicularia lorifera and Discorbis tuberculata var. australiense to the Mitchellian stage. Species which

range from the top of the Balcombian, i.e. from the Bairnsdale substage to the Mitchellian, include Gaudryina (Siphogaudryina) victoriana, Bolivina sp.nov., Marginopora vertebralis, Pavonina flabelliformis and P. triformis. Anomalina sp.(1) is typical of the Mitchellian but ranges from the top of the Bairnsdale to basal Kalimnan. Several typical Kalimnan species make their first appearance in the Mitchellian. Restricted Kalimnan species include Flintina intermedia.

Amongst the other groups of fossils, the sponges Bactronella australis and B.parvula are restricted to the Balcombian. Spicules of Ecionema newberyi are common in this stage and in the Janjukian. The maximum development is in the Longford substage especially in Sector III. Although corals are fairly widely distributed, they are scarce in the bores and in Gippsland generally. Only one specimen, referable to Conosmilia, is recorded from the Anglesean. Fourteen species are listed from the Janjukian, some ranging to the Balcombian and even to the Kalimnan. The worm Ditrupa cornea var.wormbetiensis is recorded from the Janjukian to Kalimnan with a maximum development in the Bairnsdale substage and Mitchellian. The majority of species of echinodermata occur in the Balcombian. Lovenia forbesi is restricted to the stage. Clypeaster gippslandicus is found only in the top of the Balcombian (the Bairnsdale) and in the Mitchellian. Amongst the cidaroids, Goniocidaris pentaspinosa ranges from Janjukian to Balcombian, G.prunispinosa to the Mitchellian, and Phyllacanthus duncani and Steriocidaris australiae from Balcombian to Kalimnan.

The majority of species of bryozoa make their first appearance in the Longford substage of the Balcombian with a few ranging from the Anglesean up to the Mitchellian and with some persisting to the Kalimnan. No species are restricted to the Kalimnan but a distinct assemblage is present. Aspidostoma airensis is not recorded above the Janjukian whilst Trigonopora vermicularis is apparently restricted to that stage.

Brachiopoda are common only in certain localities. The majority of species are restricted to the Balcombian. The exceptions include Stethothyris insolita and Murravia catinuliformis which range from the Janjukian to Kalimnan.

Mollusca are characteristic of certain stages and Sectors in Gippsland. The greatest and most persistent development is in the Kalimnan stage in all sectors. In Sectors I and II, they are common in the Mitchellian stage and Bairnsdale substage of the Balcombian, with an extensive assemblage in the Batesford substage in Sector II, but their specific determination in the Janjukian is often prevented by the crushed condition of specimens. One of the most interesting families is the Polyplacophora. Four species are recorded from various horizons, including two recently described by Ashby and Cotton from Hamilton, Western Victoria. A result of the intensive study of bore cores and latterly of material from the Kalimnan stage in the Lakes Entrance Shaft, is the discovery that several molluscan species, previously considered as restricted to the Balcombian stage range through to the Kalimnan. This fact is not surprising for it is only by such investigations of complete stratigraphic sections that the true range of species can be proved.

The occurrence of mollusca can be divided into 4 groups:- (1) those which are characteristic of the Kalimnan, with some forms ranging from the top of the Mitchellian with a few from the Balcombian, (2) those restricted to the Balcombian and Mitchellian, (3) those which range from the Janjukian to the Mitchellian or the top of the Balcombian, (4) those restricted to the Janjukian, with a few forms in the Anglesean. It is the third group which indicates the close

relationship between the Janjukian and the Balcombian. Restricted Janjukian species in Gippsland are rare.

The majority of ostracoda are long-ranging, being chiefly species described from recent seas. Species described from fossil forms and recorded from the Anglesean to the Mitchellian include Cythere sorrentae; from Janjukian to Kalimnan, Cythere caudispinosa, Cytherella subtruncata, Cytherura praemucronata and Krithe eggeri; from Balcombian to Mitchellian, Cythere flexicostata, Cytheropteron batesfordiense, while Bythocythere keblei is restricted to the Balcombian.

The crab, Ommatocarcinus corioensis is recorded from the Balcombian (Bairnsdale substage) and Mitchellian. Fish teeth are not common, the best specimens being present in the Anglesean sands at the base of two bores in Sector I.

11. SUMMARY.

1. The stratigraphic sequence from the Kalimnan (Lower Pliocene) down to the Anglesean (Middle Miocene) of the Tertiary marine rocks in Gippsland has been proved by the palaeontological investigation of cores from 71 bores, involving more than 92,000 feet of drilling, and of numerous surface sections.

2. The eastern boundary of the marine Tertiary basin in Gippsland is in the vicinity of Orbost on the Snowy River, where the river cliffs consist of ferruginous, shelly limestones referable to the Bairnsdale substage. Similar cliffs along the Tambo, Nicholson and Mitchell Rivers and belonging to the Bairnsdale and Batesford substages mark the northern boundary. The western margin of the area under investigation, is found in bores in the Phs. Stratford and Bundalaguah in Sector II, and in the Phs. Coolungoolun, Glencoe, Stradbroke and Woodside in Sector III. The Ninety Mile Beach marks the southern limit.

3. For convenience the basin has been divided into four sectors, which are based on differences in palaeontological and lithological characters. The sectors are -

I. Lakes Entrance (Fig.4).
II. Providence Ponds (Fig.5).
III. Merriman's Creek (Fig.6).
IV. Ninety Mile Beach (Fig.7).

4. Felspathic mudstones referable to the Jurassic Series form the basement rock of bores in Sectors II, and IV and granite and metamorphic rocks of Palaeozoic age in Sector I. No bores examined in Sector III reached bedrock.

5. The Anglesean stage is represented by lignitiferous sands and brown coals (referred to as the Yallourn Formation) which occur extensively in bores in Sectors II, III and IV, and by a thin bed of

sands and sandstones, sometimes containing fish teeth, in Sector I. The stage is recorded near the surface just beyond the western boundary of Sectors II and III and at a depth of 3,186 feet in Holland's Landing Bore in Sector IV, which is adjacent to the Ninety Mile Beach. Foraminifera are common in the sands, many species recorded becoming of zonal value in the overlying Janjukian marls and Balcombian bryozoal marls and limestones. Thick bands of brown coal are present in bores in Sector IV, 90 feet being recorded in the Lake Kakydra Bore and 60 feet in the Sperm Whale Head Bore.

6. The Janjukian stage is represented only in bores and contains two lithological units.

(a) Glauconitic sandstone is present at the base of the Janjukian in all sectors. There is little variation in its character in Sectors II, III and IV, but in Sector I, it is shelly and is oil-bearing over an area of about 4 square miles in the vicinity of Lakes Entrance.

(b) Fossiliferous marls overlie the glauconitic sandstone. In Sector I they are richly micaceous and shelly; in Sectors II and III they are slightly micaceous and contain few shells but many foraminifera and in Sector IV they are fine-grained and contain foraminifera. The mica content decreases as the distance from the palaeozoic basement rocks, which form the northern boundary of Sector I, increases. The foraminiferal assemblage is characteristic in all bores, typical species being Ammodiscus sp., Cyclammina incisa, Vaginulina gippslandica, Victoriella plecte and Lamarckina glencoensis. Molluscan species present are typical of the overlying Balcombian stage.

7. The Balcombian stage in Gippsland is represented in all sectors by bryozoal limestones, marls and marly limestones. Extensive shelly, limestone cliffs form the northern and eastern boundaries to Sectors I and II. Three substages are present.

(a) The Longford substage is the name given to the series of sediments which overlie the Janjukian stage and underlie the Batesford substage of the Balcombian in all sub-surface sections. Dowd's Quarry, Ph. Coolumgoolum (Sector III) is designated as the type section. The lithology of the sediments is chiefly bryozoal marls and marly limestones, containing numerous foraminifera but few mollusca. Many foraminiferal species become of zonal importance in the overlying Batesford substage. The majority of the Balcombian bryozoal forms make their earliest appearance.

(b) The Batesford substage is represented in bores in all sectors and in surface sections in Sectors I, II and III, by the zone of Lepidocyclina (Tryblio1epidina) gippslandica, which is associated with a characteristic foraminiferal assemblage. The sediments consist chiefly of bryozoal, marly limestones with an argillaceous facies occurring at Skinner's Section (Sector II), in which foraminifera including Lepidocyclina, Cycloclypeus and Austrotrillina are associated with corals, bryozoa and numerous mollusca of typical Balcombian species. Two zonules are apparent, an upper one or zonule of Hofkerina semiornata with its type section at McColl's Quarry, Ph. Glencoe,

and a lower one or zonule of Cycloclypeus victoriensis var. gippslandica, with its type section at Brock's Quarry in the same parish.

(c) The Bairnsdale substage has its type locality at Pound Swamp, Bairnsdale. It is represented in surface and subsurface sections by friable, bryozoal limestones and hard, ochreous, shelly limestones containing Clypeaster gippslandicus, Hinnites corioensis and Serripecten yahliensis in the upper beds. Cliff sections containing these fossils occur near Orbost and form the eastern limit of Tertiary marine deposits in Victoria. Similar cliffs along the Princes Highway west of Orbost, and the Tambo, Nicholson and Mitchell Rivers mark the northern boundary. Fossils other than foraminifera, which are common, and bryozoa which are abundant, are not numerous in bores. Ditrupa tubes are very abundant in certain bores in Sector III.

8. The Mitchellian is a new stage name instituted for the passage beds between the Balcombian and Kalimnan, which occur in all bores, in which the Kalimnan-Balcombian sequence is present, and in a few outcrops. The section at the Water Trust Excavation near Bairnsdale is taken as the type locality. The lithology in bores in Sectors I, III and IV, is grey, bryozoal marl, frequently moderately hard, with molluscan shell remains (chiefly Kalimnan species) appearing as whitish casts and moulds. The bryozoal species are typically Balcombian with a few Kalimnan forms in the upper portion of the stage. The foraminifera and mollusca exhibit an admixture of Balcombian and Kalimnan species. In Sector II an argillaceous facies is present in bores, in which numerous foraminifera, bryozoa and small well-preserved mollusca of both Balcombian and Kalimnan species are intermingled.

9. The Kalimnan stage, with its type locality at Jemmy's Point, Lakes Entrance, is represented by friable, shelly sandstones, which are well developed in surface and subsurface sections in the eastern portion of the Gippsland basin (Sector I), but which are absent in bores on the western boundary of Sectors II and III. Two zones have been determined.

(a) The upper zone or zone of Nonion victoriense is restricted to the Lakes Entrance area (Sector I) where it is represented by a rich molluscan assemblage of large specimens but of few species, in a coarse friable sandstone. The main outcrop is at the top of the Jemmy's Point section.

(b) The lower zone or zone of Planulina kalimnensis is represented in the basal portion of the Jemmy's Point section, in outcrops chiefly along the northern shore of Lake King (Reeve's Channel) extending east as far as Lake Tyers, and in numerous bore sections. Species are much more numerous than in the upper zone, while specimens in bores are small in size.

10. Almost the entire surface of the area is covered with sands and gravels of Post Kalimnan age, 500 feet being recorded in No.2 Bore, Ph.Nuntin, (Lake Kakydra).

11. A considerable thickening of Miocene sediments is shown in the central portion of the basin, south from the Mitchell River, 3,312 feet being recorded in No.1 Bore, Ph.Bengworden South (Holland's Landing) at the western end of Lake Victoria.

12. The proximity to the surface of Anglesean sands in No.6 Bore, Ph.Glencoe and in No.1 Bore to the west and in others still further west with the flanking of these sands on the north and south sides by Balcombian and Kalimnan beds, indicates the presence of an anticlinal axis which is referred to as the "Baragwanath Anticline". There is a sudden deepening of the marine Tertiary basin in an easterly direction from No.6 Bore, as shown in the Lake Wellington Bore, 4 miles to the east, where Anglesean sands were encountered at 1,250 feet and in the Tanjil-Point Addis No.2 Bore, Ph.Glencoe South, 3½ miles to the south-east at 1303 feet.

13. The presence of a fault or monoclinal structure is indicated between bores Nos.2 and 5, Ph.Glencoe which lie 12½ chains apart. The Batesford substage in the former which is the more northerly is recorded from 90 feet down to 947 feet (base of bore) and in No.5 Bore from 30 to 90 feet, the Anglesean sands being met at 520 feet.

14. The synclinal structure of the basin is shown by bores which were put down in an area adjacent to the Ninety Mile Beach from No.4 Bore, Ph.Darriman on the south-west to No.1 Bore, Ph.Boole Poole (Sperm Whale Head) to the south-east with the greatest thickening in Holland's Landing Bore in the central portion.

15. Evidence is also available from boring records that the deposition of sediments in the Lakes Entrance Sector took place in a synclinal basin.

16. Palaeontological evidence indicates that no marine sediments older than Miocene (most probably Middle Miocene) are present in the Gippsland Tertiaries. The upper Middle Miocene age of the Lepidocyclina horizon is based on the presence of the subgenus Tryblio-lepidina, the absence of Nephrolepidina, and the affinity of the species of Cycloclypeus with those of the Netherlands East Indies in the "f2-f3" stage. No zonal fossils (i.e. zonal for long distance correlation) other than Lepidocyclina are available below that horizon to indicate that the beds are older than Middle Miocene. The persistence of foraminiferal and bryozoal species in Gippsland, from the Anglesean stage, up to the top of the Balcombian stage and frequently to the lower Mitchellian, further supports this view.

17. Exhaustive faunal distribution lists, including 1,280 fossils have been compiled from the area. Distinct assemblages have been proved for the various stages.

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14. DISTRIBUTION CHART OF FOSSILS.

A comprehensive list of fossils with their distribution in various stages now follows. The chart originally prepared for inclusion in this work, showed their distribution in all sectors, but owing to the mode of presentation which it is necessary to use at the moment, this has to be deleted. It is hoped that it will be presented in its original form at a later date.

In indicating the occurrence of fossils in the stages and substages, the use of symbols has been restricted to "x", with "o" for the "very rare" presence of certain foraminifera.

Abbreviations used to indicate the stages and substages are as follows:- Kl - Kalimnan; Mn - Mitchellian; Bal - Balcombian; Jn - Janjukian; An - Anglesean; Br - Bairnsdale; Bs - Batesford; Lg - Longford.

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Acervulina inhaerens Schultze		..	x	x	x	x		
Ammobaculites agglutinans (d'Orb.)		..	..	..	..	..	..	x
Ammobaculites reophaciformis Cush.		x	x	x				
Ammobaculites sp.1		x						
Ammodiscus incertus d'Orb.		..	..	..	x	x	x	x
Ammodiscus sp.1		...	..	..	..	x	x	x
Ammolagena clavata (P.& J.)		..	..	..	..	..	x	
Ammosphaeroidina sphaeroidiniformis (Brady)		x	x	x	..	x	x	
Amphistegina lessonii d'Orb.		..	..	x	x	x	x	x
Anomalina ammonoides Reuss		x	..	x	x	x	x	x
Anomalina glabrata Cush.		x	x	x	x	x	x	x
Anomalina nonionoides Parr		x	x	x	x	x	x	x
Anomalina sp.1		x	x	x				
Astrononion australe Cush.& Edwards		x	x	x	x	x	x	x
Austrotrillina howchini (Schl.)		..	..	..	x			
Bdelloidina aggregata Carter		..	..	x	x	x	x	x
Bolivina alata (Seg.)		x	x					
Bolivina amygdalaeformis Brady		x	..	x	..	..	..	x
Bolivina beyrichi Reuss		x						
Bolivina dilatata Reuss		x	x	x	x	..	x	
Bolivina aff.dilatata Reuss		..	x					
Bolivina limbata Brady		x	x	x	x	x	x	x
Bolivina aff.limbata Brady		..	x	x	x	x	x	
Bolivina lobata Brady		x	..	..	x			
Bolivina aff.lobata Brady		..	..	..	x			
Bolivina nobilis Hantken		x	x	x	..	..	..	x
Bolivina punctata d'Orb.		x	x	x	..	..	..	x
Bolivina reticulata Hantken		..	..	..	..	..	x	
Bolivina robusta Brady		x	x	x	x	x	x	x
Bolivina sublobata Cush.		..	..	..	x			
Bolivina textularioides Reuss		x	x	x	x	..	x	
Bolivina victoriana Cushman		..	..	x	x	x	x	
Bolivina sp.nov. 1		..	x	x				
Bolivinella folia (P.& J.)		x						
Bolivinita quadrilatera (Schw.)		..	x					
Bulimina aculeata d'Orb.		x						
Bulimina affinis d'Orb.		x						
Bulimina buchiana d'Orb.		..	..	..	..	..	x	
Bulimina echinata d'Orb.		x	x					
Bulimina elegans d'Orb.		x	x	x				
Bulimina inflata Seg.		..	x	..	..	..	x	
Bulimina ovata d'Orb.		x	..	..	..	..	x	
Bulimina pupoides d'Orb.		..	x	..	..	..	x	x
Bulimina pupula Stache		..	..	..	..	..	x	x
Bulimina pyrula d'Orb.		..	..	..	..	..	x	x
Bulimina apiculata (Chapman)		x	x	x	x	x	x	x
Buliminella elegantissima (d'Orb.)		x	x	x	x	..	x	x
Calcarina verriculata Parr		..	..	..	x	x		
Cancris auricula (F.& M.)		x	x	x	x	x	x	x
Cancris hauerii d'Orb.		x	x	x	..	..	x	
Cancris hauerii var.australis Cush. & Harris		x	x	x	x	..	x	
Cancris philippinensis Cush.		x	x	x				
Carpenteria alternata Chap.& Crosp.		..	..	x	x	x	..	x
Carpenteria proteiformis Goes.		..	..	x	x	x		
Carpenteria rotaliformis Chap.& Crosp.		..	x	x	x	x	x	x
Cassidulina calabra Seg.		..	..	..	..	..	x	
Cassidulina laevigata d'Orb.		..	..	x	x	x	x	

FOSSIL	Stage	Kl	Hn	Bal			Jn	An
	Substage			Br	Bs	Lg		
Cassidulina subglobosa Brady		x	x	x	x	x	x	x
Cassidulinoides chapmani Parr		..	..	x	x	x	x	x
Ceratobulimina contraria (Reuss) ...		..	..	..	..	..	x	
Cerobertina dehiscens (H.A.& E.) ...		..	x	..	x	x	x	
Chilostomella ovoidea Reuss		..	x	x	x	..	x	
Chrysalidinella sp.		..	..	..	x			
Cibicidella variabilis (d'Orb.)		x	x	x	x	x	x	x
Cibicides lobatulus (W.& J.)		x	x	x	x	x	x	x
Cibicides cf.pseudoungerianus (Cush.)		x	..	..	..	..	..	x
Cibicides refulgens (Montf.)		x	x	x	x	..	x	x
Cibicides ungerianus (d'Orb.)		x	x	x	x	x	x	x
Cibicides victoriensis Chap.,Parr & Coll.		..	x	x	x	x	x	x
Cibicides sp. 1.....		..	x	x	x	x	x	x
Cibicides sp. 2.		..	..	x	x	x	x	x
Clavulina antipodum Stache		..	x	x	..	x	x	x
Clavulina bradyi Cush.		..	x	x	..	x	x	
Clavulina cylindrica Hantken		..	x	x	x	x	x	
Clavulina parisiensis d'Orb.		x	x	x	..	..	..	x
Clavulinoides difformis (Brady)		..	x	..	x	x	x	
Clavulinoides szaboi (Hantk) var. victoriensis Cush.		..	..	x	x	x	x	x
Cornuspira crassisepta Brady		..	..	x	..	x	x	
Cornuspira foliacea (Phil.)		x	x	x	x	x	x	
Cornuspira involvens Reuss		x	x	x	x	x	x	
Crespinella umbonifera (Parr)		..	..	x	x	..	x	
Crithionina sp.		..	..	..	..	..	x	
Cyclammina incisa (Stache)		..	..	..	x	x	x	x
Cyclammina longicompressa (Chap. & Cresp.		..	..	..	x	x	x	x
Cyclammina pauperata Chap.		..	..	..	..	x		
Cyclammina rotundata Chap.& Cresp. .		..	..	..	x	x	x	x
Cyclammina sp.		..	..	..	x	x	x	
Cycloclypeus victoriensis Cresp. ...		..	..	..	x			
Cycloclypeus victoriensis var. gippslandica Cresp.		..	..	..	x			
Dentalina communis d'Orb.		x	x	x	x	x	x	
Dentalina consobrina d'Orb.		x	x	x	x	x	x	x
Dentalina emaciata Reuss		x	x	x	x	x	x	x
Dentalina filiformis (d'Orb.)		x	x	..	x	..	x	x
Dentalina fissicostata (Gumbel)		x	x	x	x	x	x	
Dentalina insecta (Schw.)		x						
Dentalina japonica Cush.		..	..	..	x	..	x	
Dentalina mucronata (Neug.)		..	..	..	..	x	x	
Dentalina obliqua (Linne)		x	x	x	x	x	x	x
Dentalina soluta Reuss		x	x	x	x	x	x	x
Dentalina spirostriolata Cush.		..	..	..	x	x	x	
Dentalina sp.		..	x					
Dimorphina sp.		..	..	x	...	..	x	
Discorbis allomorphinoides (Reuss)..		x	x	x	x			
Discorbis australis Parr		x	x	x	x	..	x	
Discorbis bertheloti (d'Orb.)		..	x	...	x			
Discorbis bertheloti var.papillata Chap., Parr & Coll.		..	..	..	x			
Discorbis concinna (Brady)		x	..	x				
Discorbis dimidiata (P.& J.)		x						
Discorbis globularis (d'Orb.)		..	..	x	...	..	x	
Discorbis opercularis (d'Orb.)		x	x	x				
Discorbis orbicularis (Terq.)		x	x	x	x	..	x	
Discorbis patelliformis (Brady)		..	x	x	..	x		

FOSSILS	Stage	Kl	Mm	Bal			Jm	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Discorbis patelliformis (Brady) spinose var.		..	..	x				
Discorbis pileolus (d'Orb.)		..	..	..	..	..	..	x
Discorbis rarescens (Brady)		x						
Discrobis tuberculata (B.& W.) var. australiensis C.P.& C.		..	x	..	x			
Discorbis turbo (d'Orb.)		x	..	x	x	x		
Dorothia bradyana Cush.		..	..	x	..	..	x	
Dorothia gibbosa (d'Orb.)		x	x	x	x	x	x	x
Dorothia parri Cush.		..	..	x	x	x	x	x
Eggerella bradyi (Cush.)		..	x	..	..	..	x	x
Ehrenbergina serrata Reuss		..	x	x	x	x	x	x
Elphidium chapmani Cush.		x	x	x	x	x	..	x
Elphidium crassatum Cush.		x	x	x	x	..	x	x
Elphidium craticulatum (F.& M.)		x	..	x				
Elphidium crespinae Cush.		x	x	x	x	x	x	x
Elphidium crispum (Linne)		x	x	x				
Elphidium aff.hispidulum Cush.		..	..	x	x			
Elphidium howchini Cush.		..	x	x	x	x	x	x
Elphidium imperatrix (Brady)		x	x	x				
Elphidium parri Cush.		x	x	x	x	x		
Elphidium pseudoinflatum Cush.		..	x	x	x	x	x	x
Elphidium pseudonodosum Cush.		x	x	x				
Elphidium subnodosum Cush.		x	..	x				
Elphidium verriculatum (Brady)		x						
Epistomina elegans (d'Orb.)		x	x	x	x	x	x	x
Eponides concentricus (P.& J.)		x	x	x	x	x	x	x
Eponides repandus (F.& M.)		x	x	x	x	x	x	x
Eponides scabriculus (Chap.)		..	..	..	x	x	x	x
Flintina intermedia (Howchin)		x						
Frondicularia compta Brady		..	..	..	x			
Frondicularia inaequalis Costa		..	..	..	x			
Frondicularia lorifera Chap.		..	x	x	x	x		
Frondicularia robusta Brady		..	..	..	..	..	x	
Frondicularia sp. 1		..	..	x	x			
Gaudryina bradyi Cush.		..	x	x	x			
Gaudryina collinsi Cush.		..	x	x	x	x		
Gaudryina flintii Cush.		..	x					
Gaudryina rugosa d'Orb.		x	x	x	x	x	x	x
Gaudryina (Pseudogaudryina)crespinae Cush.		..	x	x	x	x	x	x
Gaudryina (Pseudogaudryina)hastata Parr		x	x					
Gaudryina (Siphogaudryina)victoriana Cush.		..	x	..	x	x		
Glandulina kalimnensis Parr		x						
Glandulina laevigata Reuss		x	x	x	x	x	x	x
Globigerina bulloides d'Orb.		x	x	x	x	x	x	x
Globigerina conglomerata Schw.		..	x	..	x	x		
Globigerina subcretacea Chap.		..	..	..	x			
Globigerinella aequilateralis(Brady)		..	..	..	x			
Globigerinoides conglobatus (Brady)		..	..	x				
Globigerinoides rubra (d'Orb.)		..	..	..	x			
Globigerinoides trilobus (Reuss)		x	x	x	x	x	x	x
Globorotalia canariensis (d'Orb.)		..	x	x	x			
Globorotalia crassa (d'Orb.)		..	x	..	..	..	..	x
Globorotalia fimbriata (Brady)		..	..	..	x			

FOSSILS	Stage	Kl	Mn	Bal			Jm	Am
	Substage			Br	Bs	Lg		
Globorotalia scitula Brady		x	x	..	x	x	x	x
Globulina gibba (d'Orb.)		x	x	..	x	x	x	x
Globulina gibba var.globosa (Münst.)		..	..	x				
Globulina cf.rotundata (Born.)		..	..	..	..	..	x	
Glomospira charoides (P.& J.)		..	..	..	..	..	x	
Guttulina irregularis (d'Orb.)		x	x	x	x	x	x	
Guttulina lactea (W.& J.)		x	x	x	x	x	x	x
Guttulina problema (d'Orb.)		x	x	x	x	x	x	x
Guttulina regina (B.P.& J.)		x	x	x	x	x	x	x
Guttulina regina var.chapplei Parr.		x	..	x	..	..	x	
Guttulina regina var.crassicostata Parr		x	x	x				
Guttulina seguenza (Brady)		..	..	..	x			
Guttulina yabei Cush. & Ozawa		x	x	x	..	x	x	
Guttulina cf.yamazakii Cush.& Ozawa		..	x	x				
Guttulina (Sigmoidina) pacifica Cush. & Ozawa		..	..	..	..	..	x	
Guttulina (Sigmoidina) silvestrii Cush. & Ozawa		..	..	x	x	..	x	
Gypsina globulus Reuss		..	x	x	x	x	..	x
Gypsina howchini Chap.		..	..	..	x	x		
Gyrcidina soldanii (d'Orb.)		x	x	x	x	x	x	x
Haplophragmoides sp.		..	..	..	..	..	..	x
Heronallenia lingulata (B.& H.)		x	x	x	x	x	x	x
Heronallenia wilsoni (H.A.& E.)		x	..	x	x	x	x	
Hofkerina semiornata (Howchin)		..	..	..	x	x	x	x
Hormosina sp.		..	..	..	..	..	o	
Hyperammina sp.		..	..	..	..	..	x	
Karrerielia barbati Cush.		..	..	..	..	..	x	x
Lagena acuticosta Reuss		x	x	x	..	x	x	
Lagena apiculata (Reuss)		..	x	x	..	x	x	
Lagena aspera Reuss		..	x	..	..	..	x	
Lagena clathrata Brady		..	..	..	x			
Lagena clavata (d'Orb.)		..	..	..	..	..	x	
Lagena cronata P.& J.		x	x					
Lagena distoma P.& J.		x	x					
Lagena favosopunctata Brady		x	x	x	x	x	x	x
Lagena cf.formosa Schw.		x						
Lagena globosa (Montf.)		x	..	x	x	..	x	x
Lagena gracilis Willm.		x						
Lagena gracillima (Seg.)		x	x	x	..	x	x	
Lagena hexagona Willm.		x	x	x	x	x	x	x
Lagena hispida Reuss		..	x	x	x	..	x	
Lagena lacunata B.& H.		..	x					
Lagena laevis (Montf.)		x	x	x	x	x	x	x
Lagena marginata (W.& B.)		x	x	x	x	x	x	x
Lagena orbignyana (Seg.)		x	x	x	x	x	x	x
Lagena perlucida (Montf.)		x	..	..	x			
Lagena plumigera Brady		..	..	..	x	..	..	x
Lagena quadrata Willm. var. rizzae Seg.		..	..	..	x			
Lagena semistriata Willm.		x	..	x	x			
Lagena squamosa (Montg.)		x	..	..	..	x		
Lagena striata (d'Orb.)		x	x	x	x	x	x	x
Lagena sulcata (W.& B.)		x	x	x	x	x	x	
Lagena sulcata var.interrupta Willm.		..	..	..	..	..	..	o
Lamarckina glencoensis Chap.& Cresp.		..	..	..	..	x	x	
Lenticulina articulata (Reuss)		x	..	x	x	x	x	x

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Lenticulina calcar (Linne)		x	x	x	x	x	x	
Lenticulina convergens (Born.)		..	..	..	..	..	x	
Lenticulina costata (F.& M.)		x	x	x	x	x		
Lenticulina costata var.multicosta (Cush.)		x	x	x				
Lenticulina crassa (d'Orb.)		x	..	x	x			
Lenticulina crepidula (F.& M.)		x	x	x	x	x	x	
Lenticulina cultrata (Montf.)		x	x	x	x	x	x	x
Lenticulina denticulifera (Cush.)		x						
Lenticulina gemmata (Brady)		..	..	..	x			
Lenticulina gibba (d'Orb.)		x	x	x	x	x	x	x
Lenticulina gyroscalprum (Stache)		..	..	..	..	x	x	x
Lenticulina lata (Cornuel)		..	x	x	..	x	x	
Lenticulina mamilligera (Karrer)		..	..	..	x	..	x	
Lenticulina orbicularis (d'Orb.)		x	x	x	x	x	x	x
Lenticulina papillosa (F.& M.)		..	..	..	x			
Lenticulina pseudorotulata Asano		x	x	x	x	x	x	x
Lenticulina reniformis (d'Orb.)		..	..	..	..	..	x	
Lenticulina rotulata (Lam.)		x	x	x	x	x	x	x
Lenticulina schloenbachi (Reuss)		x	..	..	..	..	x	
Lenticulina tenuis (Born.)		x	..	..	..	..	..	x
Lenticulina vortex (F.& M.)		..	x	x	x	..	x	x
Lenticulina sp. 1		..	x	x	x	x	x	x
Lepidocyclina (Trybliolepidina) batesfordensis Cresp.		..	..	..	x			
Lepidocyclina (Trybliolepidina) gippslandica Cresp.		..	..	..	x			
Lepidocyclina(Trybliolepidina) howchini Chap. & Cresp.		..	..	..	x			
Lingulina carinata d'Orb.		..	..	x	x	x	x	
Lingulina costata d'Orb.		..	..	x	x			
Lingulina grandis Cush.		..	..	x	x			
Lingulina metungensis Chap.& Cresp.		..	x	x	x	x	x	x
Lingulina seminuda Hantk.		..	..	x	x			
Listerella communis (d'Orb.)		x	x	x	x	x	x	x
Listerella howchini Cush.		..	x					
Listerella victoriensis Cush.		..	..	x	..	x	x	
Listerella sp.nov.		..	x					
Marginopora vertebralis (Q.& G.)		..	x	x				
Marginulina asprocostulata Stache		..	..	..	..	..	x	x
Marginulina costata (Batsch)		..	..	x	x	x	x	
Marginulina glabra d'Orb.		x	x	x	x	x	x	x
Marssonella trochus (Brady)		..	..	..	x	..	x	x
Massilina cultrata (Brady)		x	x	x				
Massilina lapidigera Parr		x	x	x				
Massilina torquayensis Chap.		..	..	..	..	x	x	
Miniacina minuta (Chap.)		..	..	..	x			
Nodosaria comata (Batsch)		..	..	x				
Nodosaria costulata Reuss		x	x	x	x	x	x	
Nodosaria pyrula d'Orb.		..	x	..	x	x		
Nodosaria radicula (Linne)		..	..	..	x	x	x	
Nodosaria raphanus (Linne)		..	x	..	x	x	x	
Nodosaria simplex Silv.		..	..	..	..	..	x	
Nodosaria vertebralis (Batsch)		x	x	x	x	x	x	x
Nodosaria sp. 1.		x	x	x	x	x		
Nonion depressulum (W.& J.)		x						
Nonion pompilioides (F.& M.)		x	..	x	x			
Nonion victoriense Cush.		x	x	x				

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Lenticulina calcar (Linne)		x	x	x	x	x	x	
Lenticulina convergens (Born.)		..	..	..	..	..	x	
Lenticulina costata (F.& M.)		x	x	x	x	x		
Lenticulina costata var.multicosta (Cush.)		x	x	x				
Lenticulina crassa (d'Orb.)		x	..	x	x			
Lenticulina crepidula (F.& M.)		x	x	x	x	x	x	
Lenticulina cultrata (Montf.)		x	x	x	x	x	x	x
Lenticulina denticulifera (Cush.)		x						
Lenticulina gemmata (Brady)		..	..	..	x			
Lenticulina gibba (d'Orb.)		x	x	x	x	x	x	x
Lenticulina gyroscalprum (Stache)		..	..	..	..	x	x	x
Lenticulina lata (Cornuel)		..	x	x	..	x	x	
Lenticulina mamilligera (Karrer)		..	..	..	x	..	x	
Lenticulina orbicularis (d'Orb.)		x	x	x	x	x	x	x
Lenticulina papillosa (F.& M.)		..	..	..	x			
Lenticulina pseudorotulata Asano		x	x	x	x	x	x	x
Lenticulina reniformis (d'Orb.)		..	..	..	..	..	x	
Lenticulina rotulata (Lam.)		x	x	x	x	x	x	x
Lenticulina schloenbachi (Reuss)		x	..	..	..	..	x	
Lenticulina tenuis (Born.)		x	..	..	..	..	..	x
Lenticulina vortex (F.& M.)		..	x	x	x	..	x	x
Lenticulina sp. 1		..	x	x	x	x	x	x
Lepidocyclina (Trybliolepidina) batesfordensis Cresp.		..	..	..	x			
Lepidocyclina (Trybliolepidina) gippslandica Cresp.		..	..	..	x			
Lepidocyclina(Trybliolepidina) howchini Chap. & Cresp.		..	..	..	x			
Lingulina carinata d'Orb.		..	..	x	x	x	x	
Lingulina costata d'Orb.		..	..	x	x			
Lingulina grandis Cush.		..	..	x	x			
Lingulina metungensis Chap.& Cresp.		..	x	x	x	x	x	x
Lingulina seminuda Hantk.		..	..	x	x			
Listerella communis (d'Orb.)		x	x	x	x	x	x	x
Listerella howchini Cush.		..	x					
Listerella victoriensis Cush.		..	..	x	..	x	x	
Listerella sp.nov.		..	x					
Marginopora vertebralis (Q.& G.)		..	x	x				
Marginulina asprocostulata Stache		..	..	..	..	..	x	x
Marginulina costata (Batsch)		..	..	x	x	x	x	
Marginulina glabra d'Orb.		x	x	x	x	x	x	x
Marssonella trochus (Brady)		..	..	..	x	..	x	x
Massilina cultrata (Brady)		x	x	x				
Massilina lapidigera Parr		x	x	x				
Massilina torquayensis Chap.		..	..	..	..	x	x	
Miniacina minuta (Chap.)		..	..	..	x			
Nodosaria comata (Batsch)		..	..	x	..	..		
Nodosaria costulata Reuss		x	x	x	x	x	x	
Nodosaria pyrula d'Orb.		..	x	..	x	x		
Nodosaria radicula (Linne)		..	..	..	x	x	x	
Nodosaria raphanus (Linne)		..	x	..	x	x	x	
Nodosaria simplex Silv.		..	..	..	..	..	x	
Nodosaria vertebralis (Batsch)		x	x	x	x	x	x	x
Nodosaria sp. 1.		x	x	x	x	x		
Nonion depressulum (W.& J.)		x						
Nonion pompilioides (F.& M.)		x	..	x	x			
Nonion victoriense Cush.		x	x	x				

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Nonionella sp.		..	..	..	..	..	..	o
Notorotalia cf. clathrata (Brady)		x	x					
Notorotalia howchini (Chap., Parr & Collins)		..	x	x	x	x	x	x
Notorotalia sp. nov.		x						
Operculina victoriensis Chap. & Parr.		..	..	x	x	x	x	x
Ophthalmidium inconstans (Brady)		x	x	x	...	..	x	
Orbulina universa d'Orb.		x	x	x	x	..	x	x
Parafrondicularia helenae Chapm.		x						
Parafrondicularia sp. nov.		..	..	..	x			
Patellina corrugata Willm.		x	x	x	x	x		
Pavonina flabelliformis d'Orb.		..	x	x				
Pavonina triformis Parr		..	x	x				
Placopsilina cenomana d'Orb.		..	..	..	x	..	x	
Planispirina contraria (d'Orb.)		x	..	..	..	..	x	
Planorbulina mediterranensis d'Orb.		x	x					
Planorbulinella inaequilateralis (H.A. & E.)		..	..	..	x	x		
Planorbulinella plana (H.A. & E.)		..	..	..	x	x		
Planularia patens (Brady)		x						
Planularia tricarinella Reuss		x						
Planularia sp. 1		..	..	..	x	x	x	
Planulina ariminensis (d'Orb.)		x	...	x	..	..	x	
Planulina kalimnensis Parr		x	x	x				
Planulina wuellerstorfi (Schw.)		x	x	x	x	x	x	x
Planulina sp.		..	..	..	..	..	x	x
Planulinoides biconcavus (P. & J.)		x	x	x				
Plectofrondicularia sp. nov.		..	..	..	x			
Pleurostomella alternans Schw.		x	..	..	x			
Pseudopolymorphina doanei (Gall. & Wiss.)		x	x					
Pseudopolymorphina doanei var. beaumariensis Parr		..	..	..	x			
Pseudopolymorphina hanzawai Cush. & Ozawa		..	..	x				
Pseudopolymorphina cf. jonesi C. & O.		..	..	..	..	..	x	
Pseudopolymorphina victoriensis Parr		x						
Polystomellina miocenica Cush.		..	x	x	x	x	x	
Pullenia quinqueloba (Reuss)		x	x	x	x	x	x	x
Pullenia sphaeroides (d'Orb.)		x	..	x	x	x	x	x
Pulleniatina obliquiloculata (P. & J.)		..	..	..	..	..	..	x
Pulvinulinella tenuimarginata Chap., Parr & Coll.		..	x	x	x	x	x	x
Pyrgo anomala (Schl.)		..	..	x	x	x	x	
Pyrgo bulloides (d'Orb.)		x	x	x	..	x	x	x
Pyrgo depressa (d'Orb.)		x	x	x	x	x	x	x
Pyrgo elongata (d'Orb.)		x	x					
Pyrgo irregularis (d'Orb.)		..	x	x	..	..	x	
Pyrgo ringens (Lam.)		..	..	..	..	x		
Pyrgo vespertilio (Schl.)		x	x					
Pyrgoella sphaera (d'Orb.)		x	..	..	x	..	x	
Pyrulina cylindroides (Roemer)		..	..	x	..	..	x	
Pyrulina fusiformis (Roemer)		x	x	x	x	x	x	
Quinqueloculina agglutinans d'Orb.		..	x	x	..	..	x	
Quinqueloculina ammophila Parr		x	x	x	x			
Quinqueloculina lamarckiana (d'Orb.)		x	x	x	x	x	x	
Quinqueloculina polygona (d'Orb.)		x						

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Quihqueloculina seminulum (Linne) ...		x	x	..	..	x	..	x
Quinqueloculina venusta Karrer		..	x	x				
Quinqueloculima vulgaris d'Orb.		x	x	x	x	x	x	x
Ramulina globulifera Brady		..	..	x	x	..	x	
Rectobolivina bifrons Brady var. striatula Cush.		x	x					
Reophax sp.		x	x	x				
Reussella ensiformis (Chap.)		..	..	x	x			
Reussella spinulosa (Reuss)		..	x	x	x	x		
Robertina sp.		..	x	..	..	..	x	
Saracenaria italica (Defr.)		x	x	x	x	x	x	x
Sherbonina atkinsoni Chap.		..	..	..	..	o		
Sherbonina sp.nov.		..	..	..	x			
Sigmoidella elegantissima (P.& J.) ..		x	x	x	x	x	x	x
Sigmoidella kagaensis Cush.& Ozawa ..		..	..	x	x	x	x	
Sigmomorphina chapmani (H.A.& E.) ...		..	..	..	x	x	x	
Sigmomorphina flintii (Cush.)		..	..	..	..	..	x	
Sigmomorphina regularis (Münster)....		..	..	..	x			
Sigmomorphina cf. schwageri (Karrer)..		x	..	..	...	..	x	
Sigmomorphina subregularis Parr		..	x	x				
Sigmomorphina vaughani Cush.& Ozawa		..	..	..	x	x	x	
Sigmomorphina williamsoni (Terq.) ...		..	..	..	..	..	x	x
Sigmomorphina cf. yabei Cush.& Ozawa..		..	..	..	..	..	x	
Sigmoilina schlumbergeri (Silv.)		x	x	x	..	..	x	
Sigmoilina sigmoidea (Brady)		x	x	..	..	x	x	
Siphonina australis Cush.		x	x	x	x	x	x	x
Siphonina reticulata (Czj.)		..	..	..	..	..	x	
Siphoninoides echinatus (Brady)		..	x	x	x			
Siphonodosaria hispida (d'Orb.)		x	..	..	...	..	x	
Siphonodosaria hispida var. sublineata Brady		..	..	..	..	..	..	x
Siphonodosaria scalaris (Batsch)		x	x	x	x	x		
Siphonodosaria scalaris var. separans Brady		..	..	x	x	..	x	
Siphonodosaria subscalaris var. parvicostata Cush.		..	..	x				
Sphaeroidina bulloides d'Orb.		x	x	x	x	x	x	x
Sphaeroidina variabilis Cush.		..	..	x	..	..	x	x
Spirillina decorata Brady		..	..	x	x	x	x	
Spirillina inaequalis Brady		..	..	..	x			
Spirillina limbata Brady var. tuberculolimbata Chap.		..	..	..	x	..	x	
Spirillina pectinimarginata C.,P.& C.		..	..	..	x	x	x	
Spirillina vivipara Ehren.		..	..	..	..	x	x	
Spiroloculina affixa Terq.		x						
Spiroloculina antillarum d'Orb.		..	..	x				
Spiroloculina arenaria Brady		..	x	x				
Spiroloculina canaliculata d'Orb. ...		..	..	..	..	..	x	
Spiroloculina dispansa Chap.& Cresp.		x	x	x				
Spiroloculina linneana (d'Orb.)		..	..	..	..	x		
Spiroloculina tenuiseptata Brady		..	..	..	..	x	x	x
Streblus beccarii (Linne)		x	x					
Textularia abbreviata d'Orb.		x	x	x	..	..	x	
Textularia agglutinans d'Orb.		..	x	x	x	..	x	
Textularia carinata d'Orb.		x	x	x	x	x	x	x
Textularia concava (Karrer)		..	x					
Textularia fistulosa Brady		..	x	x	x	x	x	x

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
FORAMINIFERA								
Textularia flintii Cush.		..	..	x	..	x	x	
Textularia foliacea H.A. & E.		..	x					
Textularia gramen d'Orb.		..	..	x	..	..	x	x
Textularia sagittula Defr.		x	x	x	x	x	x	x
Textularia stricta Cush.		..	x	x	x			
Trifarina bradyi Cush.		..	..	x	x	x	x	x
Triloculina circularis Born.		..	x	..	..	..	x	
Triloculina oblonga (Montag.)		x	x	x				
Triloculina schreibersiana (d'Orb.)		x	x	x	x	x	x	x
Triloculina tricarinata d'Orb.		x	x	x	x	x	x	x
Triloculina trigonula (Lam.)		x	x	..	..	x	x	
Trochammina sp.		..	..	..	x	..	x	x
Trochamminoides sp.		..	..	..	..	..	x	
Tolypammina vagans (Brady)		..	..	..	..	..	o	
Tubulogenerina mooraboolensis Cush.		..	..	x	x	x	x	
Uvigerina ampullacea Brady		..	..	..	x	..	x	x
Uvigerina asperula (Czj.)		..	..	..	..	..	x	
Uvigerina canariensis d'Orb.		..	..	x	x	x	x	
Uvigerina interrupta Brady		..	..	..	x	x	x	
Uvigerina cf. pigmea d'Orb.		x	x	x	x	x	x	x
Uvigerina schwageri Brady		..	x	x	..	x	x	x
Uvigerina tenuistriata Reuss		x	..	x	x	x		
Vaginulina gippslandica Chap. & Crosp.		..	..	..	..	..	x	x
Vaginulina legumen (Linne)		..	..	..	x	x	x	x
Vaginulina cf. linearis (Mont.)		..	..	x	x	x		
Vaginulina vertebralis Parr		x						
Verneuilina triquetra (Münst.)		..	x	x	x	..	x	x
Victoriella plecte (Chap.)		..	..	..	..	..	x	
Virgulina pauciloculata Brady		x						
Virgulina schreibersiana Czj.		x	x					
SPONGIDA								
Bactronella australis Hinde		..	..	..	x	x		
Bactronella parvula Hinde		..	..	..	x	x		
Ecionema newberyi (McCoy)		..	..	x	x	x	x	x
ANTHOZOA								
Balanophyllia sp.		..	..	..	..	..	x	
Bistylia adherens T. Wds.		..	..	..	..	..	x	
Conocyathus scrobiculatus Denn.		x	..	x	x			
Conosmilia anomala Duncan		..	..	..	..	x	x	
Cyathosmilia liraecostata Denn.		..	..	..	..	..	x	
Cyathosmilia velata Denn.		..	..	..	..	..	x	x
Deltocyathus stellaris Denn.		..	..	..	..	..	x	
Flabellum curtum Denn.		x						
Flabellum distinctum Denn.		..	..	..	..	x	x	
Flabellum duncani T. Wds.		..	..	..	..	x	x	
Flabellum gambieriense Duncan		..	x	x	..	..	x	
Flabellum gippslandicum Denn.		x	x					
Flabellum victoriae Duncan		..	x	..	..	x	x	
Mopsea hamiltonensis Thomson		..	..	..	x	x	x	x
Mopsea tenisoni Chap.		x	x	x	x	x	x	x
Mopsea sp. (1)		x	x	x	x	x	x	

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
ANTHOZOA								
Notophyllia gracilis Denn.		x						
Notophyllia variolaris T.Wds.		x	x					
Placotrochus deltoideus T.Wds.		..	.x	..	x			
Placotrochus elongatus Duncan		..	..	x	..	..	x	
Placotrochus cf.magnus Denn.		..	..	x	x			
Sphenotrochus alatus T.Wds.		x	x	x	x			
Sphenotrochus australis Duncan		x						
Sphenotrochus emarciatus Duncan		x	x	x	..	..	x	
Trematotrochus clarkei Denn.		x	x	x	..	..	x	
Trematotrochus complanatus Denn.		..	..	..	..	..	x	
Trematotrochus fenestratus T.Wds.		x	x	..	x	x	x	
Trematotrochus kitsoni Denn.		..	..	..	x			
VERMES								
Ditrupa cornea McCoy var. wormbeticnsis Chap.		x	x	x	.x	x		
Ditrupa sp.		x	x	x	..	..	x	x
Serpula ouyenensis Chapman		..	..	..	x	x	x	
Spirorbis heliciformis Eichwald		..	..	x	x			
ECHINODERMATA								
Arachnoides incisa Tate		x						
Arachnoides (Monostychia) australis Laube		..	..	..	x			
Antedon protomaeronema Chap.		..	..	x				
Clypeaster gippslandicus McCoy		..	x	x				
Echinocyamus(Scutellina)patella Laube		..	..	..	x	x	x	
Echinocyamus sp.		..	x	..	..	..	x	
Fibularia gregata Tate		..	..	x	x			
Fibularia sp.		..	..	..	x			
Goniocidaris pentaspinosa Chap.& Cud.		..	x	x	x	x	x	
Goniocidaris prunispinosa Chap.& Cud.		..	x	x	x	x	x	
Lovenia forbesi T.Wds.		..	..	x	x	x		
Paradoxechinus novus Laube		..	..	..	x			
Phyllacanthus duncani Chap.& Cud.		x	x	x	x			
Prionocidaris sp.		..	..	..	..	..	x	
Psammechinus woodsi Laube		..	..	..	x	..	x	
Psammechinus woodsi var.humilior Bittner		..	..	x				
Steriocidaris australiae Chap.& Cud.		x	..	x	x	x		
BRYOZOA								
Acanthocella suggerens (Waters)		..	..	x	x	x		
Acanthodesia simplex (McG.)		..	x	x	x	x	..	x
Acanthodesia regularis (Mapl.)		..	..	x	x	..	x	x
Adeonellopsis clavata (Stol.)		..	x	x	x	x		
Adeonellopsis grisea (McG.)		..	x	x	x	x	x	

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
BRYOZOA								
Adeonellopsis mucronata (McG.)		..	x	x	x	..	x	
Adeonellopsis obliqua (McG.)		..	x	x	x	x	x	
Adeonellopsis symmetrica (McG.)		..	..	x	x	x	x	
Allantopora confinis Canu & Bass.		..	..	..	x			
Amphiblestrum arethusa (d'Orb.)		..	..	..	x			
Amphiblestrum concameratum Waters		..	..	..	x			
Amphiblestrum grande Canu & Bass.		..	x	..	x			
Amphiblestrum robustum Mapl.		..	x	..	x	..	x	
Amphiblestrum variabile Mapl.		..	..	x				
Arachnopusia lincaris Canu & Bass.		..	x	x	x			
Aspidostoma airensis Mapl.		..	..	..	..	..	x	x
Bathosella laticella Canu & Bass.		..	..	..	x			
Bigemellaria pedunculata McG.		..	..	x	x	x		
Bracebridgia emendata Waters		..	..	..	..	..	x	
Buffonellodes baculina Canu & Bass.		..	..	..	x			
Buffonellodes profunda (McG.)		..	x	x	x	x		
Bulbipora areolata McG.		..	..	x	x	x		
Caberea darwini Busk		..	..	x	x			
Caberea grandis Hincks		x	x	x	x	x	..	x
Caleschara denticulata (McG.)		..	x	x	x	x	x	
Caloporella speciosa McG.		..	..	..	x	x	x	
Canda fossilis Waters		..	x	..	x			
Canda inermis McG.		..	x	..	x	x		
Catenicella hastata McG.		..	..	x				
Cellaria australis McG.		x	x	x	x	x	x	x
Cellaria contigua McG.		x	x	x	x	x	x	x
Cellaria depressa Mapl.		x	x	..	x	x		
Cellaria divaricata Busk.		x	x	x	x	x		
Cellaria enormis Mapl.		..	x	x	x	x	x	x
Cellaria fistulosa Waters		x	..	..	..	x		
Cellaria gracilis Busk		..	..	x	x	x	x	x
Cellaria laticella Mapl.		..	x	..	..	x		
Cellaria rigida McG.		x	x	x	x	x	..	x
Cellaria rigida perampla Waters		x	x	x	x	x	x	x
Cellaria rigida venusta McG.		..	x	x	..	x	..	x
Cellaria robusta Mapl.		..	..	..	x	x		
Cellaria tumida Mapl.		..	x	..	x	x	x	
Cellepora biradiata Waters		..	x	x	x			
Cellepora coronopus M.Edw.		..	x	x	x	x		
Cellepora fossa (Haswell)		x	x	x	x	x	x	
Cellepora tridenticulata var. nummularia Busk		..	..	x	x	x		
Chaperia annulus (Manzoni)		..	..	x	x			
Chaperia cylindriformis (Waters)		..	x	x	x	x		
Chiastosella daedala (McG.)		..	x	x	..	x		
Chiastosella gabrieli Stach		..	x	x	x			
Chiastosella porosa Canu & Bass.		..	x	x	x	x		
Chiastosella watersi Stach		..	..	x				
Conescharellina cancellata (Busk)		..	x	x	x			
Conescharellina philippinensis (Busk)		x	x	x	x	x		
Corbulipora ornata McG.		x	..	x	x	x		
Costaticella beneccostata (Lev.)		x	x					
Costaticella latifrons (McG.)		..	x	..	..	x		
Costazia longirostris (McG.)		..	..	..	x			
Costazia producta (McG.)		..	..	x	x	x		
Craspedozoum elongatum Canu & Bass.		..	..	x	x	x		
Craspedozoum roboratum Hincks		..	..	..	x			
Crateropora patula (Waters)		..	x	x	x	x		

FOSSILS	Stage	Kl	Mm	Bal			Jm	Am
	Substage			Br	Bs	Lg		
BRYOZOA								
Cribrilaria radiata (Moll.)		..	..	..	x			
Cribrilina cornuta McG.		..	x	x	x			
Cribrilina crassicollis Canu & Bass.		..	..	x	x	x		
Cribrilina dentipora Waters		..	..	x	x			
Cribrilina elevata McG.								
Cribrilina terminata Waters		..	x	x	x	x		
Cribrilina terminata var. coronata Canu & Bass.		..	x	x	x			
Cribrilina triseriata Canu & Bass.		..	..	x	x	x		
Crisia acropora Busk		x	x	x	x	x	x	x
Crisia macrostoma McG.		..	..	..	x			
Crisia tenuis McG.		..	..	..	x			
Crisulipora sp.		..	..	x	x	x		
Cucullipora tetrasticha McG.		..	..	x	x	..	x	
Dakaria crassocirca Canu & Bass.		x	x	x	x	x		
Deontopora mooraboolensis Hall		..	x	..	x	x	x	
Diastopora discoidea McG.		..	..	x	x			
Diastopora torquata (Kirkp.)		..	..	x	..	x		
Didymosella larvalis McG.		x	x	x	x	x		
Discofascigera tubulifera McG.		..	..	x				
Ditaxipora internodia (Waters)		..	..	x	x	x		
Ellisinidra profunda (McG.)		..	..	x	..	x		
Ellisinidra pyriformis Canu & Bass.		..	x	x	x	x		
Emballotheca angustata Canu & Bass.		..	..	..	x	x		
Emballotheca mamillata (Mapl.)		..	x	x	x			
Entalophora australis Busk		..	x	x	x	x	x	
Entalophora longipora McG.		..	x	x	x	x	x	x
Entalophora punctata McG.		..	..	..	x	x		
Escharoides erectus Canu & Bass.		..	..	x	x	x	x	
Exochella grandis Canu & Bass.		..	..	..	..	x		
Exochella granulata (McG.)		..	..	x	x	x		
Fasciculipora fruticosa McG.		..	..	x				
Fenestrulina praetexta Canu & Bass.		..	..	x				
Figularia orbicula (McG.)		..	..	x	x	x	x	
Filisparsa concinna Mapl.		..	..	x	x	x	..	x
Filisparsa orakeiensis Stol.		..	..	x	x	x	..	x
Floridinella australiensis C. & B.		..	x	..	..	x		
Floridinella depressa (McG.)		..	x	x				
Frondipora palmata Busk		..	..	x	..	x		
Gephyrophora bilamellaria Canu & Bass.		x	..	x	x	x		
Gigantopora cribraria (McG.)		..	..	x	x	x	x	
Gigantopora hystrix Canu & Bass.		..	..	l.	x			
Heteropora pisiformis McG.		..	..	x	x	x		
Hiantopora liversidgei (T.Wds.)		..	x	x	x	x		
Hiantopora monoceros Busk		..	x	x	..	..	..	x
Hincksina geminata (Waters)		..	..	x	x	x	x	x
Hippomenella abdita (McG.)		..	x	x	x	x		
Hippomenella rarirostrata C. & B.		..	..	x				
Hippomenella rectilineata (McG.)		..	x	x	x			
Hippomenella rugosa (Mapl.)		..	x	x	x			
Hippoporella testu Canu & Bass.		..	..	x				
Hornera diffusa McG.		x	..	x	x	x	x	
Hornera foliacea McG.		x	x	x				
Hornera frondiculata McG.		..	x	x	x	x		

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage				Bs	Lg		
BRYOZOA								
Hornera frondiculata var. aperta McG		..	x	x	x			
Hornera promimens McG.		...	..	x				
Hornera sulcata McG.		..	..	x	x			
Hornera striata Stache		x	x	x	x	x	..	x
Hornera tuberculata McG.		x	x	x	x	x	x	x
Idmonea conferta McG.		..	..	x	x			
Idmonea contorta Busk		..	x	x	x			
Idmonea divergens McG.		..	x					
Idmonea cf. filiformis Canu & Bass.		..	..	..	..	x		
Idmonea geminata McG.		..	x	x	x	x		
Idmonea incurva McG.		..	x	x	x	x		
Idmonea lata McG.		..	..	..	..	x		
Idmonea milneana d'Orb.		x	x	x	x	x		
Idmonea semispiralis McG.		..	x	..	x	x	x	
Idmonea trigona McG.		..	x	x	x	x	..	x
Lacerna convexa McG.		..	..	x	x			
Lekythopora hystrix McG.		..	x	..	x	x		
Lepralia bairnsdalei Waters		..	x	x	x	x		
Lepralia continua McG.		..	x	x	x	x	x	
Lepralia filiformis (Waters)		..	x	x	x			
Lepralia gippslandica Waters		..	..	x				
Lepralia nodulosa McG.		..	x	x	x			
Lepralia obliqua McG.		..	..	..	..	x		
Lepralia perforata McG.		..	x	x	x			
Lepralia quadrata McG.		..	x	x	x			
Lepralia spatulata Waters		x	x	x	x	x		
Lepralia subimmersa McG.		..	x					
Lepralia vallata McG.		..	..	x	x			
Lepralia vermicularis McG.		..	x	x	x			
Lichenopora australis McG.		..	..	x	x			
Lichenopora hispida Flem.		..	..	x				
Lichenopora porosa McG.		..	..	..	x			
Lichenopora radiata Aud.		..	x	x	x	x		
Lichenopora wilsoni (McG.)		..	x	x	x	x		
Liriozoa laevigata Waters		..	..	..	x			
Liripora bicolor McG.		..	..	..	x	x		
Liripora fasciculata McG.		..	..	x				
Liripora superposita McG.		..	x					
Lunulites canaliculata McG.		x	x	x				
Lunulites parvicella T.Wds.		x	x	x	x			
Lunulites rutella T.Wds.		x						
Macropora clarkei (T.Wds.)		..	x	x	x	x	x	
Macropora crassatina (Waters)		..	..	x	x	x		
Macropora cribrilifera Mapl.		..	..	..	x			
Meeynoecia cylindrica Canu & Bass.		..	..	..	x			
Mecynoecia proboscidea (M.Edw.)		..	x	x	x	x	x	x
Melicerita acutimarginata McG.		x	x	x	x	x		
Melicerita angustiloba Busk		x	x	x	x	x	x	
Melicerita sorrentae Chap. & Cresp.		..	x	x				
Membranipora cyclostoma McG.		..	..	x				
Membranipora delicatula Busk		..	x	x	x	..	x	
Membranipora dentata Waters		x						
Membranipora depressa McG.		..	x	x	..	x		
Membranipora elliptica McG.		..	..	x	x			
Membranipora gregsoni McG.		..	..	x	..	x		
Membranipora intermedia Kirk		..	..	..	x			

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
BRYOZOA								
Membranipora macrostoma (Reuss)		..	x	x	..	x		
Membranipora marginata McG.		..	x					
Membranipora perfragilis McG.		..	..	x	x			
Membranipora porcellana Mapl.		..	..	..	x			
Membranipora sculpta McG.		..	x					
Membranipora striata McG. var.		..	..	..	x	x		
Membraniporella tenuicosta McG.		..	..	x	x	x		
Menipea alternata McG.		..	x					
Menipea lineata McG.		..	..	..	x	x		
Mesonoa hochstetteriana (Stol.)		..	x	x	x	x	..	x
Metrarabdotos moniliferum (M.Edw.) ..		..	..	x	..	x	x	x
Metroperiella transversa (McG.)		..	x	x	x	..	x	
Metroperiella sp.nov.		..	..	x				
Micropora carinata Mapl.		..	..	..	x	x		
Microporella macropora Stol.		..	..	..	..	x		
Microporella spicata McG.		..	..	x				
Mucronella apiculata McG.		..	..	..	x			
Mucronella elongata C.& B.		..	..	x	..	..	x	
Mucronella irregularis Mapl.		..	..	x	x			
Mucronella teres McG.		..	x	..	x			
Nellia oculata (Busk)		..	x	x	x	x		
Omoiosia elongata C.& B.		..	..	..	x	x	x	
Otionella cupola (T.Wds.)		x	x	x	x	x	x	
Otionella cupola var.spiralis Chap. .		..	..	..	..	..	x	
Pachystomaria parvipuncta McG.		..	..	..	x			
Palmicellaria magna C.& B.		..	..	..	x	x		
Palmicellaria quadrifrons McG.		..	..	..	x	x		
Palmicellaria uniserialis Mapl.		..	..	..	x			
Peristomella praestans (Hincks)		x	x	x				
Petraliella bi-incisa (McG.)		..	..	..	..	x		
Petraliella corrugata (Waters)		..	x	x	x	x		
Petraliella denticulata C.& B.		..	..	x				
Petraliella tractifera C.& B.		..	..	..	x			
Phylactella chapmani C.& B.		..	..	x				
Phylactella porosa McG.		..	..	..	x			
Plagioecia patina (Lam.)		..	..	x				
Plagioecia sp.		..	..	x	x			
Plagiopora disticha McG.		..	x	..	x			
Porella baculina C.& B.		..	x	x	x	x		
Porella centralis (Waters) var. laevigata Mapl.		..	..	x	x			
Porella cylindrorostris C.& B.		..	..	x				
Porella denticulata C.& B.		..	x	..	x	x		
Porella excavata C.& B.		..	..	..	x			
Porella obliqua (McG.)		..	x	x				
Porella operculata C.& B.		..	..	x	x	x	x	
Porella punctata McG.		..	..	x				
Porella rhomboidalis Mapl.		x	x	x	x	x		
Porella tuberosa C.& B.		..	x	x	x	x	x	
Porina coronata Reuss		..	x	x	x			
Porina cribraria McG.		..	..	..	x			
Porina gracilis (McG.)		x	x	x	x	x	x	x
Porina vertebralis Stol.		..	x	x	x	x	x	
Prostomaria gibbericollis McG.		..	..	x	x			
Ramphonotus lusorius (Waters)		..	..	..	..	x		
Retepora aciculifera McG.		..	..	x	x			

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
BRYOZOA								
Retepora beaniana King		x	x	x	x	x	x	x
Retepora corioensis McG.		..	..	..	x	x		
Retepora fissa McG.		..	x	x	x	x		
Retepora rimata Waters		..	..	x	x	x		
Retepora schnapperensis McG.		..	..	x	x	x		
Retepora subimmersa McG.		..	x	x	x	x		
Retepora tessellata var.benemunita Hincks		..	..	x				
Rhynchopora longirostris Hincks		x	x					
Rhynchopora bispinosa Johnston		..	x	..	..	..	x	
Schismopora granum Hincks		..	..	..	..	x		
Schizellozoon permunitum McG.		x	x	x	x	x	x	
Schizolavella phymatopora (Reuss)		..	x	x	x	x	x	
Schizomavella marginata (Mapl.)		..	..	..	x	x		
Schizomavella plagiostoma (McG.)		..	x	x	x	x		
Schizoporella alata McG.		x	x	x	x	x		
Schizoporella bombycina Waters		..	x	x	..	x		
Schizoporella burlingtonensis (Waters)		x	x	x	x	x	..	x
Schizoporella cecilii (Aud.)		..	..	x				
Schizoporella clypeata C.& B.		..	..	x				
Schizoporella graysoni (McG.)		..	x					
Schizoporella granulata McG.		..	..	..	x	x		
Schizoporella hispida Mapl.		..	..	x				
Schizoporella lata McG.		..	x					
Schizoporella nitens McG.		..	x	x				
Schizoporella orbiculifera C.& B.		..	x	x	x	x	x	
Schizoporella pustulosa C.& B.		..	x					
Schizoporella strictifissa McG.		..	..	x	x			
Schizoporella submersa Waters		..	x	..	..	..	x	
Schizoporella tenuilamellosa C.& B.		..	..	..	x			
Scrupocellaria crenulata McG.		..	x	x	x			
Scrupocellaria sp.		..	..	..	x	x		
Scuticella gippslandica Stach		..	x	x				
Scuticella lata Stach		..	x					
Scuticella marginata (Waters)		..	..	x	x	x		
Scuticella nobilis (McG.)		..	x					
Scuticella ventricosa (Busk)		..	x	..	x	x		
Scuticella urnula (McG.)		..	..	..	x			
Selenaria concinna T.Wds.		x	x	..	x			
Selenaria cribrosa Mapl.								
Selenaria maculata Busk		x	x	..	..	x	x	
Selenaria marginata T.Wds.		x	x	..	..	x		
Selenaria marginata var.lucens McG.		..	..	..	..	x		
Selenaria punctata T.Wds.		x						
Smittina bisinuata (Mapl.)		..	x	x	x			
Smittina cribraria (McG.)		..	..	x	x			
Smittina elongata McG.		x	x	x	x	x		
Smittina modesta (McG.)		..	..	x				
Smittina praeclara (McG.)		..	..	..	x			
Smittina reticulata (McG.)		..	..	x	x			
Smittina reticulata var.calceola McG.		..	x	x	x			
Smittina reticulata var.nitida McG.		..	x	x				
Smittinella magna C.& B.		..	..	..	..	x		
Smittinella porrecta (T.Wds.)		..	..	..	..	x	x	
Smittinella tatei (T.Wds.)		x	x	x	x	x	x	
Smittinella tatei var.tubulosa McG.		..	x	x	x			

FOSSILS	Stage	Kl	Mn	Bal			Jm	Am
	Substage			Br	Bs	Lg		
BRYOZOA								
Spiropora verticellata (Goldf.)		..	x	x	x	x	x	x
Spiroporina tubulifera (McG.)		..	..	..	x	x	x	
Stamenocella fusiformis C.& B.		..	..	x	x	x	x	
Steganoporella dennanti Mapl.		..	..	..	x			
Steganoporella lateralis McG.		..	..	..	x			
Steganoporella magnilabris Busk		x	x	x	x	x		
Stephanosella strictifissa (McG.) ...		..	..	..	..	x		
Strophipora harveyi (Thomp.)		..	..	x	x			
Strophipora lata McG.		..	..	x				
Tecticavea schnapperensis McG.		..	..	..	x			
Telepora(Superaytis)digitata (Waters)		..	..	x	x	x		
Tetraplaria australis T.Wds.		,,	..	x	x	x		
Tetraplaria filiformis Waters		..	..	..	x			
Thalamoporella gracilis Waters		x	x	x	x			
Thalamoporella rozieri var. longi-striata (Mapl.)		x						
Tremopora radicifera (Hincks)		..	x	x	x			
Tremopora staminis C.& B.		..	x	x	x			
Tretosina arcifera C.& B.		..	..	..	..	x		
Trigonopora vermicularis Mapl.		..	..	..	..	..	x	
Tubiporella elevata (Waters)		..	..	x	x	x		
Tubiporella magnirostris (McG.)		..	x	x	x	x	x	x
Tubucellaria cereoides Ellis & Stol.		x	x	x	x			
Tubucellaria marginata McG.		x	x	..	x			
Velumella depressa C.& B.		..	x	x	x	..	x	
Vincularia gigantea C.& B.		..	..	..	x	x		
Vittaticella enormis (Mapl.).....		..	..	..	x			
BRACHIOPODA								
Aldingia pumula (Tate)		x						
Aldingia woodsi (Tate)		..	..	x	x			
Aldingia sp.		..	..	..	x	x		
Bouchardia sp.		..	..	..	x			
Cryptopora acutirostrum (Chap.)		x	..	x	x	x		
Magadina compta (Sow.)		..	..	x	x			
Magadinella woodsiana (Tate)		..	..	x				
Magellania corioensis McCoy		..	..	..	..	..	x	
Magellania furcata (Tate)		..	..	..	x			
Magellania garibaldiana Dav.		..	..	x	x	x		
Magellania grandis T.Wds.		..	..	x				
Malleia portlandica (Chap.)		..	..	x				
Megathyris sp.nov.		..	..	..	..	x		
Murravia catinuliformis Tate		x	x	x	x	x	x	
Murravia flindersi (Chap.)		..	..	x	x	x	x	
Murravia triangularis (Tate)		..	..	x	x	x	x	
Stethothyris insolita (Tate)		x	x	x	x	x	x	
Terebratalia tateana (T.Wds.)		..	..	x	..	x		
Terebratulina suessi Hutton		..	..	x	x	x		
Thecidium australe Tate		x	..	x	x			
PELECYPODA								
Aloidis(Notocorbula)coxi (Pils.)		x	x	x				
Aloidis(Notocorbula)cphamilla (Tate)		x	x	..	..	..	x	

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
PELECYPODA								
Aloidis(Notocorbula)pyxidata (Tate)		x	..	x	x	..	x	
Anomia tatei Chap. & Singl.		x	x					
Antigona cognata (Pritch.)		x						
Antigona dennanti (Chap. & Cresp.)..		x						
Antigona dimorphophylla (Tate)		x	x	..	..	..	x	
Antigona striatissima Tate		x						
Arca(Barbatia)celleporacea (Tate) ..		x	x	x	x	x		
Arca(Barbatia)consutilis Tate		..	x	..	x			
Arca(Barbatia)crustata Tate		..	x	x	x			
Arca(Barbatia)dissimilis Tate		x	x					
Arca(Barbatia)cf.limatella Tate		x						
Arca(Barbatia)microundula Chap. & Cresp.		x	..	x	..	x		
Arca(Plagiarca)cainozoica (Tate) ...		..	..	x	..	x	x	
Bassina paucirugata (Tate)		x						
Callanaitis cainozoicus (T.Wds.) ...		..	x	x	x	..	x	
Cardita kalimnae Pritch.		x	x					
Cardita sorrentae Chap.& Cresp.		x						
Cardium sp.nov.		x						
Catelysia propinqua (T.Wds.)		x	x					
Chama lamellifera (T.Wds.)		x	..	..	x	..	x	
Chlamys antiaustralis (Tate)		x	x					
Chlamys flindersi (Tate)		..	..	x				
Chlamys foulcheri (T.Wds.)		..	..	x	x	x	x	
Chlamys cf.keiloriana Cresp.		..	x	..	..	x		
Chlamys meringae (Tate)		x	x	x				
Chlamys murrayanus Tate		..	x	x	x			
Chlamys praecursor (Chap.)		..	..	..	x	x	x	
Chlamys sturtianus (Tate)		x	x	x	..	..	x	
Clausinella allporti (T.Wds.)		x	x					
Clausinella multitaeniata (Tate) ...		x	..	x	..	..	x	
Clausinella subroborata (Tate)		x	x					
Condylocardia tenuicostata Chap. & Gab.		x						
Ctenamusium atkinsoni (John.)		..	x	x	x	x	x	
Cucullaea corioensis McCoy		x	x	x	x	x	x	
Cucullaea corioensis var.praelonga Singl.		x	x					
Cuna concentrica Hedley		x	x					
Cuna delta (Tate & May)		x	x					
Cuna lamellata Tate		..	..	x	..	..	x	
Cuna multilamella Tate		x	..	..	..	..	x	
Cuna particula Hedley		x	x					
Cuna polita Tate		x	x					
Cuna radiata Tate		x	x	..	..	x	x	
Cuspidaria adelaidensis Tate		x						
Cuspidaria subrostrata Tate		..	x	x				
Cuspidaria velicata Chap.& Cresp. ..		x	x					
Dimya dissimilis Tate		x	..	x	x	x	x	
Diplodonta balcombensis Pritch.		..	..	..	x	..	x	
Divaricella dentata (Tate)		..	x					
Divaricella sp.		x						
Dosinia densilineata Pritch.		..	..	..	..	..	x	
Dosinia grayi Zittel		x						
Dosinia johnstoni Tate		x	x					
Eotrigonia semiundulata (McCoy)		..	..	x	x	x		

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
Eucrassatella camura (Pritch.)		x						
Eucrassatella dennanti (Tate)		..	..	x	x			
Eucrassatella kingicoloides (Pritch.)		x						
Fossularca capulopsis Pritch.		..	x					
Gari hamiltonensis Tate		x	..	..	..	..	x	
Glycymeris convexa (Tate)		x	x					
Glycymeris gunyoungensis Chap.& Singl.		..	..	..	x			
Glycymeris halli Pritch.		x						
Glycymeris halli var.paucicostata Pritch.		x						
Glycymeris maccoyi (John.)		..	..	..	..	..	x	
Glycymeris planuiscula Chap.& Singl.		..	x	x				
Glycymeris subtrigonalis (Tate)		x	x	x	x			
Glycymeris tenuicostata (Reeve)		x	x					
Hemicardium sp.		..	..	..	..	..	x	
Hinnites corioensis McCoy		..	x	x				
Kellyia micans Tate		x						
Lentipecten lucens Tate		x	x					
Lepton trigonale Tate		x	x	..	..	x		
Lima bassi T.Wds.		..	x	..	x			
Lima(Limatula)jeffreysiana (Tate)		x	x	x	x	..	x	
Limnea transenna T.Wds.		x	x	..	x	..	x	
Limopsis beaumariensis Chap.		x	x	x				
Limopsis chapmani Singl.		..	..	..	x	..	x	
Limopsis chapmani valida Singl.		..	..	..	..	..	..	x
Limopsis maccoyi Chap.		x	..	x	x	x	x	
Limopsis morningtonensis Pritch.		..	x	x	x	x	x	
Lissarca cincturata Chap.& Cresp.		x	x	x	..	..	x	
Lissarca rubricata Tate		x	x	x	..	x	x	
Lucina (Phacoides) sp.		x						
Macrocallista submultistriata (Tate)		x						
Macrocallista tenuis (Tate)		x						
Mactra aciniformis Tate		x						
Mactra howchiniana Tate		x	x					
Meretrix eburnea Tate		..	x	..	x	x	x	
Modiola cf.adelaidensis Tate		x						
Montacuta sericea Tate		x						
Myochama trapezia Pritch.		..	..	..	x			
Myodora brevis Sow.		x						
Myodora corrugata Tate		x	x					
Myodora gabrieli Chap.& Cresp.		x	..	x				
Myodora tenuilirata Tate		..	..	..	x	..	x	
Neolepton novacambricum Hedley		x	x	x	..	x	x	
Neotrigonia acuticostata (McCoy)		x	x					
Neotrigonia howitti (McCoy)		x	x					
Notostrea tarda (Hutton)		..	x					
Nucula kalimnae Singl.		x						
Nucula tenisoni Singl.		x						
Nuculana chapmani Singl.		x	x	x	..	x	x	
Nuculana crassa Hinds		x						
Nuculana fontinalis (Pritch.)		..	x					
Nuculana fortis (Hedley)		x						
Nuculana miliacea Hedley		x	x					
Nuculana vagans (Tate)		x	x	x	x	x		

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
PELECYPODA								
Nuculana woodsi (Tate)		x	x	x				
Ostrea arenicola Tate		x	x	x				
Ostrea hyotidoidea Tate		x						
Ostrea sp.		x	..	x	x			
Panope orbita Hutton		x	x	x				
Panope sp.		..	..	..	..	..	x	
Philobyra bernardi Tate		..	..	..	x	x	x	
Philobyra cf. cuboides Verco		..	..	..	x			
Placunanomia solla Tate		..	..	..	x			
Pronucula morundiana Tate		x	..	x	x	x		
Pronucula semistriata Tate		x						
Propoleda huttoni (T.Wds.)		x	x					
Protocardia antisemigranulata McCoy		..	..	..	x			
Protocardia hemimeris Tate		x	x	..	..	..	x	
Protocardia ornithopetronica Chap.& Cresp.		..	x					
Pteria(Meleagrina)crassicardia (Tate)		x	x					
Salaputium abbreviata (Tate)		x	x					
Salaputium commune (Tate)		x	x	x	..	x	x	
Sarepta obolella Tate		..	..	x	..	..	x	
Semele krausei (McCoy)		x	x					
Septifer fenestratum Tate		..	..	..	..	x		
Serripecten yahliensis (T.Wds.)		..	x	x	x	x		
Serripecten yahliensis var. semi-laevis (McCoy)		..	x	x	..	x		
Spondylus bailcyanus Chap.		..	x	x				
Spondylus gaederopoides McCoy		..	x	x	..	..	x	
Spondylus pseudoradulus McCoy		x	x	x	..	..	x	
Tellina aequilatera Tate		x	..	x				
Tellina albinelloides Tate		x						
Tellina masoni Tate		x						
Toredo sp.		x						
Trigonia tubulifera Tate		x						
Venericardia calva (Tate)		x	x					
Venericardia compacta (Tate)		x	x	x	x			
Venericardia delicatula (Tate)		..	..	..	..	..	x	
Venericardia depressulata Chap. & Cresp.		x						
Venericardia gippslandica Chap.& Cresp.		x	x					
Venericardia gracilicostata (T.Wds.)		..	x	x	x	x	x	
Venericardia polynema Tate		..	x	x	..	..	x	
Venericardia scabrosa (Tate)		x	x	x				
Venericardia spinulosa (Tate)		x	x	x	..	..	x	
Venericardia spinulosa var.dennanti Chap. & Cresp.		x	x	..	..	x		
Venericardia subcompacta Chap.& Cresp.		x	x					
Venericardia trigonalis (Tate)		x						
Venerupis paupertina Tate		x						
Zenatiopsis angustata Tate		x						
SCAPHOPODA								
Cadulus sp.		x						

FOSSILS	Stage	Kl	Ln	Bal			Jn	An
	Substage			Br	Bs	Lg		
SCAPHOPODA								
Dentalium(Episyphon)tornatissimum Tate		x						
Dentalium(Fissidentalium) mantelli Zittel		x	x	x	x	x	x	
Dentalium (Lacirdentalium) lacteolum Tate		x						
Dentalium (Lacirdentalium) largi-crescens Tate		x	x	..	x	..	x	
Dentalium (Lacirdentalium) sub-fissura Tate		x	x	x	..	..	x	
Dentalium (Paradentalium) aratum Tate		x	x	..	x	..	x	
Dentalium (Paradentalium) lata-sulcatum Tate		x						
Dentalium (Paradentalium) semiaratum Chap. & Cresp.		x	x	..	..	..	x	
POLYPLACOPHORA								
Acanthochiton sp.		..	..	x				
Afossochiton rostratus Ashby & Torr		..	x	x	x	..	x	
Afossochiton sp.		x	x	..	..	x		
Afossochiton (Telochiton) dendus Ashby & Cotton		..	x					
Lepidopleurus sinervus Ashby & Cotton		x						
Oochiton halli Ashby		..	..	..	..	x		
Protochiton granulosus (Ashby & Torr)		x	x					
Protochiton sp.		x						
GASTEROPODA								
Ancilla hebra (Tate)		..	x					
Ancilla ligata (Tate)		x	x	x	..	x		
Ancilla orycta (Tate)		x						
Ancilla papillata (Tate)		x						
Ancilla pseudaustralis (Tate)		..	x					
Antiphalium mülleri (Tate)		x	x					
Apiotoma bassi Pritch.		..	..	..	..	..	x	
Argobuccinum maccoyi Pritch.		..	x	x	x			
Astele sp.		..	..	..	..	..	x	
Asthenotoma consutilis T.Wds.		..	..	..	x			
Astraea aster (T.Wds.)		..	..	x	x	x	x	
Astraea sp.		x						
Ataxocerithium concatenatum Tate		..	..	x	..	x	x	
Aulica weldi (T.Wds.)		x	x					
Austrodrillia decemcostata Ludbrook		x						
Austrodrillia kalimnae (Pritch.)		x						
Austrodrillia trucidata Ludbrook		x						
Bankivia howitti Pritch.		x						
Bathytoma pritchardi Tate		x	x					
Bathytoma rhomboidalis T.Wds.		..	x					
Bathytoma sp.		x						
Bittium turritelliforme (Angas)		..	..	x	..	x		
Brookula singletoni Chap.& Cresp.		x	..	..	..	..	x	
Buchozia hemiothone (T.Wds.)		..	..	x	x	..	x	
Calliostoma semiornata Chap.		..	..	x				

FOSSILS	Stage	Kl	Mn	Bal			Jm	Am
	Substage			Br	Bs	Lg		
GASTEROPODA								
Calliostoma sp.		x						
Calliostoma sp.nov.		x						
Calyptraea subtabulata Tate		..	...	..	..	..	..	x
Calyptraea undulata Tate		..	..	..	..	..	..	x
Calyptropsis arachnoides Tate		x						
Cancellaria capillata Tate		..	x					
Cancellaria exaltata Tate		..	...	..	..	..	..	x
Cancellaria platypleura Tate		x	..	x				
Cancellaria wannonensis Tate		x	..	x				
Cantharidus exiguus (T.Wds.)		..	x					
Cantharidus sp.nov.		x						
Cerithiella trigemmata Chap.& Cresp.		x	x	x	x	x	x	x
Cerithiopsis cribarioides (T.Wds.)		..	..	..	..	..	..	x
Cerithiopsis mitchellensis Chap.& Cresp.		..	..	..	..	..	..	x
Cerithiopsis roticosa Chap.& Cresp.		..	..	..	..	..	x	x
Cerithiopsis woolnoughi Chap.& Cresp.		x	x	x	..	x		
Cerithium aphelles T.Wds.		..	..	x				
Cocculina gunyoungensis Chap.& Gabr.		..	x					
Collonia parvula T.Wds.		..	x	x	x	x	x	
Columbarium acanthostephes Tate		..	..	x				
Columbarium foliaceum Tate		..	..	..	x			
Conomitra ligata Tate		..	x	x	x	..	x	
Conus acrotholoides Tate		..	..	..	..	..	x	
Conus complicatus Tate		..	..	..	x			
Conus cf.donnanti Tate		..	..	..	x			
Conus hamiltonensis Tate		x	..	..	x			
Conus ligatus Tate		x	x	..	x			
Crepidula dubitabilis Tate		x						
Crosseia cancellata T.Wds.		..	x	x	x	..	x	
Cyclostrema inscriptum Tate		x	x					
Cyclostrema microns T.Wds.		..	x					
Cyclostrema sp.		..	x	..	x			
Cylichnella altiplica (Coss.)		..	..	x	x	..	x	
Cylichnella angustata (Coss.)		x	x	..	..	x	x	
Cylichnella aratula (Coss.)		x	x	x	..	x	x	
Cylichnella cuneopsis (Coss.)		x	x	..	x	..	x	
Cylichnella exigua (Coss.)		x	x					
Cylichnella infundibulata (Coss.)		..	..	..	..	..	x	
Cylichnella phanerospira (Coss.)		..	..	x	x			
Cymatium annectans (Tate)		x	x	..	x	..	x	
Cymatium textile (Tate)		..	..	..	..	x	x	
Cymatium tortirostris (Tate)		..	..	..	..	x		
Cymatium woodsi (Tate)		..	..	..	x			
Cymatium sp.nov.		x						
Cypraea consobrina McCoy		x						
Cypraea eximia Sow.		..	x	..	x			
Cypraea leptorhyncha McCoy		..	x	x				
Cypraea parallella Tate		..	..	..	x			
Cypraea pyrulata Tate		..	..	x	x			
Cypraea subsidua Tate		..	..	..	..	..	x	
Cypraea sp.		..	x					
Daphnella gracillima T.Wds.		x	..	..	..	..	x	
Daphnella granulosa Chap.& Cresp.		x	..	..	..	..	x	
Eburnopsis sp.		x						
Eglisia cf.triplicata (Tate)		x	x					
Emarginula delicatissima Chap.& Gabr.		..	..	x	x	..	x	

FOSSILS	Stage / Substage	Kl	Mn	Bal			Jn	An
				Br	Bs	Lg		
GASTEROPODA								
Emarginula dennanti Chap.& Gabr.		x	..	..	x	..	x	
Emarginula transenna T.Wds. 1.....		x	x	x	x	x	x	
Emarginula wannonensis Harris		..	..	..	x	x		
Epigrus cylindracus T.Wds.		x	x					
Epigrus variciferus T.Wds.		x	..	x				
Estea kershawi (T.Wds.)		x	x	x	x			
Etrema alliterata Hedley		x	x					
Etrema pseudoelegans Chap.& Cresp. ..		x	x	x	..	x		
Eucithara subglabra Chap.& Cresp. ...		..	x					
Eulima acutispira T.Wds.		..	..	..	..	..	x	
Eulima bicurvata Chap.& Cresp.		..	..	x	..	..	x	
Eulima longiconica Ludbrook		x						
Eulima sp.		..	x	..	..	..	x	
Eulimella aurantica (Angas)		x						
Eulimella nitidula Chap.& Cresp.		x	x	x	..	x	x	
Filodrillia dilectoides (Chap.& Gabr.)		x						
Filodrillia stereoides Chap.& Cresp.		x	x	x				
Friginatica polita (T.Wds.)		x	x	x	x	x	x	
Fulgoraria ancilloides (Tate)		x	..	..	..	..	x	
Fusinus gippslandicus (Tate)		x						
Gibbula sp.		..	..	..	..	..	x	
Guraleus volutiformis Chap.& Cresp. .		x	x	x	..	x		
Haurakia gabrieli Chap. & Cresp.		..	x	x	x	..	x	
Haurakia sp. (1)		..	x					
Inquisitor detritus Ludbrook		x						
Inquisitor integra (T.Wds.)		..	x	x	..	..	x	
Inquisitor sandleroides (T.Wds.)		x	x	x	x	..	x	
Inquisitor cf.trevori (T.Wds.)		..	x					
Inquisitor johnstoni (T.Wds.)		..	..	..	..	..	x	
Laetifautor bicarinatus Ludbrook		..	x					
Latirus cf.altifrons Tate		..	..	..	..	..	x	
Liopyrga quadricingulata Tate		x						
Liotella capitata Hedley		..	x	..	x			
Liotella roblini (Johnston)		..	x	..	x			
Lironoba tenisoni (Tate)		x						
Lyria harpularia Tate		..	..	..	..	..	x	
Marginella crassidens Chap.& Cresp. .		x						
Marginella globiformis Chap.& Cresp..		x	..	..	..	x	x	
Marginella hordeacea (Tate)		x						
Marginella kalimnae Chap.& Cresp. ...		x	x					
Marginella cf.kitsoni Chap.		..	..	x	x	..	x	
Marginella micula Tate		x	x	x	x	x	x	
Marginella muscarioides Tate		x	..	..	x			
Marginella propinqua Tate		x	..	..	..	x		
Marginella wentworthi T.Wds.		x	x	x	x	x	x	
Marginella winteri Tate		x	..	..	..	..	x	
Marginella woodsi Tate		x						
Mathilda decorata Hedley		x	x	..	x	..	x	
Mathilda transenna T.Wds.								
Megatebennus concatenatus Crosse & Fischer		..	..	..	x	..	x	
Merelina sculptilis May		x	x					
Mesalia sp.		..	..	..	..	..	..	x
Mitra alokiza T.Wds.		x						

FOSSILS	Stage	Kl	Mn	Bal			Jn	An
	Substage			Br	Bs	Lg		
GASTEROPODA								
Monodonta constricta Lam.		x						
Montfortula gemmulata Chap.& Gab.		..	..	..	x			
Morio wilsoni Tate		..	..	..	..	..	x	
Murex amblyceras Tate		..	..	..	..	..	x	
Murex cf.asteriscus Tate		..	x					
Murex lophoessus Tate		..	x	x				
Murex polyphyllus T.Wds.		..	x	x	x	x	x	
Murex velificus Tate		..	..	..	x	..	x	
Nassarius crassigranosus(Tate)		x						
Nassarius spiraliscabrus Chap.& Gabr.		x						
Nassarius sublirella (Tate)		x						
Nassarius tatei (T.Wds.)		x	x	x	x			
Natica hamiltonensis Tate		x	x	x	x	..	x	
Natica subnoae Tate		x	..	x	x			
Natica subvarians Tate		x						
Notogibbula sp.		x						
Odostomia deplexa (Tate & May)		x	x	x	..	x		
Odostomia mayi Tate		x						
Olivella nymphalis (Tate)		x	x	x				
Personella clarkei Chap.& Cresp.		x						
Phos gregsoni Tate		x						
Phos liraecostatus T.Wds.		x	x					
Phos tardicrescens Tate		..	x					
Polinices cunninghamensis (Harris)		x						
Polinices substolida (Tate)		x						
Polinices wintlei (T.Wds.)		..	..	..	..	..	x	
Pterospira hannafordi (McCoy)		..	x	..	..	x	x	
Pterospira validicostata (Tate)		..	x					
Pyramidella jonesiana (Tate)		x	x	x	..	..	x	
Pyramidella polita Johnston		x	x	x	..	x		
Pyrene cainozoica (T.Wds.)		..	x					
Pyrene oxleyi (T.Wds.)		..	x	x	..	..	x	
Pyrene sp.		..	x	..	..	..	x	
Ringicula lactea Johnst.		x	..	x				
Ringicula tatei Coss.		x	x	x				
Ringicula tenuilirata Coss.		..	..	x	..	..	x	x
Rissoina stevensiana (T.Wds.)		x	..	..	..	x	x	
Rissolina profunda (Chap.& Gab.)		x	x	..	..	..	x	
Rissopsis buliminoides Tate & May		x						
Roxania bullaeformis Coss.		x						
Roxania woodsi Tate		..	..	..	..	..	x	
Scaphander tatei Coss.		x						
Semiactaeon microplocus Coss.		x	x	..	x			
Semicassis sufflata T.Wds.		..	..	..	..	..	x	
Semicassis trinodosa Tate		..	..	x				
Sigapatella corrugata (Tate)		x						
Sigapatella crassa (Tate)		x	x					
Struthiolaria lirata Tate		x						
Styliola rangiana Tate		..	..	x				
Syrnola tasmanica T.Wds.		x						
Teinostoma calva Chap.& Cresp.		x	x	x	x	..	x	
Teinostoma depressula Chap.& Gabr.		x						
Tenagodes occlusus T.Wds.		x	x	..	..	..	x	
Terebra catinifera Tate		x						

T

FOSSILS	Stage	Kl	Mn	Bal			Jm	An
	Substage			Br	Bs	Lg		
GASTEROPODA								
Terebra geniculata Tate		x						
Terebra simplex T.Wds.		x						
Terebra subcatinifera Tate		x						
Tornatina longispira Coss.		x	x					
Triforis wilkinsoni T.Wds.		x	x	x	x	x	x	
Trivia avellanoides McCoy		...	x	..	x			
Trophon halli Chap.& Cresp.		..	x	x	..	x		
Trophon (Enatimene) metungensis Chap.& Cresp.		x	x					
Turbonilla constricta Chap.& Cresp.		x	..	x				
Turbonilla mulderi Chap.& Cresp.		..	x	..	..	..	x	
Turbonilla radicans Chap.& Cresp.		x	x	x	x	x	x	
Turbonilla tenuissima Chap.& Cresp.		..	x	x	x	..	x	
Turbonilla weeahensis Chap.& Gabr.		x						
Turris murndalianus (T.Wds.)		..	..	x				
Turris triliratus (Harris)		..	..	x				
Turritella acinella Chap.& Gabr.		x	x					
Turritella acricula Tate		x	x	x	x	..	x	
Turritella aldingae Tate		..	x	x	..	x	x	
Turritella conspicabilis Tate		x	x	x	x	..	x	
Turritella medioplicatilis Chap.& Cresp.		..	..	..	..	..	x	
Turritella multicincturalis Chap.& Cresp.		x						
Turritella murrayana Tate		..	..	x	..	x	x	
Turritella murrayana var.subrudis Cotton & Ludbrook		x						
Turritella pagodula Tate		x						
Turritella platyspira T.Wds.		x	..	x	x	..	x	
Turritella tristira Tate		x	x	x	..	x	x	
Turritella warburtoni T.Wds.		..	x	..	..	..	x	
Turritella sp. 1		..	x	x				
Turritella sp. 2.		x						
Tylospira coronata (Tate)		x	x					
Typhis evaricosus Tate		..	..	x				
Typhis laciniatus Tate		..	..	..	x			
Typhis (Cephonochelus) rugicostatus Chap.& Cresp.		x	x					
Umbraculum australe Harris		...	..	..	..	x		
Uromitra euglypha (Tate)		x						
Uromitra paucicostata Tate		..	x	x	x	x		
Vermicularia (Thylacodes) adelaidensis Tate		..	x	x				
Vermicularia (Thylacodes) conohelix T.Wds.		..	..	..	..	..	x	
Vermicularia (Thylacodes) funicalis Cresp.		..	x	..	..	..	x	
Vermicularia (Thylacodes) rudis Tate		..	x	..	..	..	x	
Vermicularia (Thylacodes) sp.		..	..	..	..	..	x	
Volvulella tatei Cossm.		x	x					
Volutospira anticingulata (McCoy)		..	..	x	..	..	x	
CEPHALOPODA								
Nautilus geelongensis Foord		..	..	x				
OSTRACODA								
Aglaia clavata G.S.B.		x	x	x	x	x	x	

FOSSILS	Stage	Kl	Mm	Bal			Jm	An
	Substage			Br	Bs	Lg		
OSTRACODA								
Alatacythere praeantarcticum (Chap.)		x	x	x	x	x	x	
Argilloecia badia G.S.B.		x	x	x	..	x	x	
Bairdia amygdaloides G.S.B.		x	x	x	x	x	x	
Bairdia croskeiana G.S.B.		..	..	..	..	x	x	
Bairdia foveolata G.S.B.		..	..	x	..	x	x	
Bairdia ovata G.S.B.		..	..	..	x			
Bairdia subdeltoidea Münster		x	x	x	x	x	x	x
Bythocypris reniformis G.S.B.		..	..	..	..	x		
Bythocypris tumefacta Chap.		x	x	x	x	x	x	x
Bythocythere arenosa G.S.B.		x	x	x	x			
Bythocythere keblei Chap.& Cresp.		..	..	..	x	x		
Bythocythere sp.nov.		x						
Cythere acupunctata G.S.B.		x						
Cythere canaliculata (Reuss)		x	x	x	x	x		
Cythere caudispinosa Chap.& Cresp.		x	x	x	x	x	x	
Cythere dasyderma G.S.B.		x	x	..	x	x	x	
Cythere demissa G.S.B.		x	x	..	..	x		
Cythere dictyon G.S.B.		x	x	x	x	x	x	
Cythere flexicostata Chap.		..	x	x	x	x		
Cythere lactea G.S.B.		x	x	x	x	x	x	
Cythere lauta G.S.B.		..	x					
Cythere lubbockiana G.S.B.		x	..	x	..	..	x	
Cythere melobesioides G.S.B.		..	x	x	x	x		
Cythere militaris (G.S.B.)		x	x	x	..	x		
Cythere cf.mosleyi G.S.B.		x						
Cythere obtusalata G.S.B.		x	..	x	x			
Cythere ovalis G.S.B.		..	..	..	..	..	x	
Cythere parallelogramma G.S.B.		x	x	x	x	x	x	
Cythere polytrema G.S.B.		..	x	x	..	..	x	
Cythere postcaudispinosa Chap.		x						
Cythere postdeclivis Chap.		..	x	..	..	x		
Cythere quadriculata G.S.B.		x	x	x	x			
Cythere rastromarginata G.S.B.		x	x	x	x	x	x	
Cythere scabrocuneata G.S.B.		x	..	..	x	x	x	
Cythere scintillulata G.S.B.		x	x					
Cythere scutigera G.S.B.		x	x	x	x	x	x	
Cythere sorrentae Chap.& Cresp.		..	x	x	x	x	x	x
Cythere velivola G.S.B.		..	x	..	x			
Cythere cf.wyville-thompsoni G.S.B.		x	x					
Cythere sp. 1.		x	x	x				
Cythere sp. 2.		..	..	x				
Cytherella cingulata G.S.B.		x	x					
Cytherella lata G.S.B.		x	x	x	x	x	x	x
Cytherella polita G.S.B.		..	x	x	x	..	x	x
Cytherella pulchra G.S.B.		x	x	x	..	x	x	
Cytherella punctata G.S.B.		x	x	x	x	x	x	
Cytherella venusta G.S.B.		..	..	..	..	..	x	
Cytherella subtruncata Chap.		x	x	x	x	x	x	
Cytherelloidea auricula (Chap.)		x	x	..	..	..	x	
Cytherelloidea intermedia (Chap.& Cresp.)		x	x	x	..	..	x	x
Cytherideis laevata G.S.B.		x	x	x				
Cytheropteron batesfordiense Chap.		..	x	x	x	x		
Cytheropteron fenestratum G.S.B.		..	x	x	x	x	x	
Cytherura cryptifera G.S.B.		x						
Cytherura lilljeborgii G.S.B.		x						
Cytherura praemucronata Chap.& Cresp.		x	..	x	x	..	x	
Cytherura sp. 1.		x						

FOSSILS	Stage / Substage	Kl	Mn	Bal Br	Bal Bs	Bal Lg	Jn	An
OSTRACODA								
Krithe eggeri Chap.		x	x	x	x	x	x	
Krithe producta G.S.B.		x	x	x	x	x	x	
Loxoconcha alata G.S.B.		x	x	x	x			
Loxoconcha australis G.S.B.		x	x	x	x	x		
Loxoconcha avellana G.S.B.		x	..	..	x			
Macrocypris decora G.S.B.		x	x	x	x	x	x	x
Macrocypris tenuicauda G.S.B.		..	..	..	..	x	x	
Macrocypris tumida G.S.B.		x	x	x	x	..	x	
Paradoxostoma ensiformis G.S.B.		..	x	x				
Pontocypris attenuata G.S.B.		..	..	..	..	..	..	x
Pseudocythere caudata G.O.Sars		x	x					
Xestoleberis foveolata G.S.B.		..	x					
Xestoleberis margaritea G.S.B.		x	..	x	..	x		
Xestoleberis variegata G.S.B.		x	x	x	x	x	x	
CIRRIPEDIA								
Balanus amphitrite Darwin var. acuta Withers		x	x	x				
Balanus sp.		x	x	..	..	x		
Scalpellum sp.		..	..	x	..	..	x	
DECAPODA								
Ommatocarcinus corioensis (Cress.)		..	x	x				
Chela of crab		x	x	x	..	..	x	
PISCES								
Carcharias (Prionodon) aculeatus Davis		..	x	..	..	..	x	x
Carcharias victoriae Chap.& Cud		..	..	..	..	..	x	x
Carcharias sp.		..	..	..	..	..	x	
Carcharodon megalodon Ag.		..	..	..	..	..	..	x
Heterodontus coleridgensis (Chap.)		..	..	..	..	..	x	x
Heterodontus sp.		..	..	..	..	..	..	x
Isurus desorii (Ag.)		..	..	..	..	..	..	x
Isurus hastalis (Ag.)		..	x					
Isurus retroflexus (Ag.)		..	x					
Lamna apiculata (Ag.)		..	..	..	..	..	..	x
Lamna bronni (Ag.)		..	x					
Odontaspis cf. attenuata (Davis)		..	..	..	..	..	..	x
Odontaspis contortidens Ag.		..	x					
Odontaspis incurva (Davis)		..	x					
Otolithus sp.		x	x	x	..	x	x	
Squatina gippslandica Chap.& Cud.		..	x					