OBSERVATIONS WITH RESPECT TO THE NATURE AND CLASSIFICATION OF THE TERTIARY ROCKS OF AUSTRALASIA.

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General Features of the Tertiary System.

Overlying the prevailing sandstones, limestones, shales, and coal beds of the Mesozoic Period are to be found vast accumulations of clays, sands, gravel, marls, calcareous grits, limestones, gypsum, and lignites, of either marine or fresh-water origin. These accumulations, as a rule, do not present the same features as those of the older rocks, inasmuch as the process of consolidation and metamorphism, excepting in rare instances, is far less complete. The rocks generally are loose and incoherent, and their exposed surfaces are less able to resist the weathering and denuding influences of air and water.

It is also manifest, from a study of these accumulations in various countries, that for the most part they were deposited within limited and comparatively shallow basins, whether as sediments of fresh-water lakes, river beds, estuaries, or seas. The frequent changes exhibited in the order and composition of their beds also indicate that they were often subjected to sudden changes of level, permitting the same limited areas to be successively and alternately invaded by the organisms of sea and land within a comparatively short period of time. These changes in some countries, as in France, America, Australia, and Tasmania, are further greatly complicated by widespread eruptions of basalts and associated tuffs, both of which are often interstratified in thin regular sheets over wide areas with the more common aqueous accumulations of sand, clay, lignite, marl, and pebble drifts. In Australia, Tasmania, and also in Scotland (leaf-beds of Mull) these basalts and their tuffs are most intimately associated with leaf-beds. In Tasmania, notably at Breadalbane, there is abundant evidence of the destruction sub-aerially of perfect forests of conifers and angiosperms, by vast outbursts of scoriæ and volcanic dust, such as that remarkable outburst which has recently buried and destroyed a rich vegetation in the vicinity of Mount Tarawera in New Zealand.

Although from the evolutionist's point of view it would be unreasonable to look for a break or hiatus in the continuity of physical and organic processes connected with the succession of rocks and organic life as regards the whole globe, still it must be borne in mind, in respect of any one region, that breaks of a very remarkable character do occur; and although evidences are becoming more and more abundant that the local break involves merely a shift of the conditions to other regions where the threads of continuity are maintained, yet such is the obscurity caused by our ignorance of the direction, extent, and exact sequence of these local shifts, and such are the complications brought about by the commingling of migratory forms from different sources in the successive provinces invaded, that we are still involved in much confusion respecting the true sequence of the rocks and organisms of different regions.

This confusion is intensified by the general tendency among geologists, in widely separated provinces, and, indeed, in opposite hemispheres, to aim at fixing parallel limits too closely,—not only with the great systematic divisions of Europe, where the sequence and boundaries of rock systems were first closely studied, but also with a definite number of minor subdivisions which strictly can only be of local value. Whereas, if due regard be paid to questions concerning unbroken continuity of laws or forces in operation[a], and the inevitable constant successive interweaving of organisms in different regions from many independent centres of origin, forming new groups of association, we should be led to expect that the slow spread of

[a] "As all the living forms of life are the lineal descendants of those which lived long before the Cambrian epoch, we may feel certain that the ordinary succession by generation has never been broken, and that no cataclysm has desolated the whole world." (Darwin—*Origin of Species*, 6th ed., 1875, p. 428.)

"Upon any theory of 'evolution,' at any rate, it is certain that there can be no total break in the great series of the stratified deposits, but that there must have been a complete continuity of life, and a more or less complete continuity of deposition from the Laurentian period to the present day. There was, and could have been, no such continuity in any one given area, but the chain could never have been snapped at one point and taken up at a wholly different one. The links must have been forged in different places, but the chain, nevertheless, remained unbroken." (Dr. H. A. Nicholson—*Manual of Palæontology*, 2nd ed., 1879, pp. 49-50.)

persistent terrestrial forms of life to the antipodes of their origin would probably in most cases occupy a vast period of time; and consequently the typical forms of a given horizon in one hemisphere should rather be sought in a succeeding horizon in the opposite hemisphere, and *vice versâ*; and the equivalents of a given subdivision in one geographical province are more likely to be indicated by the local breaks of far distant regions rather than by any local division represented, with which alliances are too frequently sought on the strength of the association of two or three typical genera which they may happen to possess in common.

The danger of this common tendency has already been fully discussed under classification and nomenclature of the Mesozoic period.[a] The great difficulty of correlating widely separated provinces, by reference to the association of typical organisms of any one distant region, is in no way concerned with *absolute contemporaneity*, for that might be reconciled by the theory of *homotaxis*, as defined by Professor Huxley.

The conception of the commingling of types from *widely separated independent centres of origin*—a most probable one—frustrates any attempt by the usual references to fix the sequence and exact relationship of the rocks of widely separated countries.

Towards the close of the Mesozoic period, and during the Tertiary period, physical, climatic, and organic changes of a remarkable character took place, both in the northern and southern hemispheres. Dr. Geikie states that some of the most colossal disturbances of the terrestrial crust of which any record remains took place within the Tertiary period; and adds: "Not only was the floor of the cretaceous sea upraised into lowlands, with lagoons, estuaries, and lakes, but throughout the heart of the Old World, from the Pyrenees to Japan, the bed of the early Tertiary or nummulitic sea was upheaved into a succession of giant mountains, some portions of that sea floor now standing at a height of at least 16,500 feet above the sea." In the southern hemisphere there is no evidence of Tertiary marine beds having been found at a greater altitude than 2000 feet above the existing sea level, but the almost continuous mass of marine formations in Australasia, from Cape York to Tasmania, testify of the won-

[a] Proc. Roy. Soc. of Tas., 1886, (pp. 164-169; 181-182).

derful physical changes that have taken place in this region within the periods. In Wallace's Island Life, pp. 460-467, a most graphic account is given of these changes with respect to their influence upon the spread of organic life. The conclusions arrived at by Mr. Wallace and Professor Hutton, based upon these terrestrial changes, throw much light upon the problems connected with the origin and spread of existing forms of life throughout Australasia, and the writer cannot do better than reproduce an abstract of Mr. Wallace's views in his own words; thus, p. 462: "If we imagine the greater part of North Australia to have been submerged beneath the ocean, from which it rose in the middle or latter part of the Tertiary period, offering an extensive area ready to be covered by such suitable forms of vegetation as could first reach it, something like the present condition of things would inevitably arise . . . The existence in North and North-east Australia of enormous areas covered with Cretaceous and other Secondary deposits, as well as extensive Tertiary formations, lends support to the view that during very long epochs temperate Australia was cut off from close connection with the tropical and northern lands by a wide extent of sea; and this isolation is exactly what was required in order to bring about the wonderful amount of specialisation and the high development manifested by the typical Australian flora . . ." From a study of the South-eastern and South-western Australian flora he also infers that the "facts clearly point to the conclusion that South-western Australia is the remnant of the more extensive and more isolated portion of the continent in which the peculiar Australian flora was principally developed. The existence there of a very large area of granite—800 miles in length by nearly 500 in maximum width—indicate such extension; for this granitic mass was certainly buried under piles of stratified rock, since denuded, and then formed the nucleus of the old Western Australian continent. But while this rich and peculiar flora was in process of formation, the eastern portion (the Cordillera) of the continent must either have been widely separated from the western, or had, perhaps, not yet risen from the ocean. If we examine the geological map of Australia . . . we shall see good reason to conclude that the eastern and western divisions of the country first existed as separate islands, and only became united at a comparatively recent epoch. This is indicated by an enormous stretch of Cretaceous and Tertiary formation extending from the Gulf of Carpentaria completely across the continent to the mouth of the Murray River[1]. During the Cretaceous period, therefore, and probably throughout a considerable portion of the Tertiary epoch, there must have been a wide arm of the sea occupying this area, dividing the great mass of land on the west—the true seat and origin of the typical Australian flora—from a long but narrow belt of land on the east, indicated by the continuous mass of Secondary and Palæozoic formations already referred to, which extend uninterruptedly from Tasmania to Cape York. Whether this formed one continuous land, or was broken up into islands, cannot be positively determined; but the fact that no marine Tertiary beds occur in the whole of this area ([2]) renders it probable that it was almost, if not quite continuous, and that it not improbably extended across to what is now New Guinea." . . . The eastern and the western islands . . . would then differ considerably in their vegetation and animal life. The western and more ancient land already possessed in its main features the peculiar Australian flora, and also the ancestral forms of its strange marsupial fauna, both of which it had probably received at some earlier epoch by a temporary union with the Asiatic continent over what is now the Java Sea. Eastern Australia, on the other hand, possessed only the rudiments of its existing mixed flora, derived from three distinct sources.

"Some important fragments of the typical Australian vegetation had reached it across the marine strait, and had spread widely, owing to the soil, climate, and general conditions being exactly suited to it; from the north and north-east a tropical vegetation of Polynesian type had occupied suitable areas in the north; while the extension of the Tasmanian peninsula, accompanied probably, as now, with lofty mountains, favoured the immigration of south

[1] The discovery at Table Cape and elsewhere of the marine beds of Eocene age, similar to those of the Murray, indicate the extension of this old Tertiary sea to Northern Tasmania. (R. M. J.)

[2] The Heathy Valley limestones of Tertiary age on Flinders' Island, and other marine deposits on several of the connecting islands in the eastern portion of Bass' Strait, indicate the probable occurrence of one or two minor straits, as at present. (R. M. J.)

temperate forms from whatever Antarctic lands or islands then existed. The marsupial fauna had not yet entered this eastern land, which was, however, occupied in the north by some ancestral struthious birds, which had reached it by way of New Guinea through some very ancient continental extension, and of which the emu, the cassowaries, the extinct Dromornis of Queensland, and the moas and kiwis of New Zealand, are the modified descendants."

From this interesting sketch of the earlier condition of Australasia much may be learned respecting the vast extent of the terrestrial changes which have taken place since the close of the Mesozoic period. It is also obvious that the changes in the alternation of sea and land in the northern hemisphere, and the character of the typical organisms which occupied the areas determined by these changes, must present striking differences as compared with contemporaneous changes in the southern hemisphere; and that, while on the broad lines of epochs or systems there may be many points of agreement, it would scarcely be wise to expect that the subdivisions of the period should offer any approach to agreement either with respect to their extent or number; and, as regards the terrestrial life of these subdivisions, we must also be prepared to expect wide differences, although agreeing in some of the broader distinctions which in a general way mark the Mesozoic and Tertiary epochs.

The nature and composition of the formations have already been referred to. As regards the life of the period, the most distinguishing features observed in contrast with the preceding one are the introduction of types of life which characterise the existing period. We find that the reign of the lycopods, cycads, and yew-like conifers has given way to that of the beech, oak, elm, willow, cinnamon, banksia, eucalyptus, and other angiosperms. This transition, it is true, was not abrupt, for the dawn of the new types had already made an appearance in many countries towards the close of the Mesozoic period (Cretaceous). The ammonites, belemnites, inocerami, scaphites, and other characteristic types of the Mesozoic rocks, disappear or sink into insignificance, and their places are taken by molluscs closely resembling existing forms, and belonging in most cases to identical genera. Towards the close of the period a great part of the species are found to be identical with existing forms. The great dominant reptiles and batrachians, which gave such a singular character to the Secondary period by their numbers and variety, have mostly disappeared from the scene, and their places are occupied by the placental and aplacental mammalian types, most of which prevail to the present day. The placental forms, however, are almost entirely unrepresented in the Australasian region, but there instead the aplacental or pouched animals of the kangaroo and wombat type have attained their highest state of development in size, number, and differentiation. Such being the case, it is clear that, whatever agreement there may be found to exist within the Tertiary period, the subdivisions of the epoch in opposite hemispheres cannot offer a very close correspondence with each other, and the associated forms of life typical of a given formation in one hemisphere would be of little assistance in approximating the boundaries or relationships of any of the subdivisions of the other hemisphere.

Classification.

The only general standard for determining the respective subdivisions of the epoch is the local order of succession of distinct formations, aided, as regards the life of the period, by relationship with existing types as indicated by the percentage of forms which are in common.

This latter method has been adopted with success by European geologists, so far as it is applied locally. For purposes of classification the shell-bearing molluscs are generally selected as the most useful and convenient class of organisms, because they are so abundant and so perfectly preserved in all countries, both in land, freshwater, and marine deposits; and are, moreover, from their diversity of specific form, with numerous varieties produced by change of habitat, so useful in indicating the changing conditions of their environments.

It is true the persistency of certain forms and the variability of others cause perplexity at times; but, upon the whole, the evidences of the conditions under which they lived and of their succession offer greater facilities for the proper classification of rocks than are presented by any other class of organisms.

This is the reason why Lyell based his original classification of the European Tertiary strata—Eocene, Miocene, and Pliocene—mainly upon the evidence of the testaceous mollusca.

By relation to existing species he arranged the known European beds into three principal groups, named on the basis of the percentage of living forms to be found in them.

Thus, the order of the three divisions was classed as follows, beginning with the oldest :—

	Contained Percentage of Species still existing.
Eocene *(dawn of* (recent) *life)*	1 to $3\frac{1}{2}$
Miocene *(less* (proportion of recent) *life)*	17 to 30
Pliocene *(more* (proportion of recent) *life)*	36 to 98

In the first edition of the Principles of Geology, Lyell recognised four distinct groups by the same method; thus :—

	Contained Percentage of Species still existing.
Eocene	$3\frac{1}{2}$
Miocene	17
Older Pliocene (Pliocene)	35 to 50
Newer Pliocene (Pleistocene)	90 to 95

The two latter groups are now for the most part linked together under the name Pliocene, and a fresh subdivision, absorbing a portion of the Lower Miocene and Upper Eocene, has been adopted very generally in Europe, termed " *Oligocene*."

The percentages given, however, are not to be taken too rigidly, for Lyell has himself stated that since the time when the original classification was made (1830) " the number of known shells, both recent and fossil, has largely increased, and their identification has been more accurately determined. Hence some modifications have been required in the classifications founded on less perfect materials."

Generally, then, it may be well to consider that the *Eocene* includes those formations in which living species represent an extremely small proportion of the testaceæ; *Miocene*, those in which the extinct species exceed those having living representatives; and *Pliocene*, those in which the extinct species bear a smaller proportion than the associated species having living representatives. The manifest objection to the use of such terms for the classification of subdivisions of the Tertiary period throughout the world is, that it *fixes* the number of subdivisions; and as it is very improbable that characteristic groups in different countries, especially in opposite hemispheres, will be found on stratigraphic and organic grounds to maintain anything approaching a natural division into three, or even four or more groups, the terms are often a hindrance.

For example, in Australia and Tasmania the marine deposits, though very extensive, do not reappear again and again throughout the epoch, and there are no means, therefore, of determining with satisfaction the exact position of the extensive leaf-bed and lignite formations[a] such as might be obtained if the latter were intercalated with successive marine deposits showing marked differences of percentage of species having living representatives, as in Europe. In this region, the adoption of the European classification would be most unsuitable and very deceptive. It is apparent, therefore, that for Australasia a broader distinction between the older and younger Tertiary deposits is absolutely necessary; and as the terms *Palæogene* and *Neogene* have already been recognised as indicating the older and younger Tertiaries respectively, they have been adopted by the author as most suitable for the classification of these rocks in Australia and Tasmania.

This arrangement is all the more necessary when we come to consider that the introduction of the fourth group, "Oligocene," between the Eocene and Miocene, is by many geologists deemed to be doubtful and arbitrary even as applied to English rocks, although fairly justifiable for some of the formations in France, Germany, and in other European countries. It is also advisable to make the broader classification for other reasons, for there is still much that is uncertain in the groupings of English and other European countries.

Mr. Starkie Gardiner has repeatedly drawn attention to the unsatisfactory classification of the vegetable deposits of Europe, and has given many weighty reasons for revis-

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[a] The attempt to determine the exact age of these deposits by the aid of successive flows or sheets of eruptive basalt, as in Victoria, is far from satisfactory, and affords no reliable guidance to the relationship of various beds in independent basins.

ing the classification which, on doubtful data, groups many of them as *Miocene.*

In commenting upon the development of Dicotyledons, Mr. Gardiner states : " Floras from Spitzbergen in the north to Australia in the south have been classed as Miocene from a very slender fancied resemblance to those of Switzerland, and a great series of strata have been assigned without sufficient reason to that age, not only in Central Europe, but in such distant lands as Greece, Madeira, Borneo and Sumatra, Sachalin and Alaska, and, in fact, wherever other evidence of age was absent." He also clearly enforces views, already advanced in this work, that, in utilising the floras of different countries " for comparison, the differences of latitude and longitude must be taken into account. Nor have we a right to suppose that all the plants preserved from an immense number of localities grew at the same elevation above the sea, while they may also have lived on very different stations and under relatively dry or moist climates." The danger of determining the ages of fossil floras in remote parts of the world by comparing and estimating the percentages common to those of Europe is also very great; for, as Mr. Gardiner remarks : " Not only have we to keep in mind the similarity that dicotyledonous leaves belonging to different genera bear to each other, a likeness increased by the process of fossilization where the matrices are similar, but the fragmentary condition of the specimens usually brought from distant countries . . . ." And additional caution is urged by this careful observer by citing the following illustration :—" Were we to take an armful of fallen leaves at random from each country, such as Siberia, Japan, Sumatra, Australia, New Zealand, Madeira, Scotland, France, Greece, and the United States, and compare them together after the manner of palæontologists, is it likely that we should find grounds for supposing that they all belonged to floras growing synchronously ? " Such reasoning is most wholesome at the present time, and amply justifies the course adopted by the author in respect of the broader subdivision suggested for Tasmania. Mr. Gardiner, however, states that his remarks are not intended to discredit those who have laboriously worked at the task of deciphering fossil floras, but " simply meant to warn hose who have to make use of the facts arrived at, that

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conclusions and the inductions drawn from them are not based upon foundations as assured as those of other branches of geology and palæontology."

The following table not only helps us to understand the different opinions of authorities at different times with respect to the classification of well known typical formations of England, but it is an index of the uncertainty of fixing many hard-and-fast subdivisions which would prove suitable for widely separated localities.

Historical Classification of

	Forbes, 1856.		*Jukes,* 1862.	
Forest-bed Group	PLIOCENE		PLIOCENE	
Chillesford Beds				
Norwich Crag				
Red Crag				
White Crag				
Mull and Antrim Leaf-beds?	MIOCENE		MIOCENE	
Hempstead Beds	EOCENE	Upper	EOCENE	Upper
Bembridge Beds				Middle
Osborne or St. Helen's Beds				
Upper Headon Beds				
Middle Lower ditto				
Upper Bagshot Sands		Middle		
Barton Beds				
Bracklesham or Middle Bagshot				
Lower Bagshot				
Part of Lower Bagshot				
London Clay		Lower		Lower
Oldhaven Beds				
Woolwich and Reading Beds				
Thanet Sands				

the British Tertiary Beds.

Von Koenen, 1863.	*Page,* 1876.	*Lyell,* 1876.	*Judd,* 1880.	*Geol. Mag. Gardiner,* 1882.	*Geikie,* 1883.	*Phillips and Etheridge,* 1885.
PLIOCENE	PLIOCENE	PLIOCENE (Lwr. | Upper)	PLIOCENE	PLIOCENE	PLIOCENE	PLIOCENE
MIOCENE	MIOCENE	MIOCENE (Lower | Upper)	MIOCENE	MIOCENE	MIOCENE	MIOCENE
OLIGOCENE (Lower | Middle | Upper)	EOCENE	EOCENE (Lower | Middle | Upper)	OLIGOCENE (Lower | Middle | Upper)	OLIGOCENE (Lower | Middle | Upper)	OLIGOCENE	OLIGOCENE
EOCENE (Lower | Middle | Upper)			EOCENE (Lower | Middle)	EOCENE (Lower | Middle | Upper)	EOCENE (Lower | Middle | Upper)	EOCENE (Lower | Middle | Upper)

The following comparative table has also been prepared by the author to show the varying characteristics of the subdivisions of the period in countries widely separated from each other, together with local modes of classification.

AUSTRALASIA.

Australia and Tasmania.—The preceding comparative table gives a fair abstract of the general features, composition, life, and classification of the rocks of the epoch in each of the Colonies of Australasia where the formations of the period are most extensively developed. In a general way it may be stated that, excluding the later raised sea beaches, the Marine Tertiary formations nearly all belong to *Palæogene* age, and are mainly confined to the southern parts of Australia and the northern parts of Tasmania, extending and occupying the greater part of the low-lying country along the course of the River Murray and the southern coast line of Australia. The Rev. J. Tenison-Woods, in a paper read before the Royal Society of Tasmania (Proc. Roy. Soc. Tas., March, 1873), describes them as commencing on the west side of the Great Australian Bight, and are but little interrupted until the high land of Cape Otway is reached. The only interruptions are granite outcrops about Fowler's Bay, Port Lincoln, &c., and the axis of the Flinders' Range, which terminates at Cape Jervis. Upon the flanks of all these, up to a certain height, the Tertiary rocks rest. In some places, such as the Australian Bight, the beds are nearly 400 feet in thickness, and these give almost at one glance a conspectus of the whole of our Tertiary (marine) formations. Between Warnambool and Cape Otway there are equally perfect series, but not superimposed; and the eastern limits of the floor of this old Tertiary sea are found in the vicinity of the spur of the Dividing Range, which abuts upon the sea at Wilson's Promontory, including the formations close to the sea in Gippsland. The more remarkable localities between Cape Otway and the eastern limit embrace formations on the eastern and western shores of Port Phillip, including Geelong, Mount Maria, Muddy Creek, Cape Schanck, &c. The cliffs on the coast near Spring Creek, 16 miles south of Geelong, expose a thickness of about 300 feet of strata. The most southerly limits of this old sea floor are found in northern Tasmania in isolated patches between Cape Grim in the extreme north-west and Flinders' Island in the north-east. The patches in Tasmania, however, though of limited extent, are of considerable thickness, and are extremely rich in fossils. The localities where they are best known occur at (1) a point a little to the south of Cape Grim, extending to Welcome River; (2) Table Cape; (3) Heathy Valley, Flinders' Island.

No marine Tertiaries are known to exist northward towards the Gulf of Carpentaria between the older formations of Western Australia and the Eastern Cordillera; and Mr. Tenison-Woods and other authorities state that the Tertiaries thin out in the direction of the northern and eastern tributaries of the Murray (Riverina District). The ancient mesial gulf dividing the old land of Western Australia from the Eastern Cordillera is in the northern portion occupied mainly by marine formations of Cretaceous age.

The lacustrine formations, also of *Palæogene* age—consisting of clays, marls, sands, lignites, leaf-beds, and pebble drifts—occur in limited basins at various altitudes throughout the eastern and southern part of Australia, and very extensively throughout Tasmania, where some of them are found probably over 1000 feet in thickness. It is estimated that the lacustrine formation known as the Launceston Tertiary Basin, in northern Tasmania, alone covered an area of not less than 600 square miles.

Volcanic Activity.

One of the most remarkable features of the Tertiary period throughout Australia and Tasmania marking the close of the Palæogene epoch is the eruption of extensive sheets, flows, and accumulations of feldspar basalts, with their associated tuffs. It is evident that great volcanic activity prevailed generally at this time, especially in the neighbourhood of ancient lakes, estuaries, and river systems. Considerable areas in such places are covered by repeated flows or sheets of basalt or scoriæ—overwhelming forests, and filling ancient valleys, lakes, estuaries, and river beds. Great waste and erosion have occurred since the period of volcanic activity, and the existing beds of watercourses now generally found at a much lower level are often cut deeply through the sedimentary basins formed by lakes during the Tertiary period.

In the main valleys occur raised alluvial flats, and on the higher slopes ancient gravel terraces; the latter frequently overlying the basalts or basaltic tuffs. Where these formations (Neogene) overlie the older granites, porphyries, metamorphic rocks or slates, they are often mined in search of auriferous and stanniferous drifts, which are generally found occupying the "leads" of the ancient watercourses. The outbursts of volcanic matter are not confined to the lower plains and valleys, for many extensive patches are found in Tasmania, in the great inland plateau, at a height of from 3000 to 4000 feet above sea level, notably at Lake St. Clair, Great Lake, Lake Sorell, and Marlborough. The western elevated plateau of Tasmania, in the neighbourhood of Magnet Range, Mount Bischoff, and Hampshire Hills, is covered to a great extent by a considerable thickness of basalt, and in the localities named this rock is found at altitudes varying between 1800 and 2500 feet above sea level.

Even in these higher levels the existence of extensive underlying beds of lignite and ligneous clays with associated leaf-beds, indicate that the outbursts occurred in regions occupied by fresh-water lakes.

Climate.

Palæogene Period.—Professor Duncan is of opinion that the evidence of the flora of the period resembles that of tropical rather than extra-tropical Australia; and that the Echinodermata of the period afford similar evidence. In addition, the marine beds at Table Cape, Tasmania—rich in reef-building corals—have recently afforded evidence of contemporaneous relationship with a flora, some of the species of which (*Sapotacites oligoneuris*, &c.) are identical with those abounding in lacustrine deposits throughout the island. Of the Tasmanian reef-building corals Professor Duncan writes: "Evidently the reefs round Tasmania, now long extinct, existed amidst all the physical conditions peculiar to coral growth on a large scale. Pure sea water, in rapid movement, and having a temperature of not less than 74° Fahrenheit, was as necessary to them as it is to those far away to the north and the north-east at the present day. The coral-isotherm would have to be 15° of latitude south of its present position in order that the reef should flourish south of Cape Howe."

We must not forget, however, that the Rev. J. Tenison-

Woods, who was the first person who made a thorough investigation of our Tertiary marine beds, has come to regard the evidences of the fauna in a different light. He infers that " our Lower Tertiary fauna is not a tropical, or even a sub-tropical one." " All that we can say," he continues, " is that certain species which are found still living now inhabit the tropics, while others remain where they are, and generally very many of the genera are now to be found in a warmer climate. It is very remarkable to find specimens of reef-building corals, but we can hardly assert under what conditions they lived, since they are so very different from the reef-builders of the present day. I suppose it is hardly attempted to account for the reef-building corals which we find in the British coral rag (oolitic), for instance, by climatal conditions alone. He further adds : " It seems to me that we are too imperfectly acquainted with the circumstances which govern the migration of species at present to be able to apply even generally any reasoning to such facts as those before us. Climate alone will not account for them." The difficulty of arriving at correct conclusions is not lessened by confining attention to the flora ; for the general prevalence of the oak, birch, elm, alder, and beech in the Tertiary lacustrine deposits, and their almost total disappearance in Australia at the close of the Palæogene period, are matters not easily disposed of by references to any one single cause. From the knowledge of the distribution of such types at the present day, we would be justified in inferring a very temperate clime, in Tasmania at least, during the earlier or middle part of the Tertiary period. And this inference is borne out to some extent by the fact that one of the survivals—the genus *Fagus*—is now only to be found in moist situations in alpine and sub-alpine heights in Tasmania, whilst the genus *Eucalyptus*, found rarely in the Tertiary deposits of Tasmania, now generally predominates over all other trees in the drier and warmer parts from the sea level to sub-alpine heights. Whatever influences were at work, therefore, towards the close of the Middle Tertiary period, it is evident in Australia that they operated in favour of the spread of the *Proteaceæ* and *Myrtaceæ*, and against the deciduous types of trees such as the oaks, elms, beeches, and alders formerly prevailing; and it is equally true that effects the reverse of this were in operation in France, Switzerland, and Great Britain, where the *Proteaceæ*, formerly so abundant, have now become extinct.

Neogene Period.—Mr. Wilkinson is of opinion that the great drift deposits left at different levels upon the sides of the valleys as they were deepened towards the close of the *Neogene* period indicate a much greater rainfall than at present, and this greater rainfall is inferred to be due to the greater extent of glaciation of portions of the northern and southern hemispheres. Whatever grounds there may be for this view, it is clear, from the absence of huge ice-borne erratics and other evidences on the lower levels, we are not justified in assuming a very serious and general refrigeration of the climate in the Australasian region.

That a considerable change of climate, however, had its beginning at this time is most probable, as evidenced by the sudden disappearance of the characteristic flora of the older or *Palæogene* epoch; and especially by the striking contrast which its unstratified irregular drift deposits (almost barren of all traces of life) present, as compared with the more regularly stratified members, replete with life remains, of the *Palæogene* epoch.

New Zealand.—In the preceding comparative table it may be seen that the great physical changes in New Zealand during the Tertiary period do not correspond with those of Australia and Tasmania. Unlike the latter, the several divisions in New Zealand are well marked by successive marine formations, and these again are in most cases easily distinguished by the different assemblages of molluscs contained in them, and by the striking differences as regards the percentages which obtain in respect of those of the species having living representatives. This is at once apparent from the following abstract of the subdivision as arranged by Professor Hutton:—

Classification of Tertiary Formations in New Zealand.

	Contained Percentage of Species still existing.
Wanganúi System (Pliocene)	70 to 90
Pareora System (Miocene)	20 to 45
Oamarú System (Oligocene)	9 to 10

It is obvious, therefore, that with such marked characteristics in the assemblages of the mollusca, the New Zealand rocks do not present to the classifier such difficulties as those referred to with respect to the members of the system in Australia and Tasmania,—where, with the exception, perhaps, of a limited patch of marine beds of later age at Flemington, Victoria, the whole of the marine formations are confined to an extensive though continuous series of formations, which, if we trust to the percentage method, must be restricted to the earliest Tertiary period (probably Eocene).

None of the various bands or groups in Australia and Tasmania contain more than from about 1 to 5 per cent. of species of molluscs having living representatives. It is significant, too, that as the molluscs of these beds are more thoroughly investigated the tendency is to reduce even this very small percentage. Whatever advantage there may be locally in distinguishing certain zones within the Australian and Tasmanian series, it seems, therefore, almost certain, according to the percentage method, that they should be classed as Eocene rather than Oligocene or Miocene, to which periods some of the divisions have been referred by some authorities.

With such advantages as those referred to, the New Zealand geologists have greater facilities for determining the position of their numerous lacustrine formations containing lignites, coals, and other vegetable drifts.

From the fact that some of the marine formations of the Paréora system are now found at an altitude of over 2000 feet above sea level, it is evident that New Zealand has been subjected to even greater physical changes than Australia and Tasmania since the early Tertiary period. The greater extent of glaciation in the Neogene epoch in New Zealand is also evidently isochronous with the supposed colder epoch in Australia and Tasmania, and it is generally regarded by the geologists of New Zealand as mainly due to the very much greater elevation of the land at that time.

Life of the Period in Australia and Tasmania.

The following tables show the probable distribution, in time, of the genera of plants and molluscs occurring in Australia and Tasmania during the Tertiary period, embracing also a fairly complete list of the various species of fossils described up to the present time. The tables, by their arrangement, readily indicate the distribution in the various Colonies where the Tertiary formations are principally developed.

In addition to the generic and specific lists of fossils, a summary has been prepared under the head of *Classes*, showing in alphabetical order the names of authors to whom we are indebted for the greater part of the original specific descriptions and determinations. It will be seen from this summary that the principal palæontological work has been accomplished by the following persons; viz.—

Plantæ—Baron von Ettingshausen, Baron F. von Mueller, and R. M. Johnston.

Rhizopoda—D'Orbigny, and Professors Rupert Jones and Brady.

Actinozoa—Dr. Duncan and Rev. J. E. Tenison-Woods.

Echinodermata—Dr. Duncan, Lamarck, and Professor M'Coy.

Polyzoa—Professor Busk and Rev. J. E. Tenison-Woods.

Mollusca—Professor Tate, Rev. J. E. Tenison-Woods, R. M. Johnston, and Professor M'Coy.

Pisces and Mammalia—Professors Agassiz and M'Coy.

Of the 908 species enumerated, Professor Tate has described 224 species, or nearly 25 per cent.; Rev. J. E. Tenison-Woods described 165 species; and the author describes or figures 116 species. The three together describe 505 species, or over 52 per cent. of the whole.

TABLE SHOWING T... URED BY

Authors of Sve...

...lia.

Laurineæ ...
Artocarpeæ
Moreæ ....
Salicineæ ..
Cupuliferæ .
Platanaceæ.
Betulaceæ .
Juglandaceæ
Myricaceæ .
Ulmaceæ ..

Tertiary Fossils.

TABLE SHOWING THE NUMBER OF SPECIES UNDER EACH CLASS, DESCRIBED, DETERMINED, OR FIGURED BY VARIOUS AUTHORS.

Authors of Species enumerated.	*Plantæ.*	*Rhizopoda.*	*Actinozoa.*	*Echinodermata.*	*Annelida.*	*Crustacea.*	*Polyzoa.*	*Brachiopoda.*	*Pelecypoda.*	*Scaphapoda.*	*Pteropoda.*	*Gasteropoda.*	*Cephalapoda.*	*Pisces.*	*Mammalia.*	TOTAL.
Adams and Reeve	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Agassiz	..	..	..	..	..	..	..	..	..	..	..	..	..	7	..	7
Alth	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Brocchi	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Bosquet	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Busk	..	..	..	..	..	..	33	..	..	..	..	..	..	..	..	33
Carter	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Davidson	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1
Darwin	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	1
Defr	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Deshayes	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	1
D'Orbigny	..	24	..	..	..	..	1	..	1	..	..	..	..	..	..	26
Duncan	..	..	31	12	..	..	..	..	..	..	..	..	..	..	..	43
Edwards and Haimes	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	3
Etheridge (R.)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
——— (R., jun.)	..	..	..	1	..	..	1	2	3	..	..	..	..	..	..	7
Ettingshausen	61	..	..	..	..	..	..	..	..	..	..	..	..	..	..	61
Fichte and Molla	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	3
Gray	..	..	..	2	..	..	..	..	1	..	..	..	..	..	..	3
Hassal	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	2
Hagenow	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Harris	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Hutton	..	..	..	..	..	..	..	1	3	..	..	2	..	..	..	6
Johnston (R. M.)	74	..	..	1	..	1	..	..	6	..	..	34	..	..	..	116
Jones and Peddar	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Lamarck	..	4	..	1	..	..	..	..	1	..	..	..	..	..	..	6
Lauba	..	..	..	9	..	..	..	..	..	..	..	..	..	..	..	9
Linnæus	..	1	..	..	..	..	1	..	2	..	..	..	..	..	..	4
M'Coy	3	1	..	6	1	..	1	1	11	..	..	22	..	4	4	54
M'Gillivray	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Montagu	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Mueller (Baron F. von)	31	..	..	..	..	..	..	..	..	..	..	..	..	..	..	31
Phillips	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Quoy and Gaimard	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Reuss	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	2
Sanger	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1
Sowerby (J.)	..	..	..	..	..	..	..	1	1	..	..	2	..	..	..	4
Sowerby (G. B.)	..	..	..	..	..	..	..	..	1	..	..	2	1	..	..	4
Stoliczka	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Sturt	..	..	..	..	..	..	4	..	6	..	..	..	..	..	..	10
Sequenza	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Tate (Professor Ralph)	..	..	..	1	..	..	..	23	168	6	5	20	1	..	..	224
Woods (Tenison)	..	..	22	3	..	..	13	5	21	..	..	101	..	..	..	165
Woods and Duncan	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Woods and Tate	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Walker and Jacob	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Wright	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Zittel	..	..	..	..	..	..	..	..	4	1	..	..	..	..	..	5
Undetermined	4	6	5	1	..	..	6	..	10	..	..	14	..	..	4	50
TOTAL	173	50	63	39	1	6	65	34	243	8	5	197	2	11	10	908

PROBABLE RANGE, IN TIME, OF THE CHARACTERISTIC GENERA OF PLANTS OCCURRING IN THE ROCKS OF THE TERTIARY PERIOD IN AUSTRALIA AND TASMANIA.

		PALÆOZOIC.			MESOZOIC.			CAINOZOIC.			
								TERTIARY.			
Families.	Genera.	Cam. to Dev.	Carb.	Per.	Tr.	Jr.	Gr.	E.	M.	P.	POST TER.
Myristicaceæ	Myristica						—	—	—	—	—
Magnoliaceæ	Magnolia						—	—	—		
	Liriodendron								—	—	—
	Illicites								—	—	—
Pittosperaceæ	Pittosporum						—	—	—	—	—
Myrtaceæ	Eucalyptus						—	—	—?	—	—
Aceraceæ	Acer								—	—	
Sapindaceæ	Sapindus								—		
	Pentacoila								—		
	Penteune								—		
	Phymatocaryon								—		
	Tricolocaryon								—		
Tillaceæ	Tilia								—	—	—
	Elæocarpus								—		
Rhamneæ	Rhamnus								—	—	—
	Pomaderrites								—		
Calycifloræ	Acrocoila								—		
Papilionaceæ	Dalbergia								—		
Celastrineæ	Celastrophyllum								—		
Olacineæ	Eisothecaryon								—		
Sterculiaceæ	Bombax								—		
Capparideæ ?	Liversidgea								—		
	Dieune								—		
	Ochtodocaryon								—		
	Plesiocapparis								—		
Menispermaceæ	Rhytidocaryen								—		
Saxifragaceæ	Ceratopetalum						—	—	—		
Sapotaceæ	Sapotacites								—		
Cæsalpineæ	Cassia								—	—	—
	Leguminocites						—		—	—	—
Verbenaceæ	Premna								—		
	Trematocaryon								—		
Boragineæ	Cordia								—	—	—
Apecynaceæ	Apocynephyllum								—	—	—
	Tabernæmontaoa								—	—	—
	Echitonium								—	—	—
Rubiaceæ	Copresma								—	—	—
Proteaceæ	Lomatia								—	—	—
	Knightia								—		
	Banksia								—		
	Conchocaryen								—	—	—
	Celyphina								—		
	Conchotheca								—		
	Dryandroides						—	—	—	—	—
Laurineæ	Cinnamomum						—	—	—	—	—
	Laurus								—	—	—
	Daphnogena								—		
Artocarpeæ	Artocarpidium								—	—	—
Moreæ	Ficonium								—	—	—
	Ficus						—	—	—	—	—
Salicineæ	Salix						—	—	—	—	—
Cupoliferæ	Fagus						—	—	—	—	—
	Quercus						—	—	—	—	—
	Castanepsis								—	—	—
Platanaceæ	Platanus						—	—	—?	—	—
Batulaceæ	Batula								—	—	—
	Alnus								—	—	—
Juglandaceæ	Juglans						—	—	—	—	—
Myricaceæ	Myrica								—		
Ulmaceæ	Ulmus								—	—	—
	Microrhagien								—		

CKS OF AUSTRALASIA,

TIC GENERA OF PLANTS OCCURRING IN THE ROCKS OF THE
AUSTRALIA AND TASMANIA.

PALÆOZOIC.			MESOZOIC.			CAINOZOIC.			
						TERTIARY.			POST TER.
n.	*Carb.*	*Per.*	*Tr.*	*Jr.*	*Gr.*	*E.*	*M.*	*P.*	
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Families.	NOZOIC.		
	RY.		POST TER.
		P.	
Coniferæ		—	—
		—	—

Pleu	—	—
Daph	—	—
Mang	—	—
Conu	—	—
Cypr	—	—
Trivi	—	—
Cassi	—	—
Cassi	—	—
Nati	—	—
Troc	—	—
Crep	—	—
Solar	—	—
Adec	—	
Scal	—	—
Cros	—	—
Turr	—	—
Torc		
Verr	—	—
Tene	—	—
Euli	—	—
Leio	—	—

		PALÆOZOIC.			MESOZOIC.			CAINOZOIC.			
								TERTIARY.			POST TER.
Families.	*Genera.*	*Dev.*	*Carb.*	*Per.*	*Tr.*	*Jr.*	*Cr.*	*E.*	*M.*	*P.*	
Coniferæ	Spondylostrobus								—	—	—
	Larix								—	—	—
	Araucaria					—	—	—	—	—	—
	Saquoia						—	—	—	—	—
	Taxites			—	—	—	—	—	—	—	—
Filices	Pteris								—	—	—
	Trichomanes								—	—	—
	Lomaria								—	—	—
	Aspidium								—	—	—

PROBABLE RANGE, IN TIME, OF THE CHARACTERISTIC GENERA OF MOLLUSCS OCCURRING IN THE ROCKS OF THE TERTIARY PERIOD IN AUSTRALIA AND TASMANIA.

	PALÆOZOIC.				MESOZOIC.			CAINOZOIC.			
								TERTIARY.			POST TER.
	Ca.	*Sil.*	*Dev.*	*Carb. Per.*	*Tr.*	*Jr.*	*Cr.*	*Eo.*	*Mio.*	*Plio.*	
Brachiopoda.											
Terebratula					—	—	—	—	—	—	—
Waldheimia				—	—	—	—	—	—	—	—
Terebratulina						—	—	—			—
Terebratella					—	—	—	—			
Megasella								—			
Thecidium					—	—	—	—			
Rhynchonella		—	—	—	—	—	—	—	—	—	
Pelecypoda.											
Aspergillum								—	—	—	—
Solecurtus								—	—	—	—
Saxicava						—	—	—	—	—	—
Panopæa							—	—	—	—	—
Corbula							—	—	—	—	—
Zonatiopsis								—	—	—	—
Myodora							—	—	—	—	—
Psammobia							—	—	—	—	—
Tellina							—	—	—	—	—
Chione							—	—	—	—	—
Cytherea							—	—	—	—	—
Dosinia								—	—	—	—
Gouldia											
Cardium		—	—	—	—	—	—	—	—	—	—
Chama							—	—	—	—	—
Chamostrea											
Lucina		—	—	—	—	—	—	—	—	—	—
Diplodonta					—		—	—	—	—	—
Sacchia								—			
Lepton								—			
Kollia								—	—	—	—
Crassatella								—	—	—	—
Montacuta								—			
Cardita								—	—	—	—
Mytilicardia								—	—	—	—
Unio					—	—	—	—	—	—	—
Anodonta								—	—	—	—
Trigonia			—	—	—	—	—	—	—	—	—
Nucula		—	—	—	—	—	—	—	—	—	—
Leda		—	—	—	—	—	—	—	—	—	—
Arca		—	—	—	—	—	—	—	—	—	—
Barbatia								—	—	—	—
Cucullæa		—	—	—	—	—	—	—	—	—	—

	PALÆOZOIC.				MESOZOIC.			CAINOZOIC.			
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	Ca.	Sil.	Dev.	Carb. Per.	Tr.	Jr.	Cr.	Eo.	Mio.	Plio.	
Pelecypoda—continued.											
Pectunculus								—	—	—	—
Limarca								—	—	—	
Limopsis					—	—	—	—	—	—	—
Modiolaria								—	—		
Septifer						—	—	—	—		
Vulsella							—	—	—	—	—
Pinna								—	—	—	—
Spondylus				—	—	—	—	—	—	—	—
Modiola		—			—	—	—	—	—	—	—
Lima				—	—	—	—	—	—	—	—
Limea						—	—	—			
Pecten			—	—	—	—	—	—	—	—	—
Hinnites					—	—	—	—	—	—	—
Placunanomia				—				—	—		
Ostrea					—	—	—	—	—	—	—
Gryphea						—	—	—	—		
Dimya								—	—		
Pteropoda.											
Styliola								—	—		
Vaginella								—	—		
Spirialis								—	—	—	
Gasteropoda.											
Helix							—	—	—	—	—
Vitrina								—	—	—	—
Bulimus								—	—	—	—
Murex								—	—	—	—
Typhis								—	—	—	—
Ricinula								—	—	—	—
Tritonium								—	—	—	—
Fusus							—	—	—	—	—
Latirus											
Buccinum								—	—	—	—
Cominella								—	—	—	—
Nassa								—	—	—	—
Voluta							—	—	—	—	—
Mitra							—	—	—	—	—
Thala								—			
Erato								—	—	—	—
Marginella							—?	—	—	—	—
Ancillaria								—	—	—	—
Columbella								—	—	—	—
Cancellaria								—	—	—	—
Terebra								—	—	—	—
Pleurotoma							—	—	—	—	—
Daphnella								—	—	—	—
Mangelia								—	—	—	—
Conus							—	—	—	—	—
Cypræa							—	—	—	—	—
Trivia								—	—	—	—
Cassis								—	—	—	—
Cassidaria							—	—	—	—	—
Natica		—	—	—	—	—	—	—	—	—	—
Trochita								—	—	—	—
Crepidula							—	—	—	—	—
Solarium								—	—	—	—
Adeorbis								—	—	—	
Scalaria				—	—	—	—	—	—	—	—
Crossea								—	—	—	—
Turritella				—	—	—	—	—	—	—	—
Torcula								—	—		
Vermetus			—	—	—	—	—	—	—	—	—
Tenagodus								—	—	—	—
Eulima				—	—	—	—	—	—	—	—
Leiostraca								—	—	—	—

OF AUSTRALASIA,

	MESOZOIC.			CAINOZOIC.			
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Carb. Per.	*Tr.*	*Jr.*	*Cr.*	*Eo.*	*Mio.*	*Plio.*	
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,, Werribee		
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Daphnogene, sp		
Proteaceæ.		
Lomatia prælon	—	
Knightia Dalton		
Banksia, sp. ind.		
,, sp. ind		
Conchocaryon S		
Celyphina Macc		
Conchotheca (?)		
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Dryandroides J		
Rubiaceæ.		
Coprosma præcu		
Apocynaceæ.		
Apocynophyllum	—	
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Tabernæmontan	—	
Echitonium obs		

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	PALÆOZOIC.				MESOZOIC.			CAINOZOIC.			
								TERTIARY.			POST TER.
	Ca.	*Sil.*	*Dev.*	*Carb. Per.*	*Tr.*	*Jr.*	*Cr.*	*Eo.*	*Mio.*	*Plio.*	
Gasteropoda—continued.											
Turbonilla							—	—	—	—	—
Odostomia								—	—	—	—
Pyramidella							—	—	—	—	—
Cerithium				—	—	—	—	—	—	—	—
Cerithiopsis								—	—		
Potamides								—	—	—	—
Rissoina								—	—	—	—
Rissoa								—	—	—	—
Liotia						—	—	—	—	—	—
Turbo		—	—	—	—	—	—	—	—	—	—
Imperator					—	—	—	—	—	—	—
Calcar								—	—	—	—
Delphinula						—	—	—	—	—	—
Trochus			—	—	—	—	—	—	—	—	—
Gibbula											
Zizyphinus								—	—	—	—
Thalotia								—	—	—	—
Euchelus								—	—	—	—
Margarita								—	—	—	—
Haliotis							—	—	—	—	—
Fissurellidæ				—	—	—	—	—	—	—	—
Emarginula				—	—	—	—	—	—	—	—
Actæon					—	—	—	—	—	—	—
Ringicula								—	—	—	—
Cylichna						—	—	—	—	—	—
Scaphopoda.											
Dentalium								—	—	—	—
Entalis								—	—		
Cadulus			—	—	—	—	—	—	—	—	—

LIST OF THE SPECIES OCCURRING IN THE ROCKS OF THE SYSTEM IN AUSTRALASIA.

		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	Neo.	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.
PLANTÆ.									
Filices.									
Pteris Humei	*Ettingshausen.*							—	
„ Belli	*R. M. Johnston.*	—							
Lomaria primæva	„	—							
Trichomanides Tasmanica	„	—							
Coniferæ.									
Spondylostrobus Smythii	*F. von Mueller.*	—				—		—	
Aracauria Johnstonii	„	—							
Taxites Thureaui	*R. M. Johnston.*	—							
Cycadites microphylla	„	—							
Monocotyledon.									
Microrhagion Liversidgei	*Ettingshausen.*							—	
Myricaceæ.									
Myrica Eyeri	„	—							
Betulaceæ.									
Betula Daltoniana	„							—	
„ Derwentensis	„	—							
„ Launcestonensis	*R. M. Johnston.*	—							
Almaceæ.									
Alnus Muelleri	*Ettingshausen.*	—						—	
Ulmus Tasmanicus	*R. M. Johnston.*	—							
Cupuliferæ.									
Quercus Hookeri	*Ettingshausen.*							—	
„ præphilippinensis	„							—	
„ drymejoides	„							—	
„ Darwinii	„							—	
„ Tasmanii	„	—							
„ sp. ind.		—							
„ Bischoffensis	*R. M. Johnston.*	—							
Fagus Wilkinsoni	*Ettingshausen.*							—	
„ Risdoniana	„	—							
Castanopsis Benthami	„							—	
Salicineæ.									
Salix Cormickii	„	—							
Moreæ.									
Ficonium Solandri	„							—	
Artocarpeæ.									
Artocarpidium Stuartii	„							—	
Laurineæ.									
Cinnamomum polymorphoides	*M'Coy.*	—						—	
„ Leichardtii	*Ettingshausen.*							—	
„ Woodwardii	„	—							
„ Hobartianum	„	—							
Laurus Australiensis	„							—	
„ Werribeensis	*M'Coy.*					—			
„ Sprentii	*R. M. Johnston.*	—							
„ sp. ind.	„					—			
Daphnogene, sp. ind.	„					—			
Proteaceæ.									
Lomatia prælongifolia	*Ettingshausen.*	—						—	
Knightia Daltoniana	„								
Banksia, sp. ind.						—			
„ sp. ind.		—							
Conchocaryon Smithii	*F. von Mueller.*					—			
Celyphina Maccoyi	„					—			
Conchotheca (?) rotundata	„					—			
„ turgida	„	—				—			
Dryandroides Johnstonii	*Ettingshausen.*	—							
Rubiaceæ.									
Coprosma præcuspidifolia	„	—							
Apocynaceæ.									
Apocynophyllum Etheridgei	„							—	
„ travertinum	„	—							
„ microphyllum	„	—							
Tabernæmontana primigenia	„							—	
Echitonium obscurum	„	—							

OF AUSTRALASIA,

E ROCKS OF THE SYSTEM IN AUSTRALASIA.

	TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.
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		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	Neo.	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.
Boragineæ.									
Cordia Tasmanica	*Ettingshausen.*	—							
Verbenacæ.									
Premna Drummondii	,,	—							
Trematocaryon Maclellani	*F. von Mueller.*					—			
Sapotaceæ.									
Sapotacites oligoneuris	*Ettingshausen.*	—							
,, achrasoides	,,	—							
Saxifragaceæ.									
Ceratopetalum Woodii	,,	—							
,, præarbutifolium	,,	—							
Menispermaceæ.									
Rhytidocaryon Wilkinsoni	*F. von Mueller*							—	
Magnoliaceæ.									
Magnolia Brownii	*Ettingshausen.*							—	
,, Torresii	,,							—	
Illicites astrocarpa	*F. von Mueller*							—	
Capparideæ.									
Liversidgea oxyspora	,,							—	
Dieune pluriovulata	,,					—			
Ochtodocaryon Wilkinsonii	,,							—	
Plesiocapparis leptocelyphis	,,	—						—	
,, priaca	,,					—			
Sterculiaceæ.									
Bombax Sturtii	*Ettingshausen.*							—	
,, Mitchellii	,,							—	
Tiliaceæ.									
Elæocarpus Bassii	,,	—							
Olaeineæ.									
Eisothecaryon semiseptatum	,,							—	
Sapindaceæ.									
Sapindus Tasmanicus	,,	—							
Pentacoila Gulgongensis	*F. von Mueller.*							—	
Penteune brachyclinis	,,					—			
,, Clarkei	,,					—			
,, trachyclinis	,,					—			
,, Allporti	,,	—							
Phymatocaryon angulare	,,					—			
,, bivalve	,,					—			
,, Mackayi	,,					—			
Tricolocaryon Barnardii	,,							—	
Pittosporaceæ.									
Pittosporum priscum	*Ettingshausen.*							—	
Celastrineæ.									
Celastrophyllum Cunninghami	,,							—	
Rhamneæ.									
Pomaderris Banksii	,,							—	
Calyciforæ.									
Acrocoila anadonta	*F. von Mueller*							—	
Myrtaceæ.									
Eucalyptus Delftii	*Ettingshausen.*							—	
,, obliqua ?	*Herit.*					—			
,, Pluti	*M'Coy.*					—			
,, Kayseri	*R. M. Johnston.*	—							
,, Milligani	,,	—							
Papilionaceæ.									
Dalbergia Diemenii	*Ettingshausen.*							—	
Cæsalpineæ.									
Cassia Cookii	,,							—	
,, Flindersii	,,	—							
Leguminosites Kennedyi	,,							—	
Incertæ sedis.									
Odontocaryon Macgregorii	*F. von Mueller*					—			
Platycoila Sullivani	,,	—				—			
Pleiacron elachocarvum	,,							—	
Rhytidotheca Lynchii	,,					—			
,, pleioclinis	,,	—				—			
Wilkinsonia bilaminata	,,					—			

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Cæsalpineæ—continued.									
Xylocaryon Lockii	*F. von Mueller.*	—				—			
Carpolithes gærtneroides	*Ettingshausen.*	—							
,, Risdonianus	,,	—							
,, sp. indet. Fig. 7	*(Johnston.)*	—							
,, ,, ,, 11	*Proc. Roy. Soc.*	—							
,, ,, ,, 13	*Tasmania*, 1874.	—							
,, ,, ,, 15		—							
,, ,, ,, 38–39	*Ibid*, 1881.	—							
,, ,, ,, 51–53	,,	—							
,, ,, ,, 54–55	,,	—							
,, ,, ,, 58	,,	—							
,, ,, ,, 61	,,	—							
,, ,, ,, 62	,,	—							
Phyllites populiformis	*Ettingshausen.*	—							
,, ficiformis	,,	—							
,, juglandiformis	,,	—							
,, ligustroides	,,	—							
,, pyriformis	,,	—							
,, phaseolites	,,	—							
,, sophoræformis	,,	—							
,, mimosæformis	,,	—							
,, sp. ind. Fig. 2		—							
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,, ,, ,, 12	*(Johnston.)*	—							
,, ,, ,, 15	*Proc. Roy. Soc.*	—							
,, ,, ,, 16	*Tasmania*, 1873.	—							
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,, ,, ,, 7		—							
,, ,, ,, 8	*Ibid*, 1874.	—							
,, ,, ,, 9	*(Johnston.)*	—							
,, ,, ,, 14		—							
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,, ,, ,, 7		—							
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,, ,, ,, 17		—							
,, ,, ,, 18	*Ibid*, 1881.	—							
,, ,, ,, 19	Estuary of the Der-	—							
,, ,, ,, 21	went. *(Johnston.)*	—							
,, ,, ,, 24		—							
,, ,, ,, 32		—							
,, ,, ,, 33		—							
,, ,, Pl. I. Fig. 5	*Ibid*, 1885.	—							
,, ,, Pl. I. ,, 6	Leaf-beds under	—							
,, ,, Pl. I. ,, 7	basalt at Waratah.	—							
,, ,, Pl. II. ,, 2	*(Johnston.)*	—							
,, ,, Pl. II. ,, 3		—							
,, ,, Fig. 1	*Ibid*, 1886.	—							
,, ,, ,, 2	*Ibid.* Leaf impressions, in-	—							
,, ,, ,, 3	cluding *Sapotacites oligo-*	—							
,, ,, ,, 4	*neuris* (Ett.), occurring in	—							
,, ,, ,, 5	the *Turritella* sandstone beds	—							
,, ,, ,, 6	at Table Cape, Tasmania,	—							
,, ,, ,, 8	among which the marine	—							
,, ,, ,, 10	shells *T. Warburtonii* and	—							
,, ,, ,, 11	*Panopeæ Agnewi* are espe-	—							
,, ,, ,, 12	cially characteristic. (John-	—							
,, ,, ,, 13	ston.)	—							

OF AUSTRALASIA,

	TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
	Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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" Dendrophyllia		
" Paracyathus (		
Eupsammia (		
Cyathosmilia l		
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Bistylia adher		
Cladocora con		
Pleiastræa St.		
" sp.		
Montlivaltia di		
Trematrochus		
ECHINODERMAT		
Arachnoides A		
" el		
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Catopygus eleg		
Cidaris, sp. ind		
Echinanthus te		
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Echinobrissus A		
Echinolampas		
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IA.	NEW SOUTH WALES

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Fossil wood. *Pine*, sp. indet. Fig. 16–18.	*Proc. Roy. Soc. Tasmania*, 1874. *(Johnston.)*	—							
" *Banksia* " " 10–13.		—							
" *Exogen* " " 19–20.		—							
" " " " 14–15.		—							
ANIMALIA.									
RHIZOPODA.									
Foraminfera.									
Amphistegina vulgaris	*D'Orb.*			—		—			
Biloculina contraria	"			—					
" depressa	"			—					
" elongata	"			—					
" ringens	*Lamarck.*			—					
" sp. indet.		—							
Cassidulina oblonga*	*Reuss.*	—		—					
Cornuspira foliacea	*Phillipi.*			—					
" involvens	*Reuss.*			—					
Cristellaria rotulata	*Lamarck.*			—					
Discorbina Berthéloti	*D'Orb.*	—		—					
" turbo	"					—			
Glandulina lævigata	"			—					
Globigerina bulloides	"			—					
Hauerina compressa	"			—					
Lituola Soldanii	*Jones & Parker.*					—			
Nummulina Raymondi	*Defr.*					—			
" sp. indet.		—							
Operculina Arabica	*Carter.*			—					
" complanata	*Defr.*			—		—			
Orbitolites complanatus	*Lamarck.*			—					
Orbulina universa	*D'Orb.*			—					
" sp. indet.		—							
Planorbulina Haidingerii	"			—		—			
" lobatula	"			—					
" reticulata	*Czjzck.*			—					
" rotula	*D'Orb.*			—					
" Ungeriana	"			—					
Planularia crepidula	*Fichtel & Moll.*			—					
Polymorphina lactea	*Walker & Jacob.*			—		—			
" sp. indet.		—							
Polystomella craticula	*Fichtel & Moll.*			—					
" macella	"			—					
Nonionina sp. indet.		—							
Pulvinulina pulchella	*D'Orb.*			—		—			
" repanda, var. elegans	"			—					
Quinqueloculina agglutinans	"			—					
" secans	"			—					
" seminulum	*Linn.*			—		—			
" subrotunda	*Montagu.*			—					
" sp. indet.		—							
Rotalia Beccarii var.	*Linn.*								
" var. Soldanii	*D'Orb.*			—					
Spiroloculina canaliculata	"			—					
Textularia agglutinans	"	—		—					
" pygmæa	"	—		—					
" sagittula	"			—		—			
Triloculina oblonga	*Montagu.*			—					
" tricarinata	*D'Orb.*			—					
" trigonula	*Lamarck.*			—		—			
Spongida.									
Tethia Newberyi	*M'Coy.*					—			
ACTINOZOA.									
Amphihelia zic-zac	*Ten.-Woods.*			—					
" incrustans	*Duncan.*			—		—			
" striata	*T. Woods.*					—			
Conocyathus cyclostratus	"					—			
" fenestratus	"					—			
Trochocyathus meridionalis	*Duncan.*					—			

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Trochocyathus Victoriæ	*Duncan.*					—			
,, heterocostatus	*T. Woods.*			—		—			
Deltocyathus viola	*Ten.-Woods & Duncan.*	—		—		—			
,, italicus	*M. Ed. & Haime.*			—		—			
,, excisus	*Duncan.*	—		—		—			
,, alatus	*Ten.-Woods.*			—		—			
,, Aldingensis	,,			—					
,, Tateanus	,,			—					
Sphenotrochus variolaris	,,					—			
,, Australis	*Duncan.*			—		—			
,, emaciatus	,,					—			
Conotrochus M'Coyi	,,	—				—			
,, typus	*Sequenza.*			—		—			
Antillia lens	*Duncan.*	—		—		—			
Smilotrochus vacuus	*Ten.-Woods.*					—			
Flabellum candeanum	*M. Ed. & Haime.*			—		—			
,, distinctum	,,			—		—			
,, Victoriæ	*Duncan.*	—		—		—			
,, Gambierense	,,	—		—		—			
,, Duncani	*Ten.-Woods.*	—							
Placotrochus elongatus	*Duncan.*	—				—			
,, deltoideus	,,	—		—		—			
,, elegans	*Ten.-Woods.*	—							
Heliastræa Tasmaniensis	*Duncan.*	—							
Thamnastræa sera	,,	—							
,, Tasmaniensis	,,	—							
Palæoseris Woodsii	,,	—				—			
Cycloseris tenuis	,,					—			
Conosmilia elegans	,,					—			
,, lituola	,,					—			
,, anomala	,,					—			
,, striata	,,					—			
,, bicycla	*Ten.-Woods.*					—			
,, contorta	,,			—					
Balanophyllia campanulata	*Duncan.*					—			
,, semiunda	,,					—			
,, armata	,,					—			
,, tubuliformis	,,					—			
,, fragilis	,,					—			
,, Australiensis	,,	—		—		—			
,, Selwyni	,,					—			
,, cylindrica (variety)	,,					—			
,, Ulrichi	,,					—			
Dendrophyllia epithecata	,,	—							
,, Duncani	*Ten.-Woods.*	—							
Paracyathus (several varieties indet.)						—			
Eupsammia (,, ,, ,,)						—			
Cyathosmilia laticostata	*Ten.-Woods.*			—					
,, tenuicostata	,,			—					
Bistylia adhærens	,,			—					
Cladocora contortilis	,,			—					
Pleiastræa St. Vincenti	,,			—					
,, sp. indet.	,,			—					
Montlivaltia discus	,,					—			
Trematrochus fenestratus	,,					—			
ECHINODERMATA.									
Arachnoides Australis	*Laube.*			—		—			
,, elongatus	*Duncan.*			—					
,, Loveni	,,					—			
Catopygus elegans	*Laube.*			—					
Cidaris, sp. indet.				—					
Echinanthus testudinarius	*Gray.*					— ?			
Echinarachnius parma	*Lamarck.*			— ?		— ?			
Echinobrissus Australiæ	*Duncan.*					—			
Echinolampas Australis	*Ten.-Woods.*			—					
,, Corioensis	*M'Coy.*					—			
,, ovulum	*Laube.*			—					

OF AUSTRALASIA,

	TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
	Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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Gryphæa tarda* ....
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NEW SOUTH

		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Echinolampas Gambierensis	*Ten.-Woods.*			—					
Echinus Woodsii	*Laube.*			—					
Eupategus Forbesii	*M'Coy.*					—			
„ Laubei	*Duncan.*					—			
„ rotundus	„			—					
„ Wrightii	*Laube.*			—					
„ Murrayensis	„			—					
Hemiaster Archeri	*Ten.-Woods.*			—					
Holaster Australiæ	*Duncan.*			—		—			
Leiocidaris Australiæ	„			—		—			
Lovenia Forbesii	*Woods & Duncan.*	—		—		—			
„ „ var. minor	*Duncan.*	—				—			
„ „ „ Woodsii	*Etheridge, jun.*	—		—		—			
Maretia anomala	*Duncan.*					—			
Megalaster compressus	„			—					
Micraster brevistella	*Laube.*	—		—					
Monostychia Etheridgei (Micraster Eth.)	*R. M. Johnston.*	—							
Paradoxechinus novus	*Laube.*			—					
Psammechinus Woodsii	„			—					
Pygorhynchus Vassali	*Wright.*					—			
Rhynchopygus dysasteroides	*Duncan.*					—			
Salenia tertiara	*Tate.*			—					
Schizaster ventricosus	*Gray.*			—					
Scutella Tamboensis	*M'Coy.*					—			
Temnechinus lineatus	*Duncan.*					—			
Pericosmus gigas	*M'Coy.*					—			
„ Nelsoni	„					—			
„ compressus	„					—			
ANNELIDA.									
Ditrupa Wormbetiensis	*M'Coy.*					—			
CRUSTACEA.									
Bairdia ovata	*Bosquet.*			—					
Cythere Normani	*G. S. Brady.*			—					
Macrocypris acuminata	*Alth.*			—					
Paracypris decora	*G. S. Brady.*			—					
Cypris Alburyana	*R. M. Johnston.*	—							
Balanus amphitrite	*Darwin.*	—							
POLYZOA.									
Caberea lata	*Busk.*			—					
Canda angulata	„			—					
Cellepora costata	„			—					
„ echinata	*Sturt.*			—					
„ escharoides	„			—					
„ Gambierensis	*Busk.*	—		—		—			
„ hemisphærica	„	—		—					
„ nummularia	„	—		—		—			
„ spongiosa	„	—		—					
„ tubulosa	„			—					
Cœleschera Australis (MS.)	„			—					
Crisia eburnea	*Linnæus.*			—					
Eschara arcuata (MS.)	*Busk.*			—					
„ bimarginata (MS.)	„			—					
„ Buskii	*Ten.-Woods.*			—					
„ Clarkeii	„					—			
„ elevata	„			—					
„ hastigera (MS.)	*Busk.*			—					
„ inornata (MS.)	„			—					
„ Liversidgei	*Ten.-Woods.*			—					
„ oculata (MS.)	*Busk.*			—					
„ papillata (MS.)	„			—					
„ piriformis	*Sturt.*			—					
„ porrecta	*Ten.-Woods.*			—					
„ rustica	„			—					
„ simplex (MS.)	*Busk.*			—					
„ Tatei	*Ten.-Woods.*			—					
„ verrucosa	„			—					
„ two species indet.				—					
„ cavernosa	*Ten.-Woods.*			—					

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	Neo.	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.
Hornera Gambiorensis	*Busk.*			—					
„ regulosa	„			—					
Idmonea ligulata (MS.)	„			—					
„ Milneana	*D'Orb.*			—					
Lepralia doliiformis (MS.)	*Busk.*			—					
„ Stawellensis	*M'Coy.*					—			
„ subcarinata (MS.)	*Busk.*			—					
„ submarginata (MS.)	„			—					
„ one or two sp. indet.		—							
Lunulites, sp. ind.						—			
Melicerta angustiloba	*Busk.*			—		—			
Membranipora appressa (MS.)	„			—					
„ bidens	*Hagenow.*			—					
„ cyclops	*Busk.*			—		—			
„ stenostoma	„			—					
Onchopora pustulosa	„			—					
„ vertebralis	*Stoliczka.*					—			
Psileschara pustulosa (MS.)	*Busk.*			—					
„ subsulcata (MS.)	„			—					
Pustulipora corrugata	*Ten.-Woods.*			—					
„ distans	*Busk.*			—					
„ ungulata	*Ten.-Woods.*			—					
„ ramosa	„	—							
Retepora Maccoyana	*Etheridge, jun.*					—			
„ monilifera	*M'Gillivray.*			—					
„ vibicata	*Sturt.*			—					
„ sp. ind.		—							
Salicornaria gracilis	*Busk.*			—					
„ Parkeri (MS.)	„			—					
„ sinuosa	*Hassall.*	—		—		—			
„ tenuirostris	„			—					
Scutularia prima (MS.)	*Busk.*			—					
Buskia typica	*Ten.-Woods.*	—							
Tubulipora Gambierensis	„			—					
BRACHIOPODA.									
Terebratula vitreoides	*Ten.-Woods.*	—		—		—			
„ Aldingæ*	*Tate.*			—					
„ subcarnea	„			—					
„ bulbosa	„			—					
Waldheimia Garribaldiana	*Davidson.*	—		—		—			
„ furcata	*Tate.*	—		—					
„ divaricata	„			—					
„ Tateana	*Ten.-Woods.*	—		—		—			
„ fimbriata	*Tate.*			—					
„ Johnstoniana	„	—		—					
„ insolita*	„			—		—			
„ grandis	*Ten.-Woods.*	—		—		—			
„ Crouchii	„			—					
„ M'Leani	*Tate.*			—					
„ Vincentiana	„			—					
„ Taylori	*Etheridge.*	—		?					
„ Corioensis	*M'Coy.*	—		—		—			
„ pectoralis	*Tate.*	?		—					
„ sufflata	„			—					
Terebratulina scoulari*	„	—		—		—			
„ Davidsoni	*Etheridge.*	—		—		—			
„ lenticularia	*Tate.*	—		—		—			
„ triangularis	„	?		—					
Terebratella Tepperi	„	—		—					
„ pentagonalis	„			—					
„ furculifera*	„			—					
„ Woodsii	„	—							
Magasella compta	*Sowerby.*			—		—			
„ Woodsiana*	*Tate.*			—		—			
„ Tenisoni	*Ten.-Woods.*			—					
„ deformis	*Tate.*			—					
Thecidium Australe	„					—			

AUSTRALASIA.

Tasmania.		South Australia.		Victoria.		New South Wales.	
Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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Cryptodon tarda ...	
Limya sigillata ...	
Mytilicardia alata	
„ compl	
„ platyç	
„ curta	
Carditella multilai	
„ rugosa	
„ radiata	
„ polita..	
„ lamellat	
Cardita trigonalis.	
„ pecten ..	
„ compacta	
„ Murrayan	
„ scabrosa .	
„ gracilicost	
„ latissima.	
„ spinulosa	
„ polynema	
„ delicatula	
„ Tasmanica	
„ solida....	
„ calvea ...	
Unio Wilkinsoni..	—
„ Johnstoni ..	

...	NEW SOUTH

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	Neo.	Pal.	Neo.	Pal.	Neo.	Pal.	Neo.
Rhynchonella squamosa*	Hutton.	—				—			
,, Baileyana	Tate.								
Pelecypoda.									
Barnea tiara	,,					—			
Jouannetia cuneata	,,			—					
Teredo Heaphyi	Zittel.			—					
,, sp. indet.						—			
Aspergillum (Humphreyia) liratum	Tate.			—					
,, ,, sp. ind.		—							
Solen sordidus	Tate.					—			
Solecurtus Legrandi	T.-Woods and Tate.	—							
,, Dennanti	Tate.					—			
,, ellipticus	,,			—					
Saxicava arctica	Linn.								
Panopaea Agnewi	T.-Woods.	—							
,, orbita*	Hutton.			—		—			
Capistrocardia fragilis	Tate.			—					
Neæra subrostrata	,,					—			
,, Adelaidensis	,,			—					
,, latesulcata	,,			—					
Corbula Gallica	Sturt.			—					
,, ephamilla	Tate.	—		—		—			
,, pixidata	Sturt.			—					
Corbis lamellosa	,,			—					
Zenatiopsis angustata	Tate.	—							
Myodora æquilateralis	R. M. Johnston.	—				—			
,, Australis	,,	—				—			
,, prælonga	Tate.					—			
,, angustior	,,					—			
,, tenuilirata	,,			—		—			
,, corrugata	,,			—		—			
,, lamellata	,,			—					
Psammobia æqualis	,,	—		—		—			
,, Hamiltonensis	,,	—				—			
Tellina lata †	Quoy and Gaimard.				—				
,, albinelloides	Tate.					—			
,, porrecta	,,			—					
,, Masoni	,,					—			
,, cainozoica	Ten.-Woods.	—							
,, æquilatera	Tate.			—		—			
,, Stirlingi	,,					—			
,, Krausei	M'Coy.					—			
Strigilla Australis	Tate.					—			
Donax Dixoni	,,					—			
,, depressa	,,				—?				
Semele Krauseana	,,			—		—			
,, vesiculosa	,,					—			
Mactra axiniformis	,,					—			
,, Hamiltonensis	,,					—			
,, Howchiniana	,,			—		—			
Anapa variabilis	,,				—?				
Chione Allporti	Ten.-Woods.	—							
,, multilamellata	Tate.			—					
,, hormophora	,,	—							
,, dimorphophylla	,,	—		—		—			
,, cainozoica	Ten.-Woods.	—		—		—			
,, subroborata	Tate.						—?		
,, propinqua	Ten.-Woods.	—				—			
,, dictua	Tate.				—?				
,, Corioensis	,,						—?		
,, sp. ind.		—		—					
Venus lævigata	Sturt.			—					
,, obliqua	,,								
Cytheræa paucirugata	Tate.					—			
,, Murrayana	,,			—					
,, tenuis	,,			—					
,, eburnea	,,	—		—		—			

Species	Author	Tasmania Pal.	Tasmania Neo.	South Australia Pal.	South Australia Neo.	Victoria Pal.	Victoria Neo.	New South Wales Pal.	New South Wales Neo.
Cythera submultistriata	Tate.			—		—			
„ sp. ind.		—							
Dosinia Johnstoni	„	—				—			
„ Grayii*	Zittel.			—					
„ imparistriata	Tate.			—					
Meroe gibberula	„					—			
Venerupis paupertina	„			—		—			
Cardium pseudomagnum	„			—		—			
„ septuagenarium	„	—							
„ moniletectum	„			—					
„ Victoriæ	„					—			
„ cuculloides	„					—			
„ antisemigranulatum	„					—			
„ hemimeris	„			—		—			
Protocardium antisemigranulatum	M'Coy.					—			
Verticordia pectinata	Tate.					—			
„ rhomboidea	„			—					
Chama lamellifera	Ten.-Woods.	—		—		—			
Chamostrea albida (*C. crassa*—Tate)	Lamarck.	—				—			
Lucina leucomomorpha	Tate.					—			
„ projecta	„					—			
„ aræa	„			—					
„ affinis	„			—					
„ nuciformis	„								
„ araneosa	„					—			
„ despectans	„					—			
„ quadrisulcata	D'Orb.								
„ fabuloides	Tate.			—					
„ planatella	„	—							
Loripes simulans	„			—					
Cryptodon mactræformis	„					—			
Diplodonta subquadrata	„	—		—		—			
Sacchia suborbicularis	„			—					
Leptum crassum	„			—					
Lepton planisulcum	„			—					
Kellia micans	„					—			
Montacuta sericea	„			—		—			
Crassatella oblonga	Ten.-Woods.	—		—		—			
„ astartiformis	Tate.	—		—		—			
„ corrugata	„			—					
„ abbreviata	„			—					
„ Dennanti	„					—			
„ aphrodina	Ten.-Woods.	—							
Mytilicardia alata	Tate.			—					
„ compta	„			—		—			
„ platycostata	R. M. Johnston.	—							
„ curta	Tate.			—					
Carditella multilamella	„					—			
„ rugosa	„			—					
„ radiata	„			—					
„ polita	„			—			—		
„ lamellata	„	—		—					
Cardita trigonalis	„	—		—					
„ pecten	„			—		—			
„ compacta	„					—			
„ Murrayana	„			—					
„ scabrosa	„			—		—			
„ gracilicostata	Ten-Woods.	—							
„ latissima	Tate.			—					
„ spinulosa	„					—			
„ polynema	„					—			
„ delicatula	„			—		—			
„ Tasmanica	„	—							
„ solida	„					—			
„ calvea	„					—			
Unio Wilkinsoni	Etheridge, jun.								
„ Johnstoni	„	—						—	

F AUSTRALASIA,

TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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Gryphæa tarda* ....
Limya sigillata ....
,, dissimilis ...

Scaphapoda.

Entalis Mantelli (D Woods) ....
,, subfissura ..
,, acriculum ..
Dentalium aratum ..
,, bifrons ..
,, lacteum .
Cadulus mucronatus.
,, acuminatus .

Pteropoda.

Styliola Rangiana ..
,, bicarinata ..
,, annulata....
Vaginella eligmostom
Spiralis tertiara ....

Gasteropoda.

Helix Geilstonensis..
,, Huxleyana ....
,, Sinclairoides...
,, Simsoniana....

...CTORIA.	NEW SOUTH WALES.

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Anodonta (Unio ?) Tamarensis	*Etheridge, jun.*	—							
Trigonia semiundulata †	*M'Coy.*	—		—		—			
„ tubulifera	*Tate.*					—			
„ acuticostata* ?	*M'Coy.*			—		—			
„ Howitti	„					—			
Nucula tumida	*Ten.-Woods.*	—		—		—			
„ Atkinsoni (*Portlandia*)	*R. M. Johnston.*	—		—		—			
„ semistriata	*Tate.*			—					
„ Morundiana	„			—		—			
„ fenestralis	„	—							
„ Marthæ	*M'Coy.*					—			
Leda obolella	*Tate.*			—		—			
„ planiusulca	„			—					
„ Huttoni	*Ten.-Woods.*	—		—		—			
„ acinaciformis	*Tate.*					—			
„ apiculata	„			—		—			
„ leptoryncha	„			—					
„ vagans (lucida—*T.-Woods*)	„			—		—			
„ prælonga	„	—				—			
„ Woodsii	„			—		—			
„ crebrecostata	*Ten.-Woods.*	—							
„ inconspicua	„			—					
Arca pseudonavicularis	*Tate.*	—		—					
„ equidens	„			—					
Barbatia dissimilis	„			—					
„ crustata	„			—					
„ celleporacea	„	—				—			
„ limatella	„			—					
„ consutilis	„					—			
„ simulans	„			—		—			
„ pumila	„					—			
Macrodon cainozoicus	„			—		—			
Cucullea Corioensis	*M'Coy.*	—		—		—			
„ Adelaidensis	*Tate.*			—					
Pectunculus cainozoicus (*Cucullea*)	*Ten.-Woods.*	—		—					
„ M'Coyii	*R. M. Johnston.*	—		—		—			
„ subtrigonalis	*Tate.*			—		—			
„ convexus	„			—		—			
„ lenticularis	„			—					
Limarca angustifrons	„			—					
Limopsis insolita*	*G. B. Sowerby.*			—					
„ aurita*†	*Brocchi.*	—		—		—			
„ Belcheri†	*Adams & Reeve.*	—		—		—			
Modiolaria singularis	*Tate.*					—			
„ arcacea	„			—					
„ semigranosa	„			—					
„ Corioensis	„					—			
Crenella globularis	„	—		—		—			
Avicula nasuta	„			—					
Meleagrina crassicardia	„			—		—			
Vulsella lævigata	„			—					
Perna, sp. indet.* (*Tate*)				—					
Pinna semicostata	*Tate.*				— ?				
„ sp. indet. (*Tate*)				—					
Spondylus pseudoradula	*M'Coy.*	— ?		—		—			
„ gæderopoides	„	—				—			
„ spinulosus (MS.)	„	— ?				—			
Modiola Adelaidensis	*Tate.*			—					
„ sp. indet. (*Tate*)				—					
„ sp. indet. (*Tate*)				—					
Lithodomus, sp. indet. (*Tate*)				—					
Mytilus sub-Menkeanus	*Tate.*			—					
„ Hamiltonensis	„					—			
„ linguatulus	„					—			
„ deperditus	„					—			
Septifer fenestratus	„					—			
Lima Bassii	*Ten.-Woods.*	—		—		—			

		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Lima squamosa (MS.)	*Ten.-Woods.*	—							
„ polyactina	*Tate.*			—					
„ linguliformis	„					—			
„ Jeffreysiana (*Lima subauriculata*)	„	—		—		—			
„ polynema	„			—					
Limea transenna	„			—		—			
„ minuta (*Cucullea*)	*R. M. Johnston.*	—							
„ alticosta	*Tate.*			—					
Pecten consobrinus	„				— ?				
„ subbifrons	„				— ?				
„ palmipes	„				— ?				
„ Murrayanus	„			—		—			
„ dichotomalis	„					—			
„ antiaustralis	„				— ?				
„ Eyrei	„			—					
„ Flindersi	„			—					
„ Peroni	„			—					
„ Sturtianus	„			—		—			
„ Aldingensis	„			—					
„ Yahlensis	*Ten.-Woods.*			—		—			
„ Foulcheri	„	—		—		—			
„ spondyloides	*Tate.*				— ?				
„ Gambierensis	*Ten.-Woods.*			—					
„ polymorphoides*	*Zittel.*	—		—		—			
„ Hockstetteri*	„			—					
„ subconvexus	*Tate.*					—			
„ incertus	*Ten.-Woods.*			—					
„ Darwini	*Sow.*			—					
„ lucens	*Tate.*	—		—					
„ Zitteli* (Amnsium Atkinsoni—*Johnston*)	*Hutton.*	—		—		—			
„ deformis	*Tate.*					—			
Vela laticostata	*Ten.-Woods.*	—							
Humilos Corioensis	*M'Coy.*			—		—			
Anomia cymbula	*Tate.*			—					
Placunanomia sella	„	—		—					
„ Ione	*Gray.*			·					
Ostrea hyotis†	*Linn.*			—					
„ arenicola	*Tate.*			—					
„ manubriata	„					—			
„ sp. indet.		—							
„ hippopus	*Tate.*			—					
„ elongata	*Sturt.*			—					
Gryphaea tarda*	*Hutton.*			—					
Limya sigillata	*Tate.*			—					
„ dissimilis	„			—		—			
SCAPHAPODA.									
Entalis Mantelli (Dentalium Kickxii—*T.-Woods*)	*Zittel.*	—		—		—			
„ subfissura	*Tate.*			—		—			
„ acriculum	„					—			
Dentalium aratum	„			—		—			
„ bifrons	„					—			
„ lacteum	*Deshayes.*	—				—			
Cadulus mucronatus	*Tate.*					—			
„ acuminatus	„				— ?				
PTEROPODA.									
Styliola Rangiana	*Tate.*					—			
„ bicarinata	„					—			
„ annulata	„			—					
Vaginella eligmostoma	„					—			
Spiralis tertiara	„					—			
GASTEROPODA.									
Helix Geilstonensis	*R. M. Johnston.*	—							
„ Huxleyana	„	—							
„ Sinclairoides	„	—							
„ Simsoniana	„	—	— ?						

USTRALASIA,

TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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„ umbilic
Pileopsis navicell
Solarium acutum
„ Wannon
Torinia gibbuloide
Adeorbis lævis ..
„ aster ..
„ acuticari
Scalaria, sp. indet
Crossea labiata ?†
Turritella Sturtii
„ Tasman
„ Warbu
„ sp. inde
„ tristira
„ transen
„ platyspi
„ sp. inde
Torcula Murrayan
Vermetus conoheli
„ sp. inde
Tenagodus occlusu
Eulima acutispira
Leiostraca Johnst

RIA.	NEW SOUTH WALES.

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Helix Tasmaniensis	*G. B. Sowerby.*	—							
Vitrina Barnardii	*R. M. Johnston.*	—							
Bulimus Gunnii	*Sowerby.*	—							
Murex Eyeri	*Ten.-Woods.*	—							
,, Legrandi	*R. M. Johnston.*	—							
,, minutus	,,	—							
,, asper	*Ten.-Woods.*			—					
,, sp. indet.				—					
Typhis M'Coyi	*Ten.-Woods.*	—		—		—			
Ricinula purpuroides	*R. M. Johnston.*	—							
Tritonium Abboti	*Ten.-Woods.*	—		—					
,, minimum	,,	—							
,, Tasmanicus	*R. M. Johnston.*	—							
Ranella Prattii	*Ten.-Woods.*			—		—			
Fusus gracillimus	,,	—							
,, Johnstonii	,,	—							
,, Meredithii	,,	—							
,, pagadoides	*M'Coy.*	—				—			
,, Tateana	*Ten.-Woods.*	—							
,, vitreoides	*R. M. Johnston.*	—							
,, transenna	*Ten.-Woods.*	—							
,, Roblini	,,	—				—			
,, funiculatus	,,					—			
Buccinum fragile	,,	—							
Pisania tenuicostata	,,					—			
Cominella cancellata	,,	—				—			
,, lyræcostata	,,	—							
Nassa Tatei	,,					—			
Voluta Agnewi	*R. M. Johnston.*	—							
,, Allporti	,,	—							
,, M'Coyi	*Ten.-Woods.*	—							
,, lirata	*R. M. Johnston.*	—							
,, pellita	,,	—							
,, Stephensi	,,	—							
,, stolida	,,	—							
,, Tateana	,,	—							
,, antiscalaris	*M'Coy.*	—		—		—			
,, anticingulata	,,					—			
,, Hannafordi	,,	—		—		—			
,, strophodon	,,	—		—		—			
,, macroptera	,,	—				—			
,, Weldii	*Ten.-Woods.*	—							
Mitra anticoronata	*R. M. Johnston.*	—							
,, sp. indet. (*T.-Woods*)				—					
,, sp. indet. ,,				—					
Thala marginata	*Ten.-Woods.*	—							
Marginella Aldingæ	*Tate.*			—					
,, muscaroides	,,			—		—			
,, Hordeacea	,,			—					
,, Wentworthi	*Ten.-Woods.*	—		—		—			
,, cassidiformis	*Tate.*					—			
,, strombiformis	*Ten.-Woods.*	—							
,, micula	*Tate.*					—			
,, inermis	,,					—			
,, Winteri	,,					—			
,, propinqua	,,			—		—			
,, Woodsi	,,					—			
,, septemplicata	,,					—			
Erato ? octoplicata	*Ten.-Woods.*	—							
,, Australis	*Tate.*			—					
,, minor	,,					—			
Ancillaria herbera	*Hutton.*			—					
,, mucronata	*Sowerby.*			—		—			
,, semilævis	*Ten.-Woods.*	—		—		—			
Columbella Oxleyi	,,	—							
,, cainozoica	,,	—							
Cancellaria Etheridgei	*R. M. Johnston.*	—							

		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Cancellaria varicifera	*Ten.-Woods.*								
Terebra simplex	„	—				—			
„ additoides	„	—		—					
Pleurotoma Johnstonii	„	—							
„ paracantha	„	—							
„ pullalascens	„	—							
„ Murndaliana	„					—			
„ sandleroides	„	—							
„ Samueli	„					—			
„ one or two species indet.		—							
Daphnella collumbelloides	*Ten.-Woods.*	—							
„ gracillima	„	—		—		—			
„ tenuisculpta	„	—							
Mangelia gracilirata	„	—							
„ bidens	„			—		—			
Conus Trailli	„			—					
„ sp. indet.				—					
„ Ralphii	*Ten.-Woods.*					—			
„ sp. indet.						—			
Cypræa Archeri	*Ten.-Woods.*	—							
„ eximia	*G. B. Sowerby.*	—				—			
„ gastroplax	*M'Coy.*					—			
„ gigas	„			—		—			
„ oviformis	*Ten.-Woods.*			—					
„ platypyga	*M'Coy.*	—				—			
„ platyrhyncha	„	—				—			
„ consobrina	„			—		—			
„ contusa	„					—			
„ leptorhyncha	„			—		—			
Trivia avellanoides	„	—		—		—			
Cassis sufflatus	*Ten.-Woods.*	—				—			
„ textilis	*Tate.*			—					
Cassidaria reticulospira	*M'Coy.*	—				—			
Natica ovata	*Hutton.*	—							
„ polita	*Ten.-Woods.*	—		—					
„ vixumbilicata	„	—							
„ Wintlei	„	—							
„ Hamiltonensis	„			—		—			
„ sp. indet.				—					
„ sp. indet.				—					
Trochita calyptræformis	*Ten.-Woods.*	—							
„ turbinata	„					—			
Crepidula Hainsworthii	*R. M. Johnston.*	—							
„ umbilicata	„	—							
Pileopsis navicelloides	„	—							
Solarium acutum	*Ten.-Woods.*			—		—			
„ Wannonensis	„					—			
Torinia gibbuloides	„	—							
Adeorbis lævis	*R. M. Johnston.*	—							
„ aster	*Ten.-Woods.*					—			
„ acuticarinata	„					—			
Scalaria, sp. indet.		—							
Crossea labiata ?†	*Ten.-Woods.*	—		—					
Turritella Sturtii	„	—							
„ Tasmanica	„	—							
„ Warburtonii	„	—		—					
„ sp. indet.				—					
„ tristira	*Tate.*	—							
„ transenna	*Ten.-Woods.*					—			
„ platyspira	„					—			
„ sp. indet.		—							
Torcula Murrayana	*Tate.*	—		—		—			
Vermetus conohelix	*Ten.-Woods.*	—							
„ sp. indet.		—							
Tenagodus occlusus	*Ten.-Woods.*	—							
Eulima acutispira	„			—					
Leiostraca Johnstonii	*Tate.*	—							

AUSTRALASIA,

TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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	Species.
Plantæ	73
Rhizopoda	50
Actinozoa	63
Echinodermata	39
Annelida	1
Crustacea	6
Polyzoa	65
Brachiopoda	34
Pelecypoda	43
Scaphapoda	8
Pteropoda	5
Gasteropoda	97
Cephalopoda	2
Pisces	8
Mammalia—	
Marsupialia	8
Cetacea	5
Carnivora	1
	08

		TASMANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Niso psila	*Ten.-Woods.*			—					
Turbonilla liræcostata	,,	—							
,, pagoda	,,			—					
Odostomia liræcostata	*R. M. Johnston.*	—							
Pyramidella Roberti	*Ten.-Woods.*	—							
,, sulcata	*R. M. Johnston.*	—							
,, polita	,,	—							
Cerithium Flemingtonensis	*M'Coy.*						—		
,, cribrarioides	*Ten.-Woods.*			—		—			
,, apheles	,,					—			
Cerithiopsis Johnstoni (MS.)	,,	—							
Triforis Wilkinsoni	,,			—		—			
,, sulcata	,,			—		—			
,, planata	,,			—					
Potamides pyramidale	*Tate.*	—							
,, semicostatum	,,	—							
Rissora Stevensiana	*Ten.-Woods.*	—							
,, dubia	*R. M. Johnston.*	—							
Rissoina Johnstoni	*Ten.-Woods.*	—							
,, Tateana	,,	—		—					
,, varicifera	,,	—							
,, concatenata	,,	—							
Liotia lamellosa	,,	—				—			
,, Roblini	*R. M. Johnston.*	—		—					
Cyclostrema acuticarinata	*Ten.-Woods.*			—					
Turbo Wyuyardensis (MS.)	*R. M. Johnston.*	—							
,, Etheridgei	*Ten.-Woods.*	—							
Imperator Tasmanica (MS.)	*R. M. Johnston.*	—							
Calcar ornatissimum	*Ten.-Woods.*	—							
,, Flindersi	,,	—							
Delphinula ? tetragonostoma	,,	—							
Trochus Josephi	,,	—							
,, sp. indet.		—							
Minolia strigata	*Ten.-Woods.*			—		—			
Gibbula æquisulcata	,,	—							
,, Clarkei	,,	—							
,, crassigranosa	,,	—							
Zizyphinus atomus	*R. M. Johnston.*	—							
,, Tasmanicus	,,	—							
,, Bloxlandii	*Ten.-Woods.*	—							
Thalotia alternata	,,	—							
,, exiqua	,,					—			
Euchelus Woodsii	*R. M. Johnston.*	—							
Margarita Keckwickii	*Ten.-Woods.*	—							
Pleurotomaria Australis (MS.)	*M'Coy.*					—			
,, tertiara	,,					—			
Huliotis Flemingtonensis (MS.)	,,						—		
,, Mooraboolensis	,,						—		
,, nævosoides	,,						—		
,, ovinoides	,,						—		
Fissurellidæ malleata	*Tate.*	—		—					
Emarginula transenna	*Ten.-Woods.*	—		—					
Actæon scrobiculatus	,,	—							
Ringicula lactea	*R. M. Johnston.*	—					—		
Tornatina involuta	*Ten.-Woods.*								
Cylichna Woodsii (*C. arachis*—Woods)	*Tate.*	—							
,, exiqua	*Ten.-Woods.*			—					
Bulla scrobiculata	,,			—					
CEPHALOPODA.						—			
Aturia (zic-zac) Australis	*J. Sowerby.*	—		—					
Belemnites senescens	*Tate.*			—		—			
PISCES.						—			
Carcharodon angistidens	*Agassiz.*	—				—			
,, megalodon	,,					—			
Lamna contortidens	,,					—			
,, denticulata	,,	—		—					
,, elegans	,,								

		Tasmania.		South Australia.		Victoria.		New South Wales.	
		Pal.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
Otodus Desori	*Agassiz.*			—		—			
Oxyrhina trigonodon	„	—				—			
„ Woodsii	*M'Coy.*			—					
MAMMALIA.									
Marsupialia.									
Phalangista, sp. indet.						—			
Bettongia cuniculoides	*M'Coy.*					—			
Nototherium, sp. indet.						—			
Phalascomys pliocenus	*M'Coy.*								
„ sp. indet.		—							
Hypsiprymnus, sp. indet.		—							
Halmaturus, sp. indet.		—							
Sarcophilus ursinus	*Harris.*					—			
Cetacea.									
Squalodon Wilkinsoni	*M'Coy.*					—			
Zeuglodon Hardwoodii	*Sanger.*			—					
Cetotolites Leggei	*M'Coy.*					—			
„ Pricei	„					—			
„ Nelsoni	„					—			
Carnivora.									
Arctocephalus Williamsi	*M'Coy.*					—			

The foregoing comparative tables contain upon the whole a fairly comprehensive list of the Tertiary fossils described up to the present time. No doubt the number of species of *Gasteropods* will be greatly expanded when Professor Tate's examination of them are completed. It is not expected, however, that the general character of the life of the period will be much affected by further additions, and the following summary will, therefore, be of some value to those who may desire to enter upon comparative work.

SUMMARY OF GENERA AND SPECIES ENUMERATED IN PRECEDING TABLES.

Classes, &c.	*Tasmania.*	*South Australia.*	*Victoria.*	*N. S. Wales.*	*Australia and Tasmania*	
	No. Species.	No. Species.	No. Species.	No. Species.	No. Genera.	No. Species.
Plantæ	115	—	26	40	68	173
Rhizopoda	10	40	12	—	26	50
Actinozoa	16	24	41	—	25	63
Echinodermata	5	23	21	—	25	39
Annelida	—	—	1	—	1	1
Crustacea	2	4	—	—	6	6
Polyzoa	9	54	10	—	20	65
Brachiopoda	16	30	13	—	7	34
Pelecypoda	63	157	122	1	79	243
Scaphapoda	2	4	7	—	3	8
Pteropoda	—	1	4	—	3	5
Gasteropoda	127	54	66	—	77	197
Cephalopoda	1	2	1	—	2	2
Pisces	3	3	6	—	4	8
Mammalia—						
Marsupialia	4	—	4	?	7	8
Cetacea	—	1	4	—	3	5
Carnivora	—	—	1	—	1	1
	373	397	339	41	357	908

RALASIA,

MANIA.		SOUTH AUSTRALIA.		VICTORIA.		NEW SOUTH WALES.	
.	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*	*Pal.*	*Neo.*
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whole a fairly comprehensive list of the ıbt the number of species of *Gasteropods* ation of them are completed. It is not of the period will be much affected by fore, be of some value to those who may

ATED IN PRECEDING TABLES.

Victoria.	*N. S. Wales.*	*Australia and Tasmania*	
[illegible]	[illegible]	[illegible]	[illegible]

arison of *es.*

NEW ZE	TH W	TASMANIA.
tangiformis, ozoa—*Isis da* marked with eogene age i eds at Drury f plants; v *lites.*	figured *r Gunn* usen a ected b . Dicot *heri,* *arwinii* *Ficonii* *amomu* *ustrali* *m Eth* *olia B* *Mitchell* *Cunnin* *Delftii,* *nosites* von Et	*s, Cypris.* Brachiopoda—*Terebratula, Waldheimia, Rhynchonella.* Lamellibranchiata—*Arca, Asper- ea, Cytherea, Cardium, Cardita, Chama, Chione, llea, Dosinia, Diplodonta, Gouldia, Lima, Limea, ucina, Myodora, Mytilicardia, Panopæa, Placun- lus, Psammobia, Solecurtus, Spondylus, Tellina, psis.* Gasteropoda—*Terebra, Pleurotoma, Daphnella, x, Typhis, Fusus, Cominella, Ricinula, Ringicula, olumbella, Voluta, Marginella, Erato, Tritonium, illa, Odostomia, Leiostraca, Cerithiopsis, Rissoa, lla, Tenagodus, Vermetus, Potamides, Trochita, nperator, Euchelus, Thalotia, Zizyphinus, Trochus, a, Liotia, Delphinula, Adeorbis, Trivia, Cypræa, Pyramidella, Fissurellidæ, Emarginula, Pileopsis, ia, Dentalium, &c.* Cephalopoda—*Aturia.* Rhizo- *a, Quinqueloculina, Discorbina, Nummulina, Mar- a, Alveolina, Polymorphina, Cassidulina, Nonionina,* ble Cape)—*Voluta anticingulata, Voluta Tateana, lla Wentworthii, Cassis sufflatus, Calcar Flindersi, Archeri, C. platypyga, Natica Wintlei, Ancillaria arburtonii, Daphnella gracillima, Typhis M'Coyi, Corbula ephamilla, Crassatella aphrodina, Dosinia Myodora Australis, Panopæa Agnewi, Waldheimia a, Lovenia Forbesi, Cellepora Gambierensis, Placo-* r, Mount Bischoff. line of *Macquarie Harbour,* from Long Bay to Kelly's ging terraces from 40 to 70 feet in height, covered by sloping to the shore—composed generally in descending of sand and clay, alternating with thick irregular coarse he ancient neighbouring rocks; (2) Carbonaceous and sandstones, regularly and horizontally stratified and layers of lignite, all being replete with the remains of a lauraceous types are particularly conspicuous. The -*Cinnamomum polymorphoides* (M'Coy), *Eucalyptus tacites oligoneuris* (Ettings.) he *Magnet Range* there exists, immediately underlying to 300 feet of white, brown, blue, and blackish clays, , and whitish sandstones, and with lignites replete with ng which the following are very characteristic; viz.—), *Eucalyptus Kayseri* (Johnston), *Quercus Bischoff- Tasmanicus* (Johnston), *Taxites Thureaui* (Johnston),

TERTIARY PERIOD.

Comparison of the General Characteristics of the Rocks of the Tertiary Period as developed in different Countres.

Arranged by R. M. JOHNSTON, F.L.S.

GREAT BRITAIN.

PLIOCENE.

Forest-bed Group (10 to 70 feet thick).—Silts, clays, with layers of peat and loam, partly estuarine and partly lacustrine, the latter containing numerous seeds, cones, stumps, and fragments of drift wood, blocks of peat, bones of mammals, &c.; the estuarine beds composed of fine sands, with clay and flint pebbles, containing *Leda myalis*, *Trophon antiquum*, *Nucula Cobboldiae*, *Tellina*. The lacustrine or freshwater beds contain cones of Scotch fir and spruce, leaves of the white waterlily, yellow pond lily, hornwort, blackthorn, bog bean, oak, and hazel; also species of freshwater and land shells, viz. *Pisidium amnicum*, *Unio pictorum*, *Paludina fontinalis*, *Limnaea stagnalis*, *Succinea putris*, *Helix arbustorum*, &c. Fifty species of mammals, two reptiles, four amphibians, and seventeen birds are also recorded from the group, nearly all belonging to existing species.

The group is best developed on the north-east of Norfolk, although it nowhere exceeds a few feet in thickness.

Chillesford Beds (1 to 10 feet thick).—This local deposit, chiefly in Suffolk, composed of shelly sands and gravels, with *Mya truncata*, *Mactra ovalis*, *Nucula Cobboldiae*, *Cyprina islandica*, *Astarte borealis*, *Tellina obliqua*, &c. Geikie states that about two-thirds of the characteristic species still live in Arctic waters.

Norwich Crag (5 to 10 feet thick).—This deposit is stated by Geikie to consist of a low foot of shelly sand and gravel, containing 130 species of shells, of which 90 per cent. are still living. A large number of bones, chiefly of extinct species of elephant, have been obtained, comprising *Mastodon arvernensis*, *Elephas meridionalis*, *E. antiquus*, *Hippopotamus major*, *Rhinoceros leptorhinus*, *Trogontherium Cuvieri*, also remains of horse, deer, otter, and beaver.

Red Crag (25 feet thick). Thin local formation, consisting of darkred or brown ferruginous shelly sand. Of its molluscs 92 per cent. are supposed to be still living. Characteristic genera are *Voluta*, *Nassa*, *Purpura*, *Pecten*, *Pectunculus*, *Mactra*, *Tellina*, *Cardium*, *Mytilus*, *Cyprina*—*Mastodon*, *Elephas*, *Rhinoceros*, *Tapirus*, *Sus*, *Equus*, *Hipparion*, *Hyaena*, *Felis*, *Cervus*, *Halitherium*. Some of these may have been derived from Miocene deposits.

White Crag (40 to 60 feet thick).—Suffolk, Coralline or Bryozoan Crag.—Shelly sands and marls, containing about 340 species of shells, and about 140 species of coral-like polyzoa. About 84 per cent. of the shells are still living. Characteristic forms are *Terebratula grandis*, *Lingula Dumortieri*, *Pecten opercularis*, *Pholadomya histerna*, *Astarte Omalii*, *Pyrula reticulata*, *Voluta Lamberti*, &c.

MIOCENE.

Great Britain is supposed to have been occupied by a land surface only during the Miocene period, which was connected with the European Continent. The leaf-beds of Bovey, Tracey, Mull, and Antrim are by some authorities doubtfully referred to this period. The latter have yielded Ferns, Vines, fig, Cinnamon, *Proteaceae*, &c. Conifers nearly allied to the huge *Sequoia* (Wellingtonia) of California, is especially abundant.

OLIGOCENE.

Hempstead Beds.—(1) Corbula beds (marine), consisting of brown and greenish nodular clays and shelly beds.
(2) Upper freshwater and estuary beds.
(3) Middle and freshwater estuary marls.
(4) Lower freshwater and estuary marls.

Characteristic Genera:

Corbula, *Cerithium*, *Cyrena*, *Rissoa*, *Panopaea*, *Melania*, *Paludina*, *Unio*, *Chara*, *Gyrogonites*, &c.

Bembridge Beds.—Marls and limestones, with *Cerithium mutabile*, *Cyrena pulchra*, *Ostrea vectensis*, also *Melania*, *Limnaea*, *Helix*, *Planorbis*, *Cyclotus*, *Bulimus*, &c.

Osborne or St. Helen's Beds.—Clays, marls, sands, and limestones, with *Chara Lyelli*, *Cyrena obovata*, *Melanopsis carinata*, *Planorbis*, *Paludina*, &c.

Headon Beds.—Marine, brackish, and freshwater beds, consisting of clays and thick beds of limestone. Characteristic of the freshwater beds is the forms *Planorbis euomphalus*, *P. rotundatus*, *P. lens*; in brackish water beds, *Potamides plana* and *P. cinctus*; and in the marine bands, *Cytherea incrassata*.

EOCENE.

Upper Eocene (Barton Clay and Upper Bagshot Sands). Attaining a thickness of 300 feet in the Isle of Wight. Over 200 species of Molluscs are known. The characteristic species are *Voluta luctatrix*, *V. ambigua*, *V. athleta*, *Conus scabriculus*, *C. dormitor*, *Pleurotoma rostrata*, *Fusus pyrus*, *Ostrea gigantea*, *Valvella depordita*, *Pecten reconditus*, *Lima compta*, *L. mcor*, *Arbicula media*, *Modiola sulcata*, *Arca appendiculata*, *Pectunculus deletus*, *Cardita sulcata*, *Crassatella sulcata*, *Chama squamosa*, *Nummulites planulata*.

Middle Eocene (Middle and part of Lower Bagshot Beds, London Basin).—The lower division consists of yellow siliceous unfossiliferous sands, with irregular clayey beds, about 100 to 150 feet thick; the upper division about 50 to 60 feet thick, made up of sands and clays, with bones of turtle and sharks, with a few molluscs (*Cardita*, *Corbula*, *Ostrea*, &c.) In the Hampshire Basin the series is over 100 feet thick, composed of clays, sands, marls, and lignites, with *Belemnopsis*, *Cypraea*, *Marginella*, *Voluta*, *Mitra*, *Conus*, *Pleurotoma*, *Murex*, *Fusus*, *Turritella*, *Ostrea*, *Pecten*, *Lima*, *Spondylus*, *Avicula*, *Pinna*, *Modiola*, *Arca*, *Limopsis*, *Nucula*, *Leda*, *Cardita*, *Crassatella*, *Chama*, *Nummulites*, *Alveolina*, &c. The clays contain remains of *Proteaceae*, fig, cinnamon, fan-palm (*Sabal*), oak, yew, cypress, laurel, lime, sumac, &c.

Lower Eocene.—This division is represented by clays, loams, sands, and pebble beds of the (1) Part of Lower Bagshot Beds, (2) London Clay, (3) Oldhaven Beds, (4) Woolwich and Reading Beds, (5) Thanet Sands, with *Ficus*, *Grevillea*, *Laurus*, *Cinnamomum*, *Coniferae*, *Astarte*, *Cyprina*, *Ostrea*, *Corbula*, *Pholadomya*, *Corbula*, *Fusus*, *Natica*, *Cerithium*, *Melania*, *Melanopsis*, *Paludina*, *Limnaea*. Bones of turtles, crocodiles, and birds have been found, also bones of mammalia, including *Coryphodon*.

NORTH AMERICA.

PLIOCENE.

Sumpter Period.—Represented in North and South Carolina by soft beds of loam, clay, or sand, which lie in depressions of the older Tertiary and Cretaceous formations. They contain forty to sixty per cent. of living species of shells. The following are stated by Dana to be specially characteristic:—*Pecten* (Amusium) *Mortoni*, *Janira hemicyclica*, *Arca* (Barbatia) *lana*, *A. lienosa*, *Scapharca Cypraea Carolinensis*, *C. pediculus*, *Conus adversarius*, *Fusus rhomboidea*, *Busycon incile*, &c., also *Mya (?)*. In the Loup Fork Beds on the Niobrara, Upper Missouri region, the White River group is overlaid by freshwater beds, and containing in their upper parts the remains of numerous extinct mammals, including Camels, Rhinoceroses, Elephants, Horses, &c., of both land and freshwater shells, which are probably of recent species. The following are especially remarkable:—Birds—*Aquila Dananus*, *Grus Haydeni*, *Graculus Idahensis*. Mammals—*Felis Augustus*, *Canis*, *Leptarctus primus*, *Elephas imperator*, *Mastodon mirificus*, *Rhinoceros crassus*; also *Procamelus*, *Homocamelus*, *Megalomeryx*, *Merycodus*, *Cervus*, *Hipparion parvulum*, *H. occidentale*, *Protohippus*, *Merychippus*, *Equus excelsus*, *Castor tortus*, *Palaeocastor*, *Hystrix*, &c. *Equus excelsus* is stated to be quite as large as the modern horse.

MIOCENE.

Yorktown Period.—At Yorktown, Atlantic Border, this division is represented by marine clays and sands, among which the following characteristic forms occur:—Mollusca—*Crepidula costata*, *Yoldia limatula*, *Callista Sayana*, *Pecten decemarius*, *P. Virginianus*, *Ostrea Virginiana*, *Venus tridacnoides*, *A. cuneus*, *Chama ...*, *Venus mercenaria*, *V. cancellata*, *Mactra lateralis*, *Pecten concentricus*, *Lunatia heros*, *Oliva literata*, *Nassa trivittata*. Fishes—*Carcharodon megalodon*, *Galeocerdo latidens*, *Hemipristis serra*, *Oxyrhina hastalis*. Mammals—*Balaena prisca*, *B. palaeatlantica*, *Delphinus Conradi*, *Phoca Wymani*, &c., *Eluthrium Leidyanus*, *Dicotyles antiquus*, *Rhinoceros matutinus*, *Anchippodus riparius*, *Lophiodon validus*.

White River Group.—Extensive beds occur in the Upper Missouri region, along the White River, belonging to the period, estimated to have a thickness of 1000 feet or more. They are all of freshwater origin. These beds contain the remains of mammals, among which are *Titanotherium Proutii*, *Hyaenodon Nebrascensis*, *Oreodon gracilis*, *O. Culbertsoni*, also *Dicpranodon*, *Amphycion*, *Dinictis*, *Anchitherium Bairdii*, *Agriochoerus antiquus*, *A. major*, *Pebrotherium Wilsoni*, *Leptauchenia*, *Protomeryx*, *Merycodus*, *Rhinoceros*, *Hyracodon*, *Lophiodon*, *Mastodon*, *Chaeropotamus*, *Leptochoerus*, *Hyopotamus*, *Elotherium*, *Chalicomys*, *Ischyromys*, *Palaeolagus*, *Eumys*. In the same group in Colorado occurs *Brontotherium gigas*, nearly as large as an elephant, *B. ingens*, still larger, and *Elotherium crassum*, two-thirds as large as a rhinoceros. Extensive beds of the same horizon of freshwater origin also occur in the John Day River Valley (1500 to 2000 feet thick), also on the James River, Va.

EOCENE.

Alabama Period includes the formations—
(1) The Claiborne and Vicksburg groups, occurring along the Gulf and Atlantic Border.
(2) Wahsatch, Green River, Bridger, and Uintah groups, situated over the Rocky Mountain slopes, where the beds are of freshwater origin.

The freshwater beds consist of clays and lignites, and the marine beds of marls, limestones, calcareous clay, sandstone, and loose sand. The Wahsatch group (Coryphodon beds) and Green River group are of great extent, each stated as being over 5000 feet thick.

Characteristic Genera.

Protozoans—*Orbitoides*. Radiates—*Flabellum*, *Ocalina*, *Scutella*, *Clypeaster*. Molluscs—*Ostrea*, *Pecten*, *Lima*, *Crassatella*, *Astarte*, *Cardita*, *Cardium*, *Corbula*, *Callista*, *Mactra*, *Leda*, *Psammobia*, *Pandora*, *Cypraea*, *Marginella*, *Conus*, *Voluta*, *Mitra*, *Pleurotoma*, *Natica*, *Turbinella*, *Triton*, *Dentalium*. Fishes—*Lamna*, *Notidanus*, *Carcharodon*, *Zeuglodon*, *Galleocerdo*, *Pristis*, *Histiophorus*, *Clupea*. Snakes—*Dinoptris* (20 feet long). Crocodiles. Birds—*Hubo*. Mammals—*Coryphodon*, *Helaletes*, *Eohippus*, *Orohippus*, *Limnoravus*, *Hyopsodus*, &c. Marsupials—*Triacodon*.

Laramie or Lignitic Period.—The beds of this division attain a thickness in the Rocky Mountains region of several thousand feet. They partly consist of brackish water beds, which in general are unconformable to the overlying Tertiaries. Lignite or carbonised wood and beds of mineral coal are largely developed. The plant remains are extremely interesting, and it is difficult to determine the position of the group, as the affinities of the plants are more closely related to the underlying Cretaceous rocks than to the beds which next succeed them.

Characteristic Genera.

Plants—*Quercus*, *Carya*, *Populus*, *Acer*, *Ulmus*, *Morus*, *Carpinus*, *Fagus*, *Juglans*, *Betula*, *Alnus*, *Corylus*, *Ilex*, *Negundo*, *Platanus*, *Sapindus*, *Ficus*, *Cinnamomum*, *Laurus*, *Bauzoin*, *Persea*, *Myrica*, *Salisburia*, *Cornus*, *Ceanothus*, *Viburnum*, *Rhus*, *Olea*, *Rhamnus*, *Magnolia*, *Smila*, *Eucalyptus*, *Thuya*, *Thuyites*, *Sequoia*, *Abies*, *Taxodium*, *Glyptostrobus*, *Sabal*, *Calamopsis*, *Flabellaria*. The genus *Inoceramus* occurs with other marine forms in the doubtful beds at the base of the group, referred by some to the Cretaceous formation.

NEW ZEALAND.

NEOGENE.

WANGANUI SYSTEM (NEWER AND OLDER PLIOCENE).

Professor Hutton (Quart. Journ. Geo. Soc., May, 1885), includes within this system the following; viz.—*Kereru series*, *Ormond series*, *Pétane series*, *Putiki series*, *Older Glacial Deposits*, *Lignites of Otago*, *Manuka*, &c. Professor Hutton states "Marine beds belonging to this system have been proved by palæontological evidence only in the southern half of North Island from Patea and Wanganui on Cook's Straits (Putiki series) to the Ngaruro River (Kereru series), and Esk River (Pétane series) in Hawkes' Bay . . . also at Poverty Bay (Ormond series) at Taranaki round Manuka Harbour, on the west side of Whangarei Harbour, and in various other places in the Province of Auckland. In the South Island the marine beds of the North appear to be represented by thick unfossiliferous gravels . . . difficult to distinguish from the upper gravels of the Pareora System," upon which they rest unconformably. "From 70 to 90 per cent. of the Mollusca, and all the Brachiopoda, are recent." (Hutton.)

Characteristic Fossils.

Mollusca—*Trophon expansus*, *Poonia Dreven*, *Pleurotoma*, *Wanganuiensis*, *P. tuberculata*, *Galerus inflatus*, *Trochus conicus*, *Zizyphinus Hodgei*, *Dentalium nanum*, *Cytherea assimilis*, *Ostrea corrugata*. Actinozoa—*Trochocyathus quinarius*, *Flabellum rugulosum*.

PALÆOGENE.

PAREORA SYSTEM (MIOCENE).

Within this System the same authority includes the following series; viz.:—*Awatere*, *Kanieri*, *Totchitu*, *Ahuriri*, *Waitemata*, and Brown Coal of Poonuhuka, &c.

In the North Island the members of the System are widely distributed, often forming cliffs; from Cape Rodney, Kawau, and Kaipara Harbour to Auckland, where they form cliffs round Waitemata Harbour; on the West Coast at White Cliffs in Taranaki; on the East Coast the system covers a large district between East Cape and Poverty Bay (Tawhiti series); Napier to Cook's Straits (Ahuriri series); in the upper parts of the Rangitiki, Wanganui, and Waitotára Rivers towards the centre of the island. In the South Island the "system attains an elevation of 3000 feet at Mount Pleasant, and also in several valleys in the centre of the New Zealand Alps." In the Port Hills, near Nelson, thick beds of gravel "are distinctly interbedded with sandstone containing Paréora fossils; and these gravels, sometimes cemented into conglomerates, pass inland to Lake Rotoiti, attaining in the Moutére and Wai-iti Hills an elevation of 2331 feet." The System lies unconformably on the Oamaru System in Auckland Province, although it is stated that in Canterbury "no unconformity has been made out."—(Hutton). A section from Howick, Auckland, to the Wairoa River, show the *Paréora System* horizontally abutting unconformably against the *Oamaru System*, while the latter, in inclined beds, rest unconformably upon the slopes of the *Maitai System*. From 20 to 45 per cent. of the species are recent.

Characteristic Fossils.

Mammalia—*Phocænopsis Mantelli*. Birds—*Moa* sp. Fishes—*Carcharodon megalodon*. Mollusca—*Cominella Robinsoni*, *Voluta corrugata*, *V. pacifica*, *Triton spengleri*, *Pleurotoma sulcata*, *Conus Traili*, *Turbo superbus*, *Natica solida*, *Struthiolaria cincta*, *S. tuberculata*, *Dentalium Mantelli*, *D. læve*, *D. solidum*, *Cucullea alta*, *Pectunculus laticostatus**, *P. globosus*, *Pecten secta*, *P. Triphooki*, *P. accrementa*, *P. Burnetti*, *P. polymorphoides**, *Cardium spatiosum*, *Crassatella ampla*, *Limopsis insolita*, *Ostrea ingens*, *O. Wullerstorfi*, *O. Nelsoniana*. Actinozoa—*Flabellum corbicula*, *Platythelia distans*.

OAMARU SYSTEM (OLIGOCENE).

Professor Hutton includes within this division the following series; viz.—*Mount Brown*, *Aotéa*, *Otótara*, *Taranganáii*, and coals of Waikato, Kaitángata, &c. The system is thought to be unconformable to the lower Waipara System. In the North Island it attains an elevation of 4000 feet east of Lake Waikaremoana. In the South Island it probably never exceeds 2500 feet. "Valuable seams of coal lie conformably below marine sandstones at the Bay of Islands and at Whangarei. In Nelson Province the brown coals of West Wanganui probably belong here, as also much of the brown coal up the Buller River." "About 9 or 10 per cent. of the species (Mollusca) appear to be recent."—(Hutton.)

Characteristic Fossils.

Aquatic Mammalia—*Kekenodon onamata*. Birds—*Palæeudyptes antarcticus*. Crustacea—*Harpactocarcinus tumidus*. Mollusca—*Aturia zic-zac*, var. *Australis*,* *Pleurotoma hebes*, *Struthiolaria senex*, *Scalaria Browni*, *S. rotunda*, *Dentalium tenue*, *Panopæa plicata*, *Pecten Hochstetteri*, *P. Zittelli*,* *P. Williamsoni*, *P. Fischeri*, *P. Hutchisoni*, *P. athleta*, *Lima lævigata*, *L. paleata*. Echinodermata—*Lovenia formosa*, *Macropneustes spatangiformis*, *Meoma Crawfordi*, *Schizaster rotundatus*. Actinozoa—*Isis dactyla*, *Flabellum laticostatum*.

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* Those species marked with an asterisk occur also in the marine beds of Palæogene age in Australia and Tasmania.

The freshwater beds at Drury and Waikato have yielded the following genera of plants; viz.—*Fagus*, *Lorantho phyllum*, *Myrtifolium*, *Phyllites*.

SOUTH AUSTRALIA.

NEOGENE.

Lacustrine Deposits of the [illegible] *Upper Murray*, [illegible] travertin, thinly bedded [illegible] composed of [illegible] stones, red and blue clays, compact earthy arg[illegible] friable sandstone, with occasional layers of coarse sand, reddish coloured calciferous clays, often abutting against the cliffs of the Upper Murray, and forming a [illegible] plateau against the margin of the older marine Tertiaries. Professor Ralph Tate states that "the materials of the upper plateau are of freshwater origin—at any rate, no palæontological evidences have been adduced for or against—whilst the extreme angularity of the sand constituents and their false-bedded arrangement [illegible] rapid accumulation, such as takes place where torrent and stream debouch into lake basins."

PALÆOGENE.

Professor Tate divides the older Tertiaries of South Australia and Victoria (composed of the sediments of the older Tertiary shallow sea which at one time divided Western Australia from the eastern Cordillera, and whose southern extremities extended as far south as Cape Grim, Table Cape, and Flinders' Island in northern Tasmania) into four principal groups in descending order; viz.—*Upper*, *Middle*, and *Lower Murravian*, and *Inferior Marine Beds*, as under —

UPPER MURRAVIAN.

Section near Glensforslan, Blanchetown, in descending order—1. Oyster bank; 2. Friable sandstone, with fragments of shells and cidaris; 3. Oyster bank; 4. Red and yellow clayey sand, with scattered oysters. In all 14 feet 6 inches.

Section North-West Bend Head Station.—1. Hard sandstone; 2. Soft sandstone, false bedded; 3. Oyster bank—a dense mass of shells in a calcareous paste, oysters, pearl shells, *Trigonia acuticostata*, &c., and casts of Univalves; 4. Sand rocks, unfossiliferous. In all, 28 feet.

Section at four miles south from Morgan.—Oyster band, 12 feet.

Observations—Fauna very meagre, and it is only at few spots where other than the ubiquitous oyster is found, and even then the forms are imperfect and difficult to determine. Besides the common oyster there is a large *Margaritifera*, *Trigonia acuticostata*, *Pectunculus M'Coyi*, *Arca* 2 sp., *Tellina*, *Mactra*, &c.—*Clypeaster Gippslandicus*.

MIDDLE MURRAVIAN.

Section, Glensforslan, near Blanchetown.—1. Dense mass of *Cellepora Gambierensis* in a reddish calcareous paste, a few oysters and fish teeth; 2. White friable earthy limestone, stained at top with iron, phosphatic concretions. Highly charged with *Waldheimia Macleana*, and casts of molluscs in gypsum; 3. Yellow limestone, with *Torcula Murrayana* in gypsum; 4. Light grey calciferous sandstone, with a thick band of *Cellepora Gambierensis*. In all, 50 feet.

Section at North-west Bend Head Station—Yellowish-grey calcareo-argillaceous sand rock, with hardish bands of *Cellepora Gambierensis*. Polyzoa abundant, numerous Palliobranchs and Echinoderms. 43 feet.

Section near Morgan.—1. Hard lumpy yellow sandstone; 2. Yellowish-grey limestone, with clayey sand layers; 3. Yellowish-brown clayey sand, with *Cellepora Gambierensis*; 4. The same, with hard lumps and imperfect stony bands, very fossiliferous, particularly rich in gasteropods; 5. Shell sand with streak of stiff blue clay; 6. Same as No. 4; 7. Yellow soft calciferous sandstone. In all, 91 feet.

Mount Gambier, white limestone.

LOWER MURRAVIAN.

Near Glensforslan.—1. Hard grey calciferous sandstone, with *Lovenia Forbesi*, *Cellepora Gambierensis*, *Nautilus*; 2. Brown friable calciferous sandstone; 3. Hard grey calciferous sandstone, with casts of *Torcula Murrayana*; 4. Brown calciferous friable sandstone, 5. Same as 3; 6. Same as 2 and 4, *Panopea* sp.; 7. Same as 3, 8. Yellow grey friable calciferous sandstone, with casts of *Torcula* in gypsum. 26 feet in all.

INFERIOR MARINE BEDS.

1. Chalk rocks, Bunda Cliffs.
2. Mudwoortie clays and other lower beds.
3. Aldinga glauconitic limestone.

Characteristic Fossils.

Middle Murravian—*Charcarodon angustidens*, *Otodus Desori*, *Lamna elegans*, *Aturia zic-zac*, *Typhis M'Coyi*, *Triton Abbotti*, *Ranella Prattii*, *Nassa Tatei*, *Ancillaria semilævis*, *A. mucronata*, *A. herbera*, *Cassis textilis*, *Voluta Hannafordi*, *V. antiscalaris*, *V. strophodon*, *Marginella Wentworthi*, *M. propinqua*, *Nisa pulo*, *Eulima acutispira*, *Leiostraca Johnstoni*, *Mangelia bidens*, *Daphnella gracillima*, *Triforis sulcata*, *T. Wilkinsoni*, *T. planata*, *Cerithium cibarioides*, *Cypræa gigas*, *C. leptorhyncha*, *C. consobrina*, *Trivia acellanoides*, *C*[illegible] *Trai*[illegible], *Cancellaria varicifera*, *Torcula Murrayana*, *Natica Beddomei*, *N. Hamiltonensis*, *Solarium acutum*, *Minolia stripta*, *Liotia Roblini*, *Cyclostrema acuticarinata*, *Xenophora undulata*, *Fissurellidæ malleata*, *Emarginula transenna*, *Cylichna exigua*, *Bulla scrobiculata*, *Pecten Yahlensis*, *P. Foulcheri*, *P. incertus*, *P. Dariensis*, *P. Atkinsoni*, *P. spondyloides*, *Lima Bassi*, *L. Jeffreysiana*, *Spondylus pseudoradula*, *Leda inconspicua*, *Nucula tumida*, *Pectunculus M'Coyi*, *Cucullæa Corioensis*, *Crassatella oblonga*, *Lepton crassum*, *Chama lamellifera*, *Corbula pyxidata*, *Chione cainozoica*, *C. dimorphophylla*, *Corbula ephamilla*, *Rhynchonella squamosa*, *Terebratula Scoulari*, *T. Davidsoni*, *Magasella Woodsiana*, *Waldheimia Garibaldiana*, *W. grandis*, *W. Taylori*, *W. Tateana*, *W. decurrenta*, *W. Corioensis*, *Terebratula vitreoides*, *Leucodera Australis*, *Echinus Woodsi*, *Trematochinus ovensis*, *Catopygus elegans*, *Micraster breviselli*, *Brissopsis Archeri*, *Holaster Australis*, *Echinolampas Gambierensis*, *Lovenia Forbesi*, *Eupatagus rotundus*, *E. Murrayensis*, *E. Wrightii*, *Arachnoides Australis*, *Megalaster compressus*, *Deltocyathus viola*, *D. alatus*, *D. excavus*, *Sphenotrochus Emarcinatus*, *Balanophyllia Australiensis*, *trochus deltoideus*, *Antillia lens*, *Balanophyllia Australiensis*, Ostracoda, foraminifera, and Polyzoa enumerated by Messrs. Waters and Brady.

Lower Murravian Species—*Zaglodon Harwoodi*, *Lovenia Forbesi*, *Magasella Woodsiana*, *Megalaster compressus*.

The greater number of these species are identical with those in the Table Cape beds, Tasmania, where, on palæontological grounds, it would be difficult to mark any satisfactory lines indicating corresponding subdivisions with those of South Australia.

NEW SOUTH WALES.

NEOGENE.

Alluvial deposits not clearly defined, from the deposits of Post Tertiary age, and referred [illegible] *Lower P*[illegible] *Miocene*.

PALÆOGENE.

Felspathic Basalts and Tuffs, &c., immediately overlying ligneous deposits, as at Gulgong, containing in abundance the remains of a flora identical with that of the Victorian and Tasmanian auriferous and stanniferous drifts.

Lignite and Leaf-bed Formations, as in the Auriferous "Deep Leads" at Gulgong, Parkes, Forbes, Home Rule, and other Gold Fields. Deposits of the Great Dividing Range, at various elevations up to 4000 feet above sea level, composed of conglomerates, siliceous sandstones, clays, and ironstones, containing leaf impressions.

Mr. Wilkinson states that in lithological character these beds have a perfect resemblance to the Lower Miocene leaf-beds of Bacchus Marsh, Victoria; some of the impressions of leaves in the former seem to be undistinguishable from the Victorian fossils. Professor M'Coy states that the fossil plants of the ironstones are strikingly distinguished from the Tertiary leaf-beds of Daylesford and other gold drift deposits by the total absence of myrtaceous plants, and that the fossil leaves from this locality indicate a Lower Miocene or Upper Eocene Tertiary flora, in which lauraceous plants form a remarkable feature. This description would also relate them to the lauraceous deposits at Maguet Range, Mount Bischoff, and Macquarie Harbour, Tasmania.

Dr. Barnard states that the leaf and fruit remains at Gulgong are found immediately beneath the basalt, as at Breadalbane and elsewhere in Tasmania, in a layer of dark bluish clay, arranged in distinct layers. This clay overlies the "drift" or "washdirt" containing the gold, and varies in thickness from one to several feet. Beneath the latter is another layer of clay, all containing trunks of fossilised trees, branches, and roots of these, together with fruits, ferns, sedges, and the remains of animal life. The old "drifts" in this district occur at a depth of from 50 to 175 feet, and Mr. Wilkinson reports that in seven years they have yielded no less than 10 tons of gold.

Characteristic Fossils.

Mollusca—*Unio Aucklandicus*, var. *Wilkinsoni*. Phanerogamæ—*Spondylostrobus Smythii*. Monocotyledones—*Murorhagium Liversidgei*. Dicotyledones—*Conchocaryon Smythi*, *Celyphina M'Coyi*, *Conchotheca (?) rotundata*, *C. turgida*, *Trematocaryon Macleilani*, *Rhytidocaryon Wilkinsoni*, *Illicites astrocarpa*, *Dieune pluriovulata*, *Ochthodocaryon Wilkinsoni*, *Plesiocapparis leptocelyphis*, *P. prisca*, *Eoothecaryon semiseptatum*, *Pentacoila Gulgongensis*, *Penteune brachyclinis*, *P. Clarkei*, *P. trachyclinis*, *Phymatocaryon angulare*, *P. bosiere*, *P. Mackayi*, *Tricoelocaryon Barnardi*, *Acrocoilus anodonta*. Plantæ incertæ sedis—*Odontocaryon Macgregorii*, *Platycoila Sullivani*, *Pleuroon electrocarpum*, *Rhytidotheca Lynchii*, *Wilkinsonia bilaminata*, &c. Nearly all of these plants were described by Sir Ferdinand von Mueller, K.C.M.G. (Geol. Survey, Vic., Decades (figured) I. and II., 1874 and 1883).

Leaf-beds of Dalton, near Gunning, regarded by Professor Dr. von Ettingshausen as *Eocene*, from which the following plants, collected by Mr. C. S. Wilkinson, have been described:—

Filices—*Pteris Humei*. Dicotyledons—*Betula Daltoniana*, *Quercus Hookeri*, *Q. praphilippinensis*, *Q. drymeoides*, *Q. Darwinii*, *Fagus Wilkinsoni*, *Castanopsis Benthami*, *Ficus Solanderi*, *Artocarpidium Sturtii*, *Cinnamomum polymorphoides*, *C. Leichardtii*, *Laurus Australiensis*, *Knightea Daltoniana*, *Apocynophyllum Etheridgei*, *Tabernæmontana primigenia*, *Magnolia Brownii*, *M. Torrensi*, *Bombax Sturtii*, *B. Mitchelli*, *Pittosporum priscum*, *Celastrophyllum Cunninghami*, *Pomaderrites Banksii*, *Eucalyptus Daffii*, *Dalbergia Hennensis*, *Cassia Cookii*, *Leguminosites Kennedyi*. All described by Professor Dr. von Ettingshausen.

VICTORIA.

UPPER TERTIARY.

[illegible]

Note.—[illegible] Professor [illegible] Tertiary [illegible] South Wales [illegible] R. M. J.

MIDDLE TERTIARY.

[illegible]

LOWER TERTIARY.

[illegible]

TASMANIA.

NEOGENE. PLIOCENE.

[illegible]

PALÆOGENE. MIOCENE, OLIGOCENE, AND EOCENE.

[illegible]

WILLIAM THOMAS STRUTT,
GOVERNMENT PRINTER, TASMANIA.

If we carefully examine the preceding lists of fossils, and compare them with corresponding tables belonging to the Mesozoic period, we can easily discern that the differences presented in plant and animal life are very remarkable. The modern aspect of the life of the Tertiary period is at once apparent.

Flora.

As regards the Plants, we find this feature well exemexemplified :—The characteristic genera of ferns of the Mesozoic period in Australia—viz., *Thinnfeldia*, *Alethopteris*, *Pecopteris*, *Neuropteris*, *Sphenopteris*, *Tæniopteris*, *Cyclopteris*—have altogether disappeared, and so also have the Cycads, Horestails, and Conifers, represented by the genera *Pterophyllum*, *Podozamites*, *Zamites*, *Phyllotheca*, *Baiera*, *Gingkophyllum*, *Salisburia*, and *Zeugophyllites*.

In their stead the vegetation of the Tertiary period in Australia is represented by sparing remains of ferns belonging to existing genera—viz., *Pteris Lomaria* and *Trichomanes*—and a wonderfully luxuriant vegetation, mainly *Angiosperms*, showing, as a whole, apparently a closer relation to the existing vegetation of Europe than to the existing plant life of Australia. A close examination of the genera of plants occurring so abundantly in our Tertiary leaf-beds leads to many interesting speculations. In the earlier formations in Tasmania and New South Wales, representatives of the existing Australian vegetation, such as *Eucalyptus*, *Pomaderris*, *Cassia*, *Lomatia*, *Banksia*, &c. are only to be found sparingly; whilst the remains of the following associated genera, still existing in Europe, are found in rich profusion—viz., *Acer*, *Laurus*, *Salix*, *Quercus*, *Platanus*, *Betula*, *Alnus*, *Myrica*, *Ulmus*, and *Fagus*.

This mixture in our Tertiary formations of the elements of the existing floras of Europe and Australia is of the greatest interest, and has recently been ably investigated by Professor von Ettingshausen. In one of his latest communications[a] he summarises the results of his painstaking investigations of the Australian Tertiary Flora as follows :—"When we take into consideration only those fossil species which are represented by fruits, seeds, and characteristic

[a] Geol. Mag., Aug., 1887, pp. 359-362.

forms of leaves, we obtain new and sufficient proofs concerning the view which I have brought forward in the first part of these contributions, that the elements of the floras are mixed together in the Tertiary Flora of Australia. These proofs consist of facts relative to the common appearance of the genera endemic in Australia with genera we find in other floras, but which are strange to the Australian one. For example, there occur in the fossil flora of Vegetable Creek and Elsmore (New South Wales) the following genera of the Australian element :—*Phyllocladus*, *Casuarina*, *Santalum*, *Persoonia*, *Grevillea*, *Hakea*, *Lomatia*, *Banksia*, *Dryandra*, *Callicoma*, *Ceratopetalum*, *Pomaderris*, *Boronia*, and *Eucalyptus*. On the other hand, we find here, intermixed with the former, types belonging to—*Sequoia* (California), *Myrica* (Europe, North America, Asia, South Africa), *Alnus* (Northern Hemisphere), *Quercus* (Northern Hemisphere), *Cinnamomum*[a] (Asia), *Sassafras* (North America and East India), *Aralia* (North America, Japan, and New Zealand), *Elæocarpus* (Tropical Asia), *Acer* (Northern Hemisphere), *Copaifera* (Tropical America)." From such considerations, this able authority concludes: "There is now scarcely any doubt that the general character of all Tertiary Floras of the globe is one and the same in regard to the mixture which they exhibit, and continued so until the separation of the elements of floras into the existing special floras towards the commencement of the present period."

He also gives a synopsis of the conclusions drawn from the general results obtained from the investigation of the Tertiary Flora of Australia, as follows :—

1. "The geographical distribution of plants in Australia at the Tertiary period deviated in many respects from the present one. Therefore the materials for comparison obtainable from the present flora of Australia are not at all sufficient for the investigation of the Tertiary one, and must be completed from other floras of the globe."
2. "Types of plants of the Southern as well as of the Northern Hemisphere of the globe are associated together in the Tertiary Flora of Australia."

[a] Also Australia.

3. "The flora elements represented in the Tertiary Flora of Australia chiefly contain Phylones (ancestor types), which are also common to other Tertiary Floras of the globe. The character of the Tertiary Flora of Australia cannot, therefore, be considered essentially different from that of the latter."
4. "The Australian Tertiary Flora, in accordance with the preceding statements, is but a part of one and the same original flora upon which all the living floras of the globe are founded."
5. "The comparison of this original flora to the present floras of the globe shows that in Australia the differentiation of the Phylones has reached its highest degree."
6. "Many analogies to the Tertiary Flora are nevertheless to be found in the living Australian Flora."

The genesis of the existing floras of the globe has thus been ably shown to have been derived from generic ancestor types living in the original flora of the Tertiary period. The genesis of these original ancestor types, themselves from a further removed line of ancestry in the Mesozoic period, is a more difficult matter, and is only briefly referred to by the learned authority quoted in his observations with respect to the New Zealand Fossil Flora[a]. In commenting upon the Cretaceous Flora of New Zealand, he states that plant remains have been collected from four localities—Pakawau, Grey River, Wangapeka, and Reefton. "The Cretaceous Flora contains" 37 species, distributed into 29 genera and 17 families. Of these 4 are *Cryptogamæ*, 8 *Coniferæ*, 4 *Monocotyledons*, 13 *Apetalæ*, and 8 *Dialypetalæ*. "Several species seem to be the ancestors of Tertiary ones, particularly of the genera *Aspidium*, *Podocarpus*, *Dacrydium*, *Quercus*, *Fagus*, *Cinnamomum*, *Dryandroides*, *Ceratopetalum*, *Cupanoides*, &c." *Ulmophylum* is also referred to as an ancestor of the Tertiary *Ulmus* and *Planera* species. The plant forms, having a characteristic Cretaceous facies associated with them, are stated to be certain conifers belonging to the genera *Podocarpium* and *Dacrydinium*.

[a] On the Fossil Flora of New Zealand (Geol. Mag., Aug., 1887, pp. 363-367.

As regards the relationship of the various Australasian leaf-beds to each other, and their exact position within the period, there is much that is uncertain and obscure. It is true that the learned authority, for whom the author entertains the highest respect, has referred the Travertin beds at Risdon and other leaf-beds of the Derwent near Hobart to Miocene age, while beds containing a very similar flora in New South Wales (Dalton and Vegetable Creek) have been referred to Eocene, and even Lower Eocene age; but as the author has recently discovered a characteristic species of the Derwent (*Sapotacites oligoneuris*, Ett.) intercalated with other plant impressions in marine beds at Table Cape, deemed to be of Eocene age, it proves that it is hazardous to attempt to define their position in accordance with the nomenclature of Europe, and especially with the particular association of genera found there within definite local subdivisions.

The reference to the wider grouping (*Palæogene*), as adopted by the author, appears to be the safer course at present, when we take into consideration the great difference in longitude and latitude of the deposits referred to, and the possible original differences of elevation.

Fauna.

The Australian Tertiary Fauna, as a whole, also presents a clearly modern aspect. The foraminifers, brachiopods, gasteropods, pteropods, and pelecypods nearly all belong to genera still existing in Australian seas. Of the Tertiary molluscs of Australia and Tasmania, however, there is, according to latest accounts, not more than 2 per cent. of the species identical with existing forms. *Fishes* of the shark family are alone known, and these are represented by four genera (*Carcharodon*, *Lamna*, *Otodus*, *Oxyrhina*), all of which have living congeners. The carnivora are represented by a member of the seal family (*Arctocephalus Williamsi*, M'Coy); and Cetaceans, by the characteristic genera *Squalodon* and *Zeugolodon*. Professor M'Coy has also figured three species of *Cetotolites* from the Tertiary beds near Geelong, which are declared to be the ear-bones of different species of whales.

Perhaps the most interesting group of mammals, so far as Australia is concerned, is the ancestral types of the existing marsupials. As yet the more remarkable forms of this group have been found in the later cave breccias and other deposits of Australia deemed to be of Post-Pliocene age.

Marsupial remains have not yet been detected in Australia in deposits older than the Tertiary period. Mammalian remains of Mesozoic age,—such as *Microlestes*, *Amphitherium*, *Amphilestes*, *Phascolotherium*, *Stereognathus*, *Plagiaulax**, *Spalacotherium**, *Galestes**, and *Peratherium* of Europe; and *Allodon*, *Ctenacodon*, *Dryolestes*, *Stylacodon*, *Asthenodon*, *Laodon*, *Diplocynodon*, *Docodon*, *Enneodon*, *Menacodon*, *Tinodon*, *Triconodon**, *Bracidus*, and *Paurodon* of the Jurassic age, in North America,—have heretofore been referred to the Marsupialia on the authority of Professor Owen and other eminent specialists: the dentition of certain of them approaching closely to the existing Hypsiprymnus of Australia; of some to the existing Opossums; and of others to the existing *Myrmecobius* of Western Australia.

The remains in the earlier Tertiary formations of Australia are generally very imperfect. From the teeth and other bones preserved, however, Professor Owen and other authorities have recognised the following genera—viz., *Bettongia*, *Hypsiprymnus*, *Halmaturus*, *Nototherium*, *Phalangista*, *Sarcophilus*, and *Phascolomys*. With the exception of the giant extinct vegetable-feeder, *Nototherium*, all the genera here referred to have living representatives either in Australia or Tasmania.

Of the genera marked with an asterisk, Professor Alleyne Nicholson states[a]: "Fourteen species are known from the Middle Purbeck beds of England (*Oolitic*), all of which are probably referable to the Marsupialia, and all of which, except *Plagiaulax*, are Polyprodont." The largest of these are deemed to be no bigger than a polecat or hedgehog. *Plagiaulax* is by various authorities believed to be most nearly allied to the existing kangaroo-rats of Australia and Tasmania (*Hypsiprymnus*). Professor Owen, however, regards it as more allied to the carnivorous group. The genera *Spalacotherium*, *Triconodon*, and *Galestes* have been referred to as insectivorous, having their nearest allies in our Australian phalangers and in the American opossums.

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[a] Manual of Palæontology, 1879, vol. ii., p. 292.

Professor Marsh, who has recently devoted much attention to these earlier forms of the Mammalia, has latterly[a] given good reason for the view that it is extremely doubtful whether these earlier forms can properly be referred to the order Marsupialia. Many of them appear to depart from the normal type of Marsupial structure, approximating to the Insectivora; and for these and other reasons, Professor Marsh has come to the conclusion that it is more probable that they represent two distinct primordial groups, termed by him Pantotheria and Allotheria, both of which are supposed to have no living representatives.

Local General Features.

Taken as a whole, the general features of the Tertiary system in Tasmania correspond exactly with those of the mainland of Australia. The rock formations may be conveniently divided into four main groups, in descending order, as follows:—

Neogene......	Older raised terrace drifts, often overlying the plateaux of basalt.
Palæogene..	1. Basaltic sheets and associated tuffs overspreading lacustrine formations. 2. Lacustrine deposits of great thickness and extent, composed of sands, clays, lignites, travertines, and sometimes including auriferous and stanniferous drifts. Contains the remains of a rich and varied flora. 3. Marine deposits in the northern part of Tasmania.

Palæogene Epoch.

Marine Formations.—The marine formations occur in isolated patches fringing the northern coast of Tasmania and the islands in Bass's Strait, notably near Cape Grim, Sandy Cove, Table Cape, and Heathy Valley, Flinders' Island. The members present a somewhat uniform

[a] Geol. Mag., July, 1887, pp. 297-298.

character, like their equivalents along the Lower Murray in Australia, and most probably they form the southern limits of the ancient Tertiary sea which occupied the greater part of the existing plains bordering the Great Australian Bight, and extending over the lower levels of South Australia and Victoria within the limits indicated in preceding chapter (p. 217). The rocks generally are composed of alternating bands of shelly limestones, calcareous sandstones, coral rag, ferruginous, gritty, and pebbly bands, replete with fossil shells, corals, foraminfers, echinoderms, sharks' teeth, &c. Certain thin zones of a hard calcareous character recur, invariably showing similar characteristic fossils, notably, *Cellepora Gambierensis*, *Lovenia Forbesi*, *Waldheimia grandis*, *W. Garribaldiana*, *Rhynchonella squamosa*.

The sandstones are also replete with fossils, in the upper beds of which the following are typical; viz.—*Turritella Warburtonii* (T. Woods), *Panopea Agnewi* (Ten.-Woods), *Voluta Tatei* (R. M. Johnston), *V. Hannafordi* (M'Coy), *V. Weldii* (T. Woods), *V. anticingulata* (M'Coy), *Cypræa Archeri* (T. Woods), *C. platypyga* (M'Coy).

In the sandstones of the Upper or "Turritella zone" at Table Cape, land plants occur, intermixed with the marine shells, among which may be noted a species of Pteris (*P. Belli*, Johnston) and (*Sapotacites oligoneuris*, Ettings.) The latter form has also been found by the author in lacustrine formations at Macquarie Harbour and Hobart, and may be of much value hereafter in determining the relative age and position of the isolated marine and lacustrine formations throughout the island.

The lowermost bed at Table Cape is almost wholly composed of the remains of *Crassatella oblonga* (T. Woods,) and rests upon the upturned edges of slates belonging to Silurian age. At Cape Grim and Table Cape the whole series are capped with bosses of nepheline basalt, similar to the older basalts of Victoria; and nowhere along the Tasmanian coast does the marine group exceed 70 feet in thickness. From the character of the molluscs and the small percentage (not exceeding 2 per cent.) of species having living representatives, it is clear that the marine beds of Tasmania must be placed at the base of the Palæogene group, equivalent to the early Eocene of other countries.

Although many earlier references are made respecting the Tertiary marine deposits of Tasmania, their history has only been worked out fully and systematically within the last eleven or twelve years. The Palæontology of these deposits has been ably investigated and described mainly by the Rev. J. E. Tenison-Woods, Professors Duncan, Busk, and Tate, from collections made in great part by the author within the last fourteen years. In addition to the numerous memoirs communicated to the Royal Society of Tasmania upon the geology and stratigraphy of the various Tertiary marine deposits of Tasmania, the author has also added somewhat to its Palæontology—about forty new species of molluscs, described by him, having been added to the general list.

The following are the sources from which the greater part of the information may be gained respecting the Geology and Palæontology of the Tasmanian deposits :—

Woods (Rev. J. E. T.) On some Tertiary Fossils from Table Cape, Tasmania. Papers and Proc. Roy. Soc. of Tas. for 1875, pp. 4 and 13-26, 3 plates.

—— On the History of Australian Tertiary Geology. *Ibid* for 1876, pp. 76-78.

—— Notes on the Fossils (from the Tertiary Marine Beds, Table Cape) collected by R. M. Johnston. *Ibid* for 1876, pp. 91-115.

—— On the Tertiary Deposits of Australia. Jour. R. Soc. of New South Wales for 1877, xi., pp. 65-82.

Duncan (Prof. P. M.) On some Fossil Corals from the Tasmanian Tertiary Deposits. Quart. Journ. Geol. Soc., 1875, xxxi., pp. 677, 688, and 380.

—— On some Fossil Reef-building Corals from the Tertiary Deposits of Tasmania. *Ibid*, xxxii., pp. 341-351 and 22.

Tate (Prof. Ralph.) On the Australian Tertiary Palliobranchs. Trans. R. Soc. S. Australia, 1880, iii., pp. 140-170, pls. 7-11 ; *Ibid.*

—— Notes of a Critical Examination of the Mollusca of the Older Tertiary of Tasmania, alleged to have living representatives. Papers and Proc. Roy. Soc. of Tas., 1884, pp. 207-214.

—— The Fossil Marginellidæ of Australia. Trans. Phil. Soc., Adelaide, for 1877-78, pp. 90-98.

—— Description of New Species of Mollusca of the

Upper Eocene Beds at Table Cape. Papers and Proc. Roy. Soc. of Tasmania for 1884, pp. 226-231.

Tate (Prof. Ralph.) Supplemental Notes on the Palliobranchs of the Older Tertiary of Australia, and a description of a New Species of Rhynchonella. Trans. Royal Soc. of South Australia, 1885, pp.

—— The Lamellibranchs of the Older Tertiary of Australia (Part I.) *Ibid* for 1885, pp. —, 11 plates: Part II. for 1886, pp. —, 7 plates.

Etheridge (R., Jun.) A Catalogue of Australian Fossils (including Tasmania and the Island of Timor) Stratigraphically and Zoologically arranged. Edited for the Syndics of the University Press, pp. viii. and 232. (8vo., Cambridge, 1878.)

M'Coy (Prof. F.) Geological Survey of Victoria; Prodromus of the Palæontology of Victoria. Decades i-vii, (1874-1885).

Johnston (R. M.) Further Notes on the Tertiary Marine Beds of Table Cape, Tasmania. Papers and Proc. Roy. Soc. of Tas. for 1876, pp. 79-90: [Section] showing position of Tertiary Marine Beds at Sandy Cove, Table Cape.

—— Notes on certain Tertiary and Post-Tertiary Deposits on Flinders', Barren, Badger, and other Islands in Bass's Straits. *Ibid*, pp. 41-50. Sections of Badger, Green, and Flinders' Islands.

—— Notes regarding certain Fossil Shells at Table Cape, supposed to be identical with living species. *Ibid* for 1884, p. 199.

—— Third Contribution to the Natural History of the Tertiary Marine Beds of Table Cape, with a description of 30 new species of Mollusca. *Ibid* for 1879, pp. 29-41.

—— Additions to the List of Table Cape Fossils, together with further Remarks upon certain Fossil Shells supposed to be identical with living species. *Ibid* for 1884, pp. 220-224.

—— Description of new species from Eocene Beds, Table Cape. *Ibid*, 1884, pp. 232-233 (two plates).

—— Notes regarding the discovery of Plant Remains in the Tertiary Marine Beds at Table Cape. *Ibid*, 1886, p. xx., two plates, leaf figures, &c.

Johnston (R. M.) Reference List of the Tertiary Fossils of Tasmania. Papers and Proc. Roy. Soc. of Tas. for 1886, pp. 124-140.

Lacustrine Formations.—The more important lacustrine formations, as might be expected, are mainly found in the original valleys and eroded basins of the earlier rocks, and generally consist of regular or irregular bands or layers of white, grey, or ferruginous sandstones, alternating with grits; blue, white, yellow, or blackish clays; lignites; and sometimes, in the neighbourhood of the older slates and crystalline rocks, the ancient channels formed in them contain drifts of a richly auriferous or stanniferous character. Many of the formations are found along the course of existing rivers and watercourses in the form of raised bordering terraces. In other places, as in the Launceston Tertiary Basin, they occupy the floor of broad undulating plains, covering an area of not less than 600 square miles, and ranging from 400 to 1000 feet in thickness. Being comparatively of a loose and incoherent nature, the beds are unable to resist the eroding influences of air and water, and are, therefore, greatly denuded along the course of existing rivers and their tributaries. The extent of this denudation is well exemplified along the lower course of the North Esk in the neighbourhood of Breadalbane, St. Leonard's, and Launceston. In this vicinity it is estimated that strata from 15 to 20 miles long, by 1 to 1½ miles broad, have been denuded to a depth ranging from 50 to 500 feet. These lacustrine deposits are found throughout the island from sea level to an altitude of four thousand feet above it; sometimes, as at Magnet Range, Mount Bischoff, Branxholm, and Ringarooma, concealing and composed of the waste of the oldest or pre-Archæan rocks, with associated stanniferous granites and porphyries; again, as at Macquarie Harbour, Beaconsfield, Lefroy, Back Creek, Tullochgorum, Mangana, and Black Boy, bordering and concealing the Silurian slates with quartz dykes and veins, from the destruction of which they have derived their auriferous drifts. At Geilston, Cornelian Bay, Hobart, Sandy Bay, and One-Tree Point they are associated with the mudstones and intrusive greenstones; while at Launceston, Longford, Ross, Jerusalem, and Hamilton, they are mainly derived from the associated or underlying sandstones, clays, shales, and carbonaceous formations of Mesozoic age.

In each case, notwithstanding the similarity or identity of fossil plants common to them all, the nature of the later rocks shows that the mineral characteristics of each basin vary in correspondence with the rocks with which they are now immediately associated, and from the waste of which, in the main, they originally derived their sands, clays, grits, and gravels.

The clays and ferruginous sandstones are in most places replete with the remains of a luxuriant vegetation, among which the leaf impressions of forms more allied to the existing European flora are especially noticeable—such as those belonging to certain extinct species of the oak, elm, beech, laurel, willow, and elder. With these occur ancestral forms of banksia, lomatia, eucalyptus, pittosporum, cinnamon, fig, araucaria, and other conifers. The mixture in our Tertiary formations of types which characterise widely separated provinces of the globe at the present day is very interesting, and has already been commented upon in a previous chapter. It would seem that the Phylones or ancestral-types of the existing flora had already attained a very high state of development and specialization into well-known generic types in the early Tertiary period, and that the existing vegetation, restricted more or less to particular provinces, now only partially preserves the descendants of genera once more widely distributed. The tendency of influences operating in later times apparently is marked in the isolation into widely separated provinces of generic groups, once intimately associated together, rather than in the direction of newer generic creations; and, therefore, it is absolutely true, as indicated by Dr. von Ettingshausen, "the materials for comparison of the flora of any one province, or even hemisphere, are not at all sufficient for the investigation of the Tertiary one, and must be completed from other floras of the globe."

During the last seventeen years the author has also devoted much time to the investigation of the Tertiary Flora of Tasmania, the results of which have been communicated in a series of papers to the Royal Society of Tasmania. Nine of these papers[a] (with numerous figures

[a] 1. Johnston (R. M.) Regarding the composition and extent of certain Tertiary Beds in and around Launceston. Proc. R. Soc. of Tasmania for 1873, pp. 34-48 (sections and figures).

of fruit, leaf impressions, &c.) are devoted to the elucidation of the Tertiary lacustrine deposits and their plant remains.

Prior to the author's investigations certain of the deposits were briefly described by Dr. Milligan, Count Strzelecki, Professor Morris, the illustrious Darwin, and Morton Allport; and two or three of the plant remains were figured by Strzelecki in his work on "The Physical Description of New South Wales and Van Diemen's Land." It is from such sources, and from various collections examined, that the eminent phytologists, Baron von Mueller (Sir Ferd.), of Victoria, and Baron von Ettingshausen, of Vienna, have been enabled recently to make a more systematic investigation of the Tertiary Flora of Tasmania. The investigations of Baron von Ettingshausen are summarised in an abstract recently communicated to the Geological Magazine, in which the labours of the author are kindly acknowledged. As the views of Baron von Ettingshausen are of the greatest value in matters pertaining to palæo-botany, the portion dealing more particularly with the Tasmanian Flora is here reproduced.

In relation to the Travertin at Geilston, near Hobart, Baron von Ettingshausen writes :—"This Travertin has been ably investigated and written on by Mr. R. M. Johnston. I have examined in the British Museum a

2. Johnston (R. M.) The Launceston Tertiary Basin; second paper. Proc. R. Soc. of Tasmania for 1874, pp. 29 and 53-62 (figures).

3. —— Note on the discovery of *Spondylostrobus Smythii* (V. Mueller), and other Fruits in the Deep-lead Drift at Brandy Creek (Beaconsfield) Gold Field. *Ibid* for 1879, pp. 29-41.

4. —— Table of the Fossil Flora of Australia of the Tertiary period. *Ibid* for 1879, p. 29.

5. —— Notes on the relations of the Yellow Limestone (Travertin) of Geilston Bay, with other fluviatile and lacustrine Deposits in Tasmania and Australia, together with Descriptions of two New Fossil Helices. *Ibid* for 1879, pp. 81-90.

6. —— Notes showing that the Estuary of the Derwent was occupied by a Freshwater Lake during the Tertiary period. *Ibid* for 1881, pp. 1-21 (diagrams and figures).

7. —— Description of some Fossil Leaves from Tertiary deposits at Mount Bischoff. *Ibid* for 1885, pp. cxii-cxiii (figures).

8. —— Description of new species of Fossil Leaves from the Tertiary deposits of Mount Bischoff, belonging to the genera *Eucalyptus*, *Laurus*, *Quercus*, *Lamia*, &c. *Ibid* for 1885, pp. 322-325 (figures).

9. —— Notes. *Ibid* for 1886, pp. xx-xxi, (figures).

series of fossil plants from Risdon, Geilston Quarry, and Shoobridge's Limekiln, &c., near Hobart. The first is one of the best localities for the Travertin containing the leaves. In the British Museum there is also a series of fossil plant-remains, which are labelled '*Erebus* and *Terror*,' and were collected during the exploring voyage of those vessels to the Antarctic Seas by Dr. C. M'Cormick, who was attached as Surgeon and Naturalist to the *Erebus*. The fossil plants I examined came from the Tertiary Travertin, which is so extensively developed in the neighbourhood of Hobart Town. Finally, I have also examined the figures (afterwards reproduced) in R. M. Johnston's Paper (' Notes showing that the Estuary of the Derwent was occupied by a Freshwater Lake during the Tertiary period.' Proc. Roy. Soc. Tas., 1881, pp. 1-21 [5 plates, sections; and 6 plates, containing 102 figures)], with the view of enlarging the knowledge of this interesting fossil flora. It contains till now 35 species, which are distributed into 21 genera and 17 families. Of the species I have to mention—*Araucaria Johnstoni* (V. Mueller), *Myrica Eyrei*, closely allied to *M. salicina* of the European Miocene; *Betula Derwentensis*, corresponding to the Miocene *B. Brongniartii*; *Alnus Muelleri*, nearly allied to the Miocene *A. gracilis*; *Quercus Tasmanii*, like the *Q. Palæococcus* of the fossil flora of Radoboj; *Fagus Risdoniana*, nearly allied to *F. Deucalionis*; *Salix Cormickii*, closely allied to *S. varians*; *Cinnamomum Woodwardii*, allied to the Miocene *C. Scheuchzeri*; *Lomatia præ-longifolia*, allied to *L. borealis* of the European, and to *L. Torreyi* of the American Tertiary flora, as well as to the living Australian *L. longifolia*; *Dryandroides Johnstoni*, referring to living species of *Banksia* and *Dryandra*; *Coprosma præ-cuspidifolia*, the ancestral species of the living *C. cuspidifolia* of Australia; *Echitonium obscurum*, allied to *E. macrospermum* of the European Miocene flora; *Elæocarpus Bassi*, nearly allied to the Miocene *E. Albrechti*; *Sapindus Tasmanicus*, nearly allied to *S. falcifolius* of the European Miocene; *Cassia Flindersii*, allied to *C. ambigua* of the same strata. Besides these, species of *Apocynophyllum*, *Cordia*, *Premna*, *Sapotacites*, and *Ceratopetalum* occur. This flora contains more characteristic genera referable to the living Australian flora than that of Dalton, in New South Wales, especially such genera as *Lomatia*, *Dryandroides*, *Coprosma*, *Ceratopetalum*, but with a great number of genera occurring in the Tertiary flora of Europe, North America, and North Asia.

"The species are mostly allied to Miocene, and therefore the leaf-beds of the Tertiary Travertin belong, I believe, to the Miocene formation.

"The result of my report is as follows:—I find the Tertiary Flora of Australia is far more nearly allied to the Tertiary Floras of other Continents than to the living flora of Australia. It seems, therefore, that the numerous forms which characterise the latter have been developed out of Pliocene or Post-Tertiary forms of plants till now unknown to us. The recent flora of Australia contains also genera which characterise other floras, but not the Australian. It was till now enigmatical how they came to form part of this recent flora, as the species are endemic, and have not wandered; for instance, the species of the European and North American genus *Fagus*, of the Asiatic genera *Tabernæmontana* and *Elæcarpus*, &c.

"As some of them now have been discovered in the Australian Tertiary,—for instance, the above-named,—there is no doubt they passed over into the living flora from the Tertiary. The proofs of this may be easily introduced into palæo-botanical science by means of future discoveries and investigations: for in every case the more species from large and well-preserved series, the more readily shall we be enabled to show the origin of our living floras."

Basalt and Basaltic Tuffs.—One of the most characteristic features marking the close of the Palæogene period in Tasmania is the prevalence of extensive sheets, dykes, and masses of nepheline and anamesite basalts, associated with basaltic tuffs, already referred to in a former chapter under the heading "VOLCANIC ACTIVITY," p. 152. These basalts, although sometimes found as conical hills and isolated patches, are generally spread out over the Tertiary leaf-beds as sheets or terraces along the valleys or plains, as in the neighbourhood of Bronté, Great Lake, Mount Bischoff, Deloraine, Port Sorell, Campbell Town, Avoca, Cornelian Bay, Beauty Bay, Branxholm.

The rock varies considerably in composition, colour, structure, and texture. Some of the characteristics are due to having been subjected to different degrees of pressure and various modes of cooling, but more frequently to the effect of long continued action of decomposing agencies. The structure of the rock is mainly sphæroidal, polygonal, or hexagonal, concretionary, and much jointed, although sometimes showing a very perfect columnar or prismatic appearance as at Emu Bay and other places along the North-West Coast; and the texture varies from compact to vesicular, vesicular-amygdaloid, or spongy (basaltic pumice); the latter form, as at One-Tree Point, Hobart, often so light that it floats in water, and, but for its black or brownish colour, might readily be mistaken for true trachyte-pumice. In Tasmania, as in the older eruptive basalts of Victoria, the three sub-species of basalt (1. Dolerite, Dolerite Lava; 2. Anamesite, Anamesite Lava; 3. Basalt, Basalt Lava) may graduate vertically or laterally into each other. Professor Ulrich's description of these three sub-species of basalt, with respect to Victoria, serve equally well for Tasmania, and may be of much value to local geologists. He states:—

"Proceeding now to a special description of the older and newer basalts relative to their lithological character, bearing in mind their essential mineral composition, viz.—"augite," "labradorite," and "titaniferous iron,"—we have in Victoria the three established sub-species,—viz. dolerite, anamesite, and basalt,—besides an infinite number of varieties dependent on texture and other characters.

(1) "Dolerite, Dolerite Lava.—A crystalline-granular, dark and light-bluish or greenish-grey rock, in which crystals of its principal components (augite and labradorite) can be distinctly recognised by the naked eye. This species has not as yet been observed within the older basalt areas, and is also rare within those of the newer.

(2) "Anamesite, Anamesite Lava.—Of a bluish or greenish, often brownish grey or black colour, and distinctly recognisable, yet so finely crystalline-granular a texture, that the component minerals (augite and labradorite) cannot be clearly distinguished without the aid of the magnifying glass, and then only by their difference in colour. It is apparently the most prevailing. Its frac-

ture is flat-conchoidal, with a glittering surface, and it is sometimes rendered porphyritic by crystals of *hornblende* and *oligoclase*, and grains of *olivine*," (one of the varieties placed under this group is described by Professor Ulrich as *nephelinite*), "having numerous crystals (hexagonal prisms) of *nepheline*, some more or less decomposed, besides large plates of black or brown *mica*, patches of *triclinic feldspar*, apparently *oligoclase*, crystals of black *hornblende*, and large grains of *titaniferous iron*." This variety is also in places characterised "by the great abundance of zeolites, especially *analcime* and *natrolite*."

(3) "Basalt, Basalt Lava.—Dark grey to mostly black, quite homogeneous-looking; in fracture generally somewhat dull, though in some places . . . quite of the aspect of *Lydian stone*.

(*a*) "Earthy Basalt.—A bluish, greyish, or brownish black, mottled, earthy-looking, and more or less vesicular mass, with frequently embedded nodules of a denser texture, found in some places on top of the plains, and also beneath sheets of hard basalt.

(*b*) "Basalt Scoria.—Of dark brown or black colour, highly vesicular or cellular; the vesicles or cells irregular in size and shape, and showing glazed walls very similar to some of the slags of iron furnaces. It occurs in masses of irregular shape and of all sizes, principally on the tops and slopes of the craters and points of eruption. The same is the case with—

(*c*) "Basaltic Pumice.—A scoria, so spongy and light that it floats in water, and might, except for its black or brownish-black colour and absence of fibrous texture, be mistaken for true trachyte-pumice." (Occurs at One-Tree Point, Hobart).

(*d*) "Basaltic Ash (Tuff).—Earthy and compacted, ashy-grey or brown, sometimes mottled in these colours; found near craters and points of eruption, frequently in stratified layers. The compacted kinds are in some localities (Warrnambool, Terang, &c.) advantageously used as building stone, being, when freshly broken, soft enough to be sawn into blocks of all sizes, but hardening considerably on exposure to the atmosphere."

"Both the older and newer basalt rocks are rich in accessory minerals, partly original, partly of secondary origin. As the most noteworthy original mineral may be mentioned, *Olivine*—common in all our basalts, but more especially characteristic of the newer; in fact it is so frequent in places (Deloraine, Table Cape) as quite to assume the place of an essential constituent of the rock. It is generally of an olive-green, sometimes emerald and bottle-green colour, has a glassy lustre, and appears in grains and larger and smaller nests or polygonal masses of granular texture, up to several pounds in weight, irregularly distributed through the rocks. . . . It seems to decompose more readily than the mass of the rock, leaving behind it a reddish-brown substance, principally consisting of hydrous ferric oxide."

In their mode of occurrence, the three sub-species and their varieties, so graphically described by Professor Ulrich, differ in some respects from those described from basalt districts in Europe, inasmuch as they do not always occur in distinct masses with defined outlines, but rather, as described by Professor Ulrich, whom the author has so largely quoted, they "form here rather irregular portions of undefinable size and shape, graduating one into the other, laterally as well as vertically throughout the same sheet or stream of lava. They present, in fact, only as it were, differing forms and stages of mineral aggregation during the cooling of the molten matter. The same quarry yields thus frequently both *anamesite* and *basalt*, and at Malmsbury a quarry produces, besides these, also *dolerite*."

It is evident, from a study of these igneous rocks, that the eruption from the same point took place again and again after considerable intervals of repose, and this is substantiated at One-Tree Point, at Hobart, and also at Geilston, by the discovery of bone breccia lying under a solid sheet of basalt, and apparently occupying the crevices of the partly denuded surface of an older flow. The bones and teeth so found appear to belong to Marsupials of the following genera:—*Hypsiprymnus*, *Phalangista*, *Phascolomys*.

Formerly both Mr. Gould and Mr. Allport concluded from the bone remains that the "Geilston travertin must be of Recent Tertiary or Post-Tertiary age," and consequently that the associated intrusive basalt must be of still more recent origin.

The discovery of certain fossil seeds of plants, which have since proved to be identical with fruits widely distributed in Australia and Tasmania, in Palæogene formations, led Mr. Allport to enquire more particularly into the circumstances connected with the discovery of the fossil bones. This enquiry fully justified his supposition that the bones were obtained from a matrix derived from the originally deposited travertin, and deposited in crevices of the same rock probably formed by the intrusion of the overlying basalt. (Notice of Roy. Soc. Proc. of Tas., 13th June, 1876).

In a paper on the Launceston Tertiary Basin, read before the Royal Society of Tasmania in the year 1876, the author suggested that the travertin beds might belong to the same series as those in the neighbourhood of Launceston, and possibly of the same age as the marine beds at Table Cape and elsewhere in Australia. This suggestion was made because of the close resemblance between certain of the undetermined leaf remains common in the respective deposits, and from the circumstance that all the deposits referred to are capped by a more or less decomposed basalt; all of which, upon analysis, proves to be the same chemically and structurally. Professor Ulrich also informed the author that the basalts at Geilston Bay, Breadalbane, and Table Cape are essentially the same as the rock known as the "Older Volcanic" in Victoria, which also frequently caps the marine beds in Victoria, now certainly proved to be of the same horizon as the marine beds at Table Cape. The recent discovery of *Sapotacites oligoneuris* (Ett.) in the marine beds of Table Cape, also common to the lacustrine beds, seems to confirm this view.

The author has also gathered abundant evidence of the very wide distribution of this rich soil-maker from nearly all parts of Tasmania, particularly in the plains about Campbell Town, Fingal, Avoca, Piper's River, Myrtle Bank, Ringarooma, Deloraine, George Town, Torquay, Flinders' Island, Lake St. Clair, Mount Bischoff, Middlesex Plains, Cattley Plains, &c., in all which places it forms the rich chocolate soil of the district, and in auriferous and stanniferous regions it frequently overspreads the older auriferous and stanniferous drifts.

Through the praiseworthy labours of Professor Ralph Tate, Professor Hutton, R. Etheridge, Jun., R. L. Jack, S. H. Wilkinson, F. A. Krause, Rev. J. E. Tenison-Woods, S. H. Wintle, R. A. F. Murray, A. W. Howitt, Norman Taylor, Daintree, Thureau, Brough Smythe, and other Australian geologists, abundant materials for the determination of the Tertiary beds have been gathered together, and, recently, in the hands of the leading palæontologists they have yielded important results. From the writings of the gentlemen named we may learn that the extensive fluviatile and lacustrine formations in Australia, particularly at Haddon, Bacchus Marsh, Malmsbury, Daylesford, Werribee, Beechworth, Tangil River, Gulgong, Richmond River, Orange River, and in the Darling Downs, Queensland, are the equivalents of similar deposits in Tasmania at Beaconsfield, Nine-Mile Springs, Muddy Creek, Tamar, Breadalbane, Avoca, included within my definition of the Launceston Tertiary Basin, and also of the yellow limestone of Geilston Bay, Hobart, and similar deposits elsewhere in various parts of the Island. These freshwater deposits are undoubtedly of vast extent and of great thickness. The relations of the isolated though closely related groups of beds cannot be definitely ascertained, nor, when we take into consideration existing distribution of particular vegetable and animal forms, can we hope to draw satisfactory conclusions in regard to their exact sequence. The preponderance of proteaceous forms in one locality, or of coniferous remains in another, gives no clue to chronological sequence. It may only indicate the existence of varied forms of contemporaneous vegetable life under, perhaps, slightly altered circumstances as regards area, soil, or altitude.

No better conception of the restriction of particular forms to certain areas can be had than from a glance at the distribution of certain forms of the existing flora and fauna, *e.g.*, *Fagus Cunninghami*, *Frenela Australis*, *Anodopetalum biglandulosum*, *Arthrotaxis cupressiformis*, *Acacia dealbata*, *Eucalyptus globulus*, *Banksia serrata*; and *Helix Launcestonensis*, *H. antialba*, *H. Weldii*, *H. Pictilis*, *H. Bischoffensis*, *H. lampra*, and *Bulimus Tasmanicus*. The remarkable restriction of these examples affords striking illustrations of localization. With respect to land and freshwater contemporaneous remains, too, we ought to expect greater local differences in separate areas than in more widely separated contemporaneous areas of marine formations.

In summing the general features of the *Palæogene* period in Tasmania, the author was much struck with their resemblance to the general features of the Lower Miocene of France as described by Lyell. In respect of these he remarks[a] :—

"Lacustrine strata, belonging for the most part to the same Miocene system, as Calcaire de la Beauce, are again met with further south in Auvergne, Cantal, and Velay. They appear to be the monuments of ancient lakes, which, like some of those now existing in Switzerland, once occupied the depressions in a mountainous region, and have been each fed by one or more rivers and torrents.

"The country where they occur is almost entirely composed of granite and different varieties of granitic schist, with here and there a few patches of secondary strata much dislocated, and which have suffered great denudation. There are also some vast piles of volcanic matter, the greater part of which is newer than the freshwater strata, and is sometimes seen to rest upon them, while a small part has evidently been of contemporaneous origin. . . .

"The study of these regions possess a peculiar interest, very distinct in kind from that derivable from the investigation either of the Parisian or English tertiary areas. For we are presented in Auvergne with the evidence of a series of events of astonishing magnitude and grandeur, by which the original form and features of the country have been greatly changed, yet never so far obliterated but that they may still, in part at least, be restored in imagination.

[a] Elements of Geology, 1871, pp. 206-207.

Great lakes have disappeared—lofty mountains have been formed by the reiterated emission of lava, preceded and followed by showers of sand and scoriæ—deep valleys have been subsequently furrowed out through masses of lacustrine and volcanic origin—at a still later date . . . new lakes have been formed by the damming up of rivers, and more than one assemblage of quadrupeds, birds, plants—Eocene, Miocene, and Pliocene—have followed in succession ; yet the region has preserved from first to last its geographical identity ; and we can still recall to our thoughts its external condition and physical structure before these wonderful vicissitudes began, or while a part only of the whole had been completed."

This remarkable picture of the lacustrine formations of the south of France would be a tolerably faithful description if taken with special reference to similar formations of vast extent in Victoria and Tasmania.

Climate of the Palæogene Period.

The climate, as evidenced by the rich flora and fauna, has already been discussed, p. 153. It is probable that the climate varied from subtropical to temperate between the close of the *Mesozoic* and the commencement of the *Neogene* periods.

Neogene Epoch.

Upper Tertiary.—In Tasmania a series of deposits, generally resting either upon the Palæogene basalts or the lacustrine or marine beds. These deposits consist mainly of clays of various shades of colour, sands coarse and fine, ferruginous sands, and, more conspicuously, of gravels and pebbles, frequently conglomerated among which, in many localities, as at Longford, occur a wonderful abundance of waterworn pebbles derived from the silicified stems of conifers and other fossil trees. The apparent absence of marine formations and of the newer basalts, found in Victoria, render it difficult to mark the upper limits of this division with any degree of satisfaction. The absence of fossils, other than those derived from the lower divisions, also deprives the classifier of the most reliable guidance in such matters. There is little doubt, however, so far as Tasmania is concerned, that there is represented a perfect continuity of land and freshwater deposits from the Mesozoic period to the present time. As we cannot, therefore, look for any limit corresponding to a complete stratigraphic break, and as no contemporaneous fossil organisms have yet been found which would help us to fix the character of the various beds, the evidence as to their age must be based upon the nature of their position in relation to altitude, superposition, and particularly to the earlier signs of erosion of existing lake-basins, valleys, and watercourses (500 to 700 feet above existing channels) throughout Tasmania. Among the more important of these deposits may be noted the gravelly and gritty accumulations forming the older terraces overlying the Archæan and Silurian formations of the western part of Tasmania, and more particularly the older gravel drift terraces of the 600 to 700 feet level forming the upper zone of the Launceston Tertiary Basin, occupying nearly the whole of the rolling plains drained by the Tamar and its important tributaries. Fine sections of these older Neogene drifts are to be seen in the neighbourhood of Breadalbane, Perth, and Longford.

Where there are elevated plains composed of lignites, leaf-beds, clays, or older basalts in ascending order, and where these, again, are immediately succeeded by sandstones, pebble drifts, and conglomerates, we may with some degree of confidence separate the latter from similar deposits formed by erosion of the older formations, and redistributed along the lower levels of the broad valleys, now in places cut to a depth of more than 500 feet below the levels of the ancient lakes and watercourses. Formations, often of great thickness, fringing the shores of Macquarie Harbour, and occurring in the neighbourhood of Port Davey, Pieman River, and Long Plains, afford similar evidence. Between the Arthur Ranges and the parallel channel of the Upper Huon similar elevated terraces, with deeply cut cross valleys eroded by old or existing tributaries, also afford evidence of the great extent of formations accumulated during the Neogene period.

The older gravel drifts, sometimes 70 feet above the more recent alluvial flats bordering the River Derwent, and forming terraces flanking the mudstones of Upper Palæozoic age, are also no doubt members of the Neogene period. Evidences of a similar character in the north-east are also abundant in the older terraces of the stanniferous region in the vicinity of Gladstone, Moorina, and Ringarooma.

Similar deposits exist in Victoria and New South Wales, and the same difficulties in respect of classification are there also experienced. The descriptions of local geologists in Victoria and New South Wales in respect of these Australian deposits are quite applicable to Tasmania. For example, if we take the graphic description of the Neogene rocks of New South Wales, so ably given by the Head of the Geological Department, Mr. G. S. Wilkinson, we may see that the relationship and character of the rocks and the difficulties of classification are very similar. At page 57 of the publication issued by the Mines Department (1882.—*Notes on the Geology of New South Wales*), Mr. Wilkinson writes :—

" Now the remains of old river beds do actually occur upon these high lands (above the 800 feet level), but as no fossils have been found in them, it is doubtful whether they belong to the Miocene or Pliocene periods. Without the aid of fossils or of natural sections showing the relation of these deposits to older or newer formations, there will always be a difficulty in determining their age. In fact it will almost be impossible to draw a hard and fast line between them, as the subaerial conditions of the Miocene period continued into the Pliocene; for, during the Upper Miocene, Pliocene, and Pleistocene periods the land appears to have been gradually rising, and, of course, subject to continued atmospheric denudation, which varied occasionally in intensity. During this long period the valleys were gradually eroded, though at intervals they were partly filled with fluviatile deposits and flows of lava, and then eroded to deeper levels. Thus in every large valley, as that in which the Macquarie drains, we find at different elevations terraces of gravel and alluvium which mark the successive levels of the valleys during the intervals when the denuding agencies were not sufficiently powerful to prevent the accumulation of such deposits. The more ancient of these fluviatile drifts are sometimes covered with basalt, showing that these old valleys, during their erosion, were at different times modified by the flowing into them of lava through which the drainage water either cut a fresh channel or was diverted, and eroded on taking another direction. In many places along the high lands of the Great Dividing Range the basaltic lava completely filled the shallower valleys and formed extensive plateaux, such as we see in the New England District." It is remarkable how applicable these remarks of Mr. Wilkinson are with respect to Tasmania. The description could not be more accurately given if applied to similar formations on the Magnet Range, at Mount Bischoff, and in the valleys of the North and South Esk, near Launceston.

Climate of the Neogene Period.

The evidences available with respect to climate are vague and unsatisfactory, as already indicated, p. 155. It is clear, however, that the conditions under which the successive irregular coarse shingly terrace drifts had been formed in the main valleys were very different from those under which the Palæogene formations were deposited, and it is also probable—as suggested in respect of equivalent formations in New South Wales by Mr. G. S. Wilkinson, and in South Australia by Professor Tate—that the mode of deposition and other circumstances indicate a much greater rainfall than at present. The paucity of life in the formations, by itself—while depriving us of the aid of Palæontology in the classification of the rocks and in inferring local climatic conditions—only affords negative evidence in support of a growing refrigeration of climate.

Whether this supposed change in the direction of a colder climate became sufficiently intense within the period to produce the local ice sheets and glaciers—of which there is evidence in valleys of the Western Highlands, notably along the deeply cut ravines of the Mackintosh River—it is difficult to determine. It is quite conceivable, however, that simultaneously with the rising of the floor of the old Palæogene sea the adjacent land partook of a corresponding elevation, and we may therefore expect to find, as a direct consequence, a considerable change of temperature over the limits of the areas so affected.

There is additional support to this view from the circumstance that in the opinion of Professor Hutton corresponding causes were producing similar effects in New Zealand during the interval between the Paréora system and the marine beds of the Wanganui system, an interval which closely corresponds with that which divides the Palæogene and Neogene epochs in Australia and Tasmania. Thus, in his "Sketch of the Geology of New Zealand" (Quart. Journal Geol. Soc., May, 1885, p. 211), Professor Hutton states, "the former great extension of our glaciers was caused by greater elevation of the land[a] during the interval between the Paréora system and the marine beds of the Wanganui system." He adds, however, that complete proof is wanting owing to the absence of fossils, as in the raised terrace drifts of Tasmania.

It may be well to state, however, that the indications pointing to a glacial period in Australia have been referred by some geologists to causes which introduced more recently the glacial epoch in Europe and North America, and that the traces of glaciers on the Alps of New Zealand and Australia were deemed by them to be the counterpart of effects produced during the glacial epoch in the northern hemisphere, and attaining their maximum there during the Pleistocene period.

But although it be admitted that the primary cause of the glacial epoch in the northern hemisphere in the Pleistocene period may be due to the high phase of eccentricity of the earth's orbit in combination with winter in aphelion—the effect of precession—it does not necessarily follow that the extreme effects of glaciation have been produced in both hemispheres or in different epochs by the recurrence of such astronomical causes alone. It is admitted that warm ocean currents have such an important bearing upon the question that, if they were not debarred to a great extent from the hemisphere specially affected by the astronomical causes referred to, glaciation of an extraordinary character would not be appreciable. Now the preponderance and the nature of the distribution of the land in the northern hemisphere render the latter more liable to the obstruction or diversion of the warm equatorial ocean currents, produced by geographical changes, while, with the smaller extent of elevated land and its insular position, the southern hemisphere would be comparatively unaffected. It is also conceivable that during the Cretaceous and early Tertiary period the greater part of the

[a] The marine beds attain an elevation of more than 2000 feet near Napier.

western equatorial current of the Pacific Ocean swept southwards through the then broad open mesial gulf dividing Eastern and Western Australia, and the diversion of this powerful warm current upon the rising of the land towards the close of the *Palæogene* period may have had a larger influence in lowering the local temperature than that due to the astronomical causes referred to.

The effect of the influence of warm oceanic currents in equalising or modifying local climatic effects, however produced, cannot well be over-estimated in regions open to their passage. To them we owe, as Dr. James Croll, Wallace, and others have so admirably shown, all the amelioration of climate in regions which otherwise would be uninhabitable. Wallace, in his very remarkable work, "Island Life," p. 183, states: "Owing to the peculiar distribution of land and sea upon the globe, more than its fair proportion of the warm equatorial waters is directed towards the western shores of Europe, the result being that the British Isles, Norway, and Spitzbergen have all a milder climate than any other parts of the globe in corresponding latitudes. That such considerations must have great weight with those who are directing their attention to the possibility of a glacial epoch in the Southern Hemisphere in later times corresponding to that of the Northern Hemisphere during the Pleistocene period is most certain; for, as Mr. Wallace explicitly states (p. 201, *loc. cit.*), "a concurrence of favourable geographical conditions is essential to the initiation of glaciation" . . . and, he continues: "When, however, geographical conditions favour warm Arctic climates—as it has been shown they have done throughout the larger portion of geological time—then changes of eccentricity, to however great an extent, have no tendency to bring about a state of glaciation, because warm oceanic currents have a preponderating influence, and without very large areas of high . . . land to act as condensers no perpetual snow is possible, and hence the initial process of glaciation does not occur."

Accordingly, from the very smaller proportion of elevated land in the Southern Hemisphere, and from the improbability of the equatorial ocean currents having been appreciably excluded at any time, owing to the absence of connected land barriers, it is reasonable to infer that the combined effects of astronomical and geographical causes—similar to those which brought about the glacial epoch in Europe and North America—are not likely to have operated intensely in Australasia. That this seems to be the more reasonable view as regards Australia is borne out by local evidences.

In the first place, the Neogene epoch of Tasmania corresponds with the Pliocene epoch of Europe, and, consequently, whatever the local climatic conditions may have been, they cannot in all respects be referred to causes which entered into combination in a succeeding epoch in the Northern Hemisphere. In the second place, while admitting the evidence of former glaciation in local alpine regions, there is no satisfactory proof that the erratics found in such regions belong to the period in which our raised terrace drifts were formed, and neither in these nor in the latter deposits of the extensive lower levels do we find any clear signs of ice action, such as are exhibited so widely in Europe and America, in the shape of moraines, boulder drift, striated blocks, perched blocks, and other huge ice-born erratics, &c. On the contrary, the prevailing terrace drifts in Tasmania are formed from materials derived from the adjacent or underlying rocks; and, with the exception of huge boulders at the base or on the slopes of mountain ranges, clearly traceable to gravitation, there is not the slightest trace of rock masses which would necessitate the agency of ice as a means of transport, if we except also those evidences in alpine regions in the Western Highlands, which are, more probably, local effects due mainly to a much greater elevation of the land in former times. The author is personally familiar with the various evidences of glaciation in Scotland at the higher and lower levels, and his knowledge of Tasmania is sufficiently wide to enable him to state with confidence that corresponding evidences in the latter place are entirely wanting within the Tertiary and later periods.

The Rev. J. E. Tenison-Woods, A. W. Howitt, and others having a most intimate knowledge of Australian Geology, give similar evidence as regards the absence of unmistakable signs of glaciation other than those now due to greater elevation, as in the Alps of New Zealand at the present day.

It is true, Professor Tate reports the occurrence of erratic boulders of granite and striated rock surfaces on the beach near Adelaide, and the opinion of such an experienced observer has great weight with me; but these signs, in the absence of further evidence, are not quite satisfactory, and they have, moreover, received different interpretations by other observers. Besides, as Professor Tate states (p. 53, Jour. and Proc. R. Soc. of S. Australia, 1884-5) that "a glacial period and a pluvial period mean the same to me (Professor Tate), being referable to the same cause—rain or snow—according to latitude or elevation," it is evident that his views do not differ materially from those concurred in by the author, who at present is inclined to hold that, although astronomical conditions may have been the initial cause of that intense form of glaciation which characterises a true glacial epoch, their direct influence would not have produced this effect, even in the Northern Hemisphere, had they not been supplemented by geographical changes which barred the warm equatorial currents from northern latitudes; and it is solely because of the absence or imperfection of the latter combination necessary to produce a true glacial period, that he dissents from the view which attributes the milder form of local glaciation in the Southern Hemisphere to the combination which resulted in the glacial epoch of Europe and North America during the Pleistocene period. Dr. von Lendenfeld quite recently has discovered traces of ancient glaciers in the Wilkinson Valley leading up to the elevated plateau of Mount Kosciusco[a], in the shape of numerous rôchs montonées and polished rocks, and his observations are also of much interest. His interpretation, however, is that (1) at the time of the glaciation of the Southern Hemisphere Australia was subjected to a glacial period as well as New Zealand; (2) that the climate was then not very cold, so that the glaciers only covered the highest part of the Australian Alps, and were consequently very small; (3) that, with the exception of small glaciers at the source of the Murray and at the head of the Crackenbach, he concluded that it is not likely that glaciers existed anywhere else in Australia at the time, although believed to be isochronous with similar alpine glaciers in New Zealand.

[a] "The Glacial Period in Australia," by R. von Lendenfeld, Ph.D. (Proc. Lin. Soc. N. S. Wales. Vol. X., Part I., pp. 44-53, plates).

This glacial period, strangely enough, is referred to a very recent period, 2000 or 3000 years ago, when he assumes, even then, the existence of the gigantic Diprotodon and other extinct marsupials, together with a pluviatile period, when the rivers were large, and when there was a dense vegetation in many parts of the country now barren. Professor Hutton accepts the facts of Dr. von Lendenfeld as regards the glaciation of the Australian Alps, but demurs to his conclusions both with respect to the time of their occurrence and the conditions under which they were caused. In his very interesting paper "On the supposed Glacial Epoch in Australia" (Proc. Lin. Soc. N. S. Wales, Vol. X., Part III., p. 335, he observes: "But although I do not wish to deny the former existence of these glaciers, it is necessary to point out that it by no means follows that they were caused by a glacial epoch; because they might equally well have been due to greater elevation combined with atmospheric moisture, and no evidence is given to show that elevation has not occurred." At page 338 he continues: "but all New Zealand geologists, whatever views they may hold as to the cause, are of opinion that the *glacier* epoch was long anterior to the *glacial* epoch of Europe and North America"; and, at p. 341, *ibid.*, he concludes: "If now I should be asked, To what, then, do you attribute the ancient glaciers of the Australian Alps? I should answer, It is more probable that Mount Kosciusco once stood some three thousand feet higher than at present, when Tasmania was joined to Australia, and Central Australia was, perhaps, a vast lake, than that the temperature of the surrounding ocean should have been reduced ten degrees without any apparent cause, which is the only alternative."

These conclusions of Professor Hutton are in complete harmony with the reasonings already advanced in this section; and, in the author's opinion, the evidences of Tasmanian rocks lend them additional support.