Norman B. Tindale

TRANSACTIONS AND PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

(INCORPORATED)

VOL. LIV.

[WITH NINE PLATES, AND TWENTY-SEVEN FIGURES IN THE TEXT.]

EDITED BY PROFESSOR WALTER HOWCHIN, F.G.S.
ASSISTED BY ARTHUR M. LEA, F.E.S.

[*Each Author is responsible for the soundness of the opinions given, and for the accuracy of the statements made in his paper.*]

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(INCORPORATED).

CONTENTS.

Transactions

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The Royal Society of South Australia (Incorporated)

VOL. LIV.

THE MAJOR STRUCTURAL AND PHYSIOGRAPHIC FEATURES OF SOUTH AUSTRALIA.

By CHARLES FENNER, D.Sc.

[Read April 10, 1930.]

I.—INTRODUCTION.

This paper is the third and last of a series of papers (cited elsewhere) which the writer has submitted to this Society as a preliminary to the preparation of an account of the Natural Regions of South Australia. A well-considered regional division of the State was considered to be necessary for the adequate study of its Human Geography, as well as for general teaching purposes. Such regions could not be erected without a comprehensive survey of the State and its people.

The first of the three papers referred to included a study of the geomorphology and human geography of the Adelaide district—the best known and most thickly settled portion of the State. The second paper dealt with the growth, movement, and achievement of the people during the State's first ninety years of existence, touching also on the underlying geographic factors. The present (third) paper aims to be purely geomorphological, and to outline the structure, land forms, and drainage systems of the State in the light of modern views on these subjects.

The fundamental paper on South Australian physiography is that by Professor W. Howchin, embodying his Presidential Address to Section C at the meeting of the A.A.A.S., in Melbourne, in 1913. Since then papers on the geomorphology of this State have been few in number, while structural work has been largely confined to the Palaeozoic and older rocks. The contributions by Howchin, Benson, Taylor, Mawson, Ward, Jack, Teale, Madigan and Hossfeld are mentioned elsewhere in this series of papers.

It will be understood, therefore, that our present knowledge of the details of the latter tectonic movements, and of the present geomorphology of the State, is distinctly limited. The country is a vast one. The workers are lamentably few. To most of these workers other aspects of geological study have proved more attractive. In this paper most of the less known areas are treated in broad detail only, fresh theories are submitted in an endeavour to explain some of the facts in the more critical areas, and an effort has been made to present a unified and modern view of the post-Miocene tectonics and the present physiographic features of South Australia.

The writer is indebted to Mr. Wm. Ham for assistance with the proofs, and to Mr. J. A. Tillett for his careful draughtsmanship.

II.—THE SOUTHERN COASTLINE.

The State of South Australia is set within a "square" of the earth's surface. That is to say, it extends between 12 degrees from east to west, and 12 degrees from north to south. But while the upper or northern half of this square is practically an unbroken expanse of land, the southern portion is of varied outline, and more than half consists of sea and gulf.

The geological history of the State, read in conjunction with the later tectonic happenings, with the prevalence of fault influence on the coastlines and with the abrupt descent of the sea floor to the Jeffrey Deep to the south (fig. 2 D), leaves little doubt that there has been large-scale foundering to the south and south-west.

As the writer has elsewhere pointed out (Trans. Roy. Soc. S. Austr., vol. liii., 1929, pp. 82-85), these great subsidences have opened up the southern districts of the State to the oceanic influences of the cyclones and anti-cyclones, greatly to the advantage of the districts concerned. These favourable influences are clearly shown in the rainfall, temperature, and evaporation maps of the State. Thus the heavily indented southern coastline, trending obliquely from latitude 32° S. to latitude 38° S., and due to post-Miocene large-scale subsidences and uplifts, must be regarded as one of the most important structural features of South Australia.

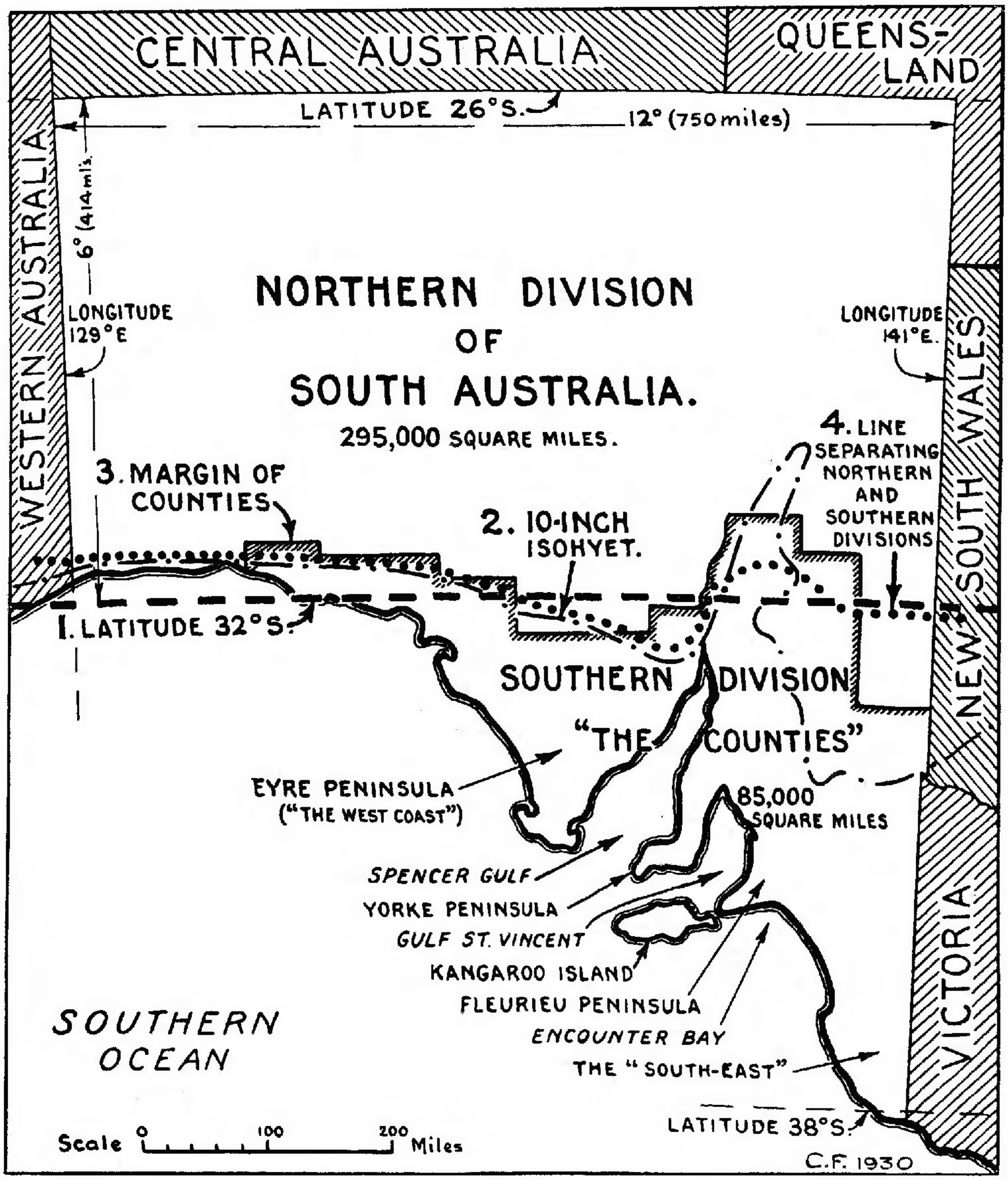

Fig. 1.

Sketch map of South Australia, showing position, shape, area, and chief place-names; also the various lines which form natural boundaries between the Northern and the Southern Divisions.

III.—THE TECTONIC MOVEMENTS OF THE GULF AND TORRENS AREAS.

(a) *The "Shatter-belt" of Australia.*—The most fertile and populous portion of South Australia is the part that is centred about the two southern gulfs, Spencer and St. Vincent. The present physiographic features of these gulf areas are the outcome of certain tectonic movements of considerable extent and importance.

Australian geographers and geologists, in a somewhat loose and general way, recognise a division of the island-continent into three major parts: (1) a great stable "shield" of ancient rocks and uniform relief in the west; (2) an eastern portion marked by wide variety of rock types, with sediments of many ages, and with complex physiographic features; and (3) an intermediate separating zone of considerable tectonic disturbance, with Miocene to recent block-faulting and differential uplift, dividing the stable western part from the less stable east.

This intermediate zone, or "shatter-belt," has not been definitely delimited, nor even positively demonstrated. Still, the conception is of value for descriptive purposes. The belt characteristically includes the areas of depression and uplift of the gulfs and central highlands of South Australia, and also of the Lake Torrens and North Flinders ranges *(vide* "The Geography of South Australia," Howchin and Gregory; and also "Adelaide, South Australia," Fenner, Trans. Roy. Soc. S.Austr., vol. li., 1927, pp. 195-200).

This zone may be taken to continue northward through the severely down-warped (and possibly faulted) area of Lake Eyre, and thence onward to the McDonnell Ranges. The last-named area has been shown by L. Keith Ward and R. Lockhart Jack, in various Bulletins of the S.A. Mines Department (also Proc. Roy. Soc. S. Austr., vol. xlix., 1925, p. 61, *et. seq.)*, to be considerably faulted.

Thence the "shatter-zone" may continue north-westerly, in a gently curving arc, through the little-known and somewhat featureless Tanami country, to the severely block-faulted and mountainous peninsula mass that lies in North-West Australia, between King's Sound and Queen's Channel. This latter area includes the King Leopold and allied ranges. The pattern of the river systems there, the character of the mountains, and the type of adjoining coast, alike bear witness to block-faulting and differential uplift along the directions suggested, *viz.,* dominantly N.W.-S.E., and subordinately N.E.-S.W. The relief is "strong," and there has been recent coastal submergence.

(b) *The so-called "Rift Valley" of South Australia.*—In the southern portion of this broken zone, which here concerns us most, we have the relatively sunken areas of the Spencer Gulf, Gulf St. Vincent, and Lake Torrens, with the adjoining uplifted land-masses of the Flinders and Mount Lofty ranges. The general structural features of this area have been dealt with in detail by the writer (Trans. Roy. Soc. S. Austr., 1927, vol. li., Sections III. and IV.).

In the paper referred to, certain objections were raised regarding the description of the above-mentioned sunken area as a Rift Valley. Further exception may be taken to its popular description as "The Great Valley of South Australia." It is desired to emphasise this point, and to produce further evidence in support of the suggestion that we are here dealing with a tectonic feature that is not properly described as a "Rift Valley"—nor even as a "Valley." At the same time, certain points regarding the age and the dynamics of this phenomenon will be considered.

In a discussion on this paper at the Royal Society of South Australia (1927), Dr. L. Keith Ward contributed the following written suggestions, not hitherto published:—"Dr. Fenner has protested against the use of the term 'Rift Valley' for the complex area, part graben, part horst, including the two gulfs and the surrounding land masses. I think that he is right on the ground that this area differs from the quite typical rift valley, such as that of Africa, etc. But one cannot expect such regularity of fracturing in a region having such complex structure as one would expect in a region with thick sub-horizontal sediments and massive lava flows affected by trough faulting. We do not yet know whether the phenomena of rift valleys are produced by normal or overthrust faulting—whether by the gravitative sinking of a wedge after relief of tensional stress by faulting, or by adjustment to compressive stresses. In the first case the faults converge downwards, and in the latter they diverge. In the case of the Mount Lofty-Flinders horst it is difficult to conceive an origin by compression, despite the massive foreland to the westward. Probably the ancient sediments were folded against this foreland in the Palaeozoic Era, but the rise of the Mount Lofty-Flinders horst has been relatively recent. We know that the Mesozoic sediments at the northern end of the Flinders Range have been affected by the earth movements, even if there is an indication in Central Australia that the great depression of Lake Eyre began to take form in Permo-Carboniferous time. The origin of the twist in the southern end of the great lineal horst might indicate a compressive stress induced by the northward movement of an earth block now foundered. But if this were so there is no sign of a northern foreland in the Lake Eyre region. Were there such a resistant block we might be tempted to compare the structure of the region under discussion, in a broad way, with the middle Rhine Valley, between the Vosges and the Schwartzwald, where it has been suggested by Weber that the graben, like others, owes its existence to compressive stress parallel to its length, with the consequent production of tension normal to the compression. But the northern end of the Mount Lofty-Flinders horst faces a structural depression, and if we take Kangaroo Island as its southern terminal, we must admit that it faces another depression in the Jeffrey Deep. It is noticeable that part of the western foreland itself—the foundation of Yorke Peninsula—became involved in the faulting, a fact which seems to indicate that the stresses which produced fractures were not so wholly controlled by geological formations as might appear from the contrasted features on the opposite sides of the Torrens Sunkland farther north."

Professor Gregory, to whom we are indebted for the conception and definition of rift valleys, himself so named this South Australian feature. But it is clear from the maps accompanying his account (p. 26, *loc. cit.)*, that Professor Gregory was not then in possession of full information regarding the detailed position of the fault lines and the consequent outlines of the relatively lifted and sunken blocks. The northern and southern "horns" of the cusps, shown in fig. 2 D, are shown in Gregory's maps as relics of "ancient east-west mountain ranges," and the sunken area itself is drawn as almost parallel-sided, which is not a true representation of the facts as we now know them. Special consideration has been given to recent literature regarding the mechanics and the terminology of such sunken areas.

De Martonne ("Traite de Geographie Physique," tome second, Paris, 1926) refers to elongated blocks of land that had been sunken, with relatively raised blocks on either side, as "ditches"—"fossés tectoniques." German physiographers use the word "graben" (after Suess) for narrow, relatively-depressed blocks, and "senkungsfelder" for larger and more irregular sunken areas. American physiographers *(e.g.,* Fenneman, A.A.A.G., vol. xviii., p. 348) use the term "moat," thus: "The basin of Lake Tahoe is in a moat, that is, on a depressed fault-block between mountains on the west and east."

In all these terms—rift, graben, moat, ditch, fossé—and indeed in the word "valley" itself, there is a definite suggestion of parallelism of the sides and of an elongate character in general.

Professor Gregory, who originated the term "rift valley" and applied it to the classic examples of the Dead Sea and the East African tectonic moats, emphasises the parallelism of the boundary faults ("The Rift Valleys and Geology of East Africa," J. W. Gregory, London, 1921, chap. xxxii.). On page 18 of that work Gregory writes: "For this type of valley I suggested the name of Rift Valley, using the term 'rift' in the sense of a relatively narrow space due to subsidence between parallel fractures." Howchin (Geography of South Australia, Adelaide,

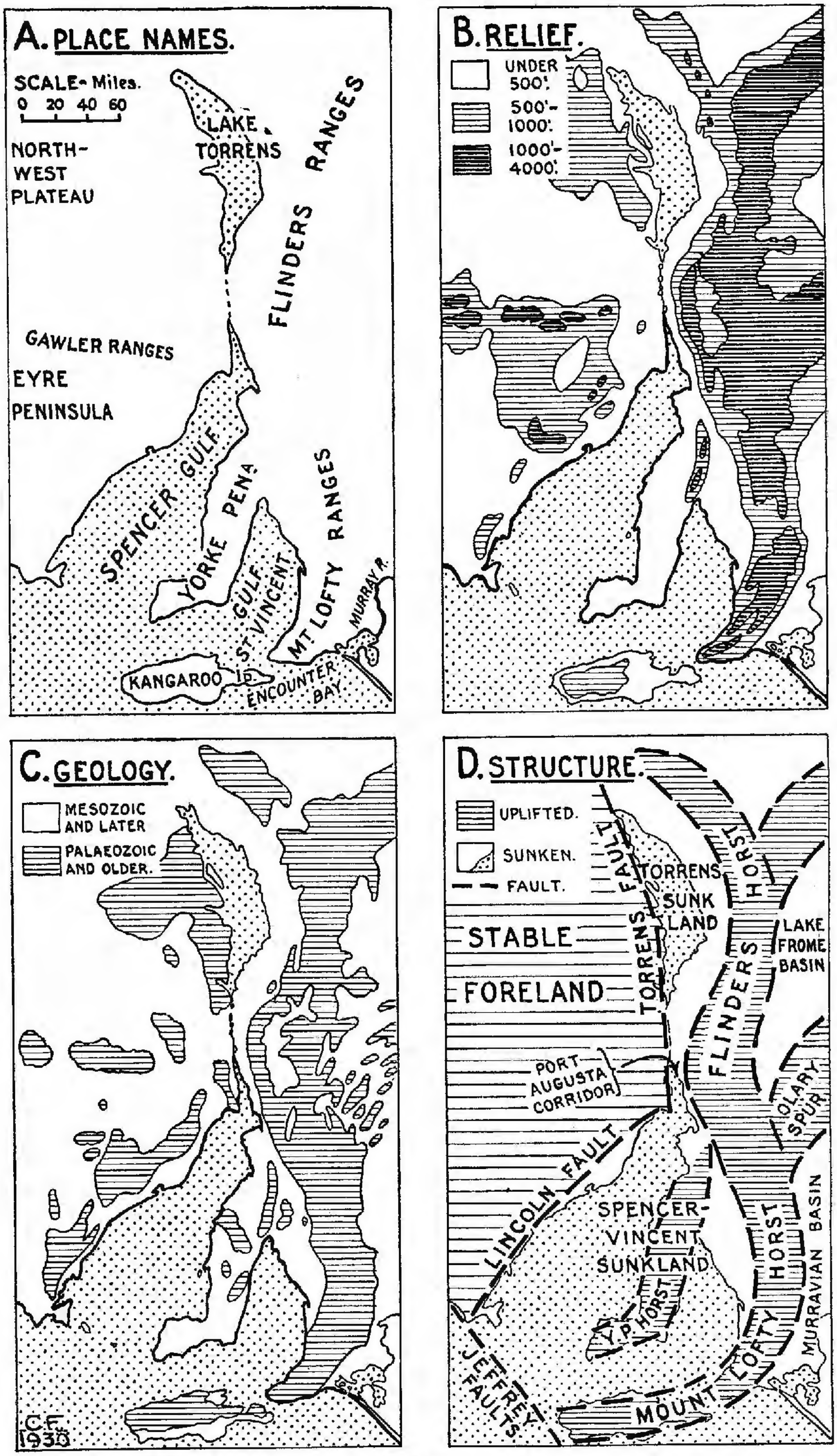

Fig. 2.

Four sketch maps illustrating the outstanding features of the Gulf and Lake Torrens Area of South Australia, as described herein.
A., Chief Place-names; B., Relief; C., Geology; D., Major Structural Features.

1918, p. 27) speaks of: "the sinking of a *strip* of country, forming a rift valley. . . ." Bailey Willis (Bulletin of the Geological Society of America, vol. xxxix., 1928, p. 493), in his definitions, gives: "Rift Valley: Valley produced by subsidences of a strip bounded by two parallel rifts"—a "rift" being a "normal fault with gravitational displacement." (See also "Geologic Structures," Bailey Willis, New York, 1923, pp. 75-82.)

Enough has been quoted to show that the authorities on these matters agree that some measure of elongation and of parallelism of the boundary faults are essentials in the structure of a rift valley. Neither of these features is present in the two cases under discussion.

The Torrens depression is shaped like a laterally-compressed capital D, while the Spencer-Vincent depression is shaped like a broadly expanded D (see fig. 2). The writer is of opinion that the name of such an important structural feature is of distinct importance. In giving addresses on these matters to teachers, laymen, and to other students, he has experienced difficulty in readily conveying to his hearers a proper conception of the structural character of this area by the use of the terms "The Great Valley of South Australia" or the "Rift Valley." He has already *(lot cit.)* suggested that these unhelpful and incorrect terms be discontinued, and he here repeats and emphasises the point. The sunken areas are better described as senkungsfelder, or, to adopt the anglicised form suggested to the writer by Professor E. W. Skeats, they might be called Sunklands: (a) the Torrens Sunkland, and (b) the Spencer-Vincent Sunkland, as set out in fig. 2 D.

(c) *The Chief Boundary Faults.*—The dominant features of the Gulf and Torrens areas are set out in fig. 2. This figure includes four sketch maps entitled A, B, C, and D. A. gives the names of the chief features involved. B. indicates the comparative relief, the simplest description being that the shaded areas are hills and highlands, and the unshaded areas are plains. C. shows the geological formations in a broad way, all the Palaeozoic and older areas being shaded, and the Triassic and younger areas (mostly Tertiary and Recent) being unshaded. It will be noted how closely this geological division coincides with the physiographic facts. In D. the chief structural features, as interpreted by the writer, are clearly set out.

Where a fault is indicated in the figure by a heavy broken line, there may be really a series of more or less parallel faults, extending both upwards into the highlands and downwards into the sunklands. Physiographic evidence of such step faults is available to all who journey along the adjoining plains on the eastern or western sides of either the Mount Lofty or the Flinders Ranges. In many cases, particularly in the Flinders Ranges and in the eastern Mount Lofty Ranges, these stepped blocks are almost diagrammatic in appearance; similar features in the fault scarp facing Adelaide have been described and figured by the writer *(loc. cit.,* figs. 5, 6, 7). The stepped blocks of the Mount Lofty Ranges are best seen in an evening view from Outer Harbour or St. Kilda. Similar stepped faults have been mapped by R. L. Jack on the Lincoln Fault, Hundred of Randell (Bull. No. 3, S.A. Mines Dept.).

To the eastward of the main arc-shaped horsts are two uplifted areas that branch away tangentially to the north-east; that on the north is the high and rugged "Yudnamutana Spur," and that further south is the lower, broader, and more maturely eroded "Olary Spur." Both of these features are much more than "spurs," but this term is left unchanged for the present. Evidence collected by Mr. R. L. Jack indicates that the low Olary ridge is not bounded by fault lines.

In emphasising the peculiar and regular arc-shaped character of the Mount Lofty and Flinders faults, the following facts, quoted by Professor W. M. Davis *(vide* "Geographical Review," October, 1927, p. 669) are of special interest:—

At the 1926 Spring meeting of the California Rift Club, Davis spoke "with especial regard to the contrast between rifts (faults) of the San Andreas type, on which movements with a large *horizontal* component seem to predominate, and rifts of the Wasatch type, on which movements with a large *vertical* component prevail. In examples of the first type the path or trace of the rift is nearly rectilinear, and there is no strong or persistent difference of elevation on its two sides. In examples of the second type the trace of the rift departs from a straight line in many concave bights from one to five or ten miles in curved length, between somewhat pronounced cusps which point from the side of elevation to the side of depression; and the side of elevation is occupied by a more or less dissected mountain range, while the side of depression is occupied by an aggraded plain of mountain-supplied detritus."

This interesting description corresponds very closely on the South Australian structures with which we are dealing. The boundary faults of the Mount Lofty and Flinders ranges horsts, for instance, appear to be of the Wasatch type. They have a large vertical component, as evidenced by the fact that within a range of twelve miles normal to the fault face adjoining the city of Adelaide there is, within the limit of some six-stepped blocks, a differential displacement of from 4,000 to 5,000 feet. The highest point of the Mount Lofty block stands at 2,330 feet above sea level, and in the Croydon bore, 12 miles distant, the surface of the same rocks has been faulted down to a depth of at least 2,260 feet.

Regarding the trace of such faults, their graceful curves, on a large scale, are their most notable feature. Such curves are certainly greater in size than those described by Professor Davis, but they otherwise fit his description. The question arises whether the straight boundary faults of the western parts of the sunken areas (the Lincoln and Torrens faults) are of the San Andreas type. They are certainly almost rectilinear, as delimited by both the geological and physiographic evidence; and the difference of elevation, though in many cases marked and regular, may perhaps be described as "neither strong nor persistent." Certainly these western faults have characters which distinguish them from those of the eastern boundaries of the sunklands (fig. 2). If this analysis is correct, we should expect the Lincoln and Torrens faults to have large horizontal components in their movements. On this point no evidence is at present available.

(d) *Festoon or Garland Structures*.—There is a further point of interest regarding these arc-shaped horsts. Among the outstanding characteristics of circum-Pacific structural features are the arc-shaped chains of uplifted land that appear on our maps as mountain ranges or island groups, according to their relation to sea level. These have been aptly called "Festoons" by Suess, Gregory, and others, and "Garlands" by Hobbs ("Les Guirlandes Insulaires, etc.," W. H. Hobbs, Annales de Geographie, tome xxxi., 1922, pp. 485-495).

Such island festoons are characteristically convex outwards towards the great Pacific basin. They are regarded as rising anticlines, Suess holding that the displacement comes from the concave (landward) side and the resistance from the ocean; while Hobbs conceives the movement to come from the ocean (convex) side, with the "môle de résistance" on the continental side.

While it is clear that these great differentially uplifted arcs of the Mount Lofty and Flinders ranges are structures of a different character from the island festoons, there is yet something that is common to the two sets of structures. The writer has already pointed out (*loc. cit.*, p. 199) that the Great East-Australian Highland Horst, reaching from Cape York to Southern Tasmania, is somewhat of this shape, and that many similar cases occur, such as the block-faulted Victorian Grampians, where the mountains consist of differentially uplifted arcs, again convex towards the east (the Pacific).

(e) *The Dynamics of the Movements*.—In his first considerations of the dynamics of the movements concerned the writer accepted the common view that block mountains such as those of the Mount Lofty and Flinders ranges had to do with normal faults and were associated with tensile stresses. In a detailed field investigation of these ranges as landscape features, there is much to suggest that the movements have been "thrust" movements, that compression and not tension has been the dominating factor. These impressions are of no positive value as evidence, but in areas as naked in structure as the Flinders Ranges, and where so little mapping has been done or sections prepared, such impressions assume a somewhat higher degree of importance.

The dynamics of "Rift" valleys has lately come in for much discussion. The fundamental principles touch on a problem of long standing and of great and almost insoluble difficulty. Are these movements due to crustal tension or to crustal compression? The idea of a "Rift Valley" as expounded by Gregory carries with it the existence of "normal" faults, of beds that occupy a total linear extension (normal to the faults) greater than before the faulting, and thus of a tensile (tearing apart) stress of the rocks of the crust—the subsidence of the "Keystone" of an anticlinal arch.

The alternative theory now put forward, and supported by considerable evidence, is that some of the so-called rift valleys are due to compression and not to tension. It is argued that the side blocks have been pushed towards one another, and that along the fault lines bounding the central block the lateral blocks have risen and ridden along thrust planes over the wide base of the central block. The name of "Ramp Valley" has been suggested to distinguish such valleys as being due to compression.

The classic argument for the "Ramp Valley" theory is Bailey Willis's paper on "The Dead Sea Problem," published by the Geological Society of America *(loc. cit.)*. The paper contains several converging lines of evidence towards the theory that the chief factor in the formation of these major tectonic features is compression and not tension. The Spencer-Vincent Sunkland is not a parallel case; there are many differences, but there are some similarities. We have no evidence to show whether the bounding faults of the local ranges and depressions are normal or thrust faults.

Another exponent of the compression theory is E. J. Wayland, of Uganda ("Nature," March, 1924, p. 388), who has worked on the "Rift Valleys" of eastern and north-eastern Africa. Wayland admits the existence of some normal faults along the boundaries of the sunken areas, but considers that these are consequent upon subsidence, and that they obscure the original structures due to crustal compression. In the "Mining Magazine," April, 1929, there is a reference to a paper by Ernest Parsons (Trans. Geol. Soc. S. Af., vol. xxxi., 1928), wherein it is again argued that the rift-making forces are compressional rather than tensional; that they are such forces as produce folding elsewhere, but in an area of exceptional stability produce fracturing with reversed faulting.

This compression theory is a suggestive one, and in the special case of the Gulf Region of South Australia it must also include the formation of the Mount Lofty and Flinders ranges; it is possible that this theory may yet provide an explanation for the peculiar fact that the "festoons" of highlands in Australia are so like, yet so distinct in character from those "compression festoons" of other areas where it is reasonable to assume a lower crustal stability than we have in the Australian region.

(f) *The Age of the Fault Block Movements.*—The age of the last great orogenic uplift in Australia, the "Kosciusko epoch," is generally considered to be early Pleistocene. But there is evidence also of movements of the same kind in the same localities at earlier dates, perhaps even as far back as the close of the Cretaceous, and it may be also that definite movements continued up to the late Pleistocene and Recent.

The writer has discussed this question in detail in his paper on the "Physiography of the Werribee River Area, Victoria" (Proc. Roy. Soc. Vic., vol. xxxi., 1918,), where the chief Australian authorities and references up to that date are quoted. The conclusion reached was that the general peneplanation of Australia was completed in lower Miocene time, and that the major faulting and differential uplift took place from late Pliocene onwards.

In the twelve or more years since that paper was written the writer has had further opportunities of studying the block mountains, sunklands, and the subsequent erosional valleys in the other States of the Commonwealth, and of further studying the arguments put forward and the conclusions reached regarding the age of similar horst and graben movements in other parts of the world, where there might reasonably be expected to be some amount of secular correlation.

The conclusion now reached is in the direction of giving a wider range in time to these block-faulting movements. Granting that the Great Peneplanation of Australia was a pre-Miocene phenomenon, some of the orogenic uplift may have been contemporaneous with the emergence of the mid-Miocene areas from the sea, and the movements possibly continued persistently, with periods of extra stress, right through the upper Miocene, and the Pliocene (which was a time of great volcanic activity), with a more intense phase in the early Pleistocene. The Pliocene phases might be associated with the formation of the horsts and graben, and that of the Pleistocene with the later rapid uplift of the western blocks of the Mount Lofty Ranges, leading to the formation of the Torrens, Sturt, and Onkaparinga gorges, and associated with all those younger and more obvious evidences of late block faulting that are found in the orogenic areas of Australia. Further, there is evidence in the Adelaide area, both at Hallett's Cove and at the southern end of the Para fault scarp (in Adelaide), of differential movements along fault lines in late Pleistocene to Recent time.

(g) *Conclusions.*—Summing up the position we may conclude that:—

i. The Gulf and Torrens areas of South Australia represent major tectonic features that form the southern portion of what is suggested to be a great broken zone extending northwards across Australia, and separating the more stable western from the less stable eastern portion.

ii. The chief elements of the tectonic features concerned are as set out in fig. 2.

iii. The names "Rift Valley" and "Great Valley of South Australia" are not considered satisfactory, and it is suggested that they be replaced by the terms: "Spencer-Vincent Sunkland" and the "Torrens Sunkland," *vide* fig. 2.

iv. The dynamics of these features are unknown; they may be due either to tension or to compression.

v. The differential block movements of uplift and depression are assumed to have commenced in the upper Miocene with considerable emphasis in the Pliocene; an extensive and important movement; specially concentrated along the western margin of the horsts, at the opening of the Pleistocene (Kosciusko epoch), with final lesser movements in the late Pleistocene to Recent. This question is further discussed in Section V (a), where the possibility of a second (? Upper Pliocene) period of planation is suggested.

IV.—PHYSIOGRAPHY AND CLIMATE.

(a) *Exoreism, Endoreism, and Areism.*—In the early days of physiographic study most workers concentrated on what was called "sub-aerial erosion." By this term was meant, in general, the normal work of erosion by rivers and their tributaries in areas of practically permanent flow. During the two last decades there has been some concentration on the physiographic cycle in arid and semi-arid lands, and it has been shown to what a high degree the agents of erosion and the products of erosive action differ according to the prevailing climatic conditions.

Among those who have assisted in drawing up standards for the assessment of the physiographic processes in arid lands, the work of Professor de Martonne, of the University of Paris, is notable. A recent paper by this authortiy has proved to be of special assistance in considering the problems presented by the interactions of physiography and climate in South Australia. ("Regions of Interior-Basin Drainage," Emm. de Martonne, Geographical Review, July, 1927, pp. 397-414).

De Martonne has shown the very important distinction that exists between areas where the precipitation is sufficient to cause the development of a drainage system that leads to the sea (exoreic), compared with an area where the precipitation is lower, or the evaporation greater, or the absorption more marked, or where some or all of these factors may operate together so that the streams developed never have sufficient power to find a way to the sea, and either disappear in an alluvial basin or end in centres of internal (endoreic) drainage. In still other areas, where the conditions are even more arid, there is no run-off at all, and no stream courses are developed; such areas are called areic regions.

The three terms used, with their definitions, are as follows; each of them being derived from Greek words:—

Exoreism, meaning through-flowing, or drainage to the ocean.

Endoreism, inward-flowing, or interior basin drainage; and

Areism, which indicates regions with no flow, where there is no run-off at all.

To these the writer proposes to add a fourth and minor type: "Cryptoreism," a form of exoreism, signifying hidden (underground) flow, as in the south-eastern region of South Australia.

"The deserts," writes de Martonne, "are par excellence the regions of interior-basin drainage or endoreism, but they present a particular case where run-off is nil, and for which the term areism is proposed."

In fig. 3 the various factors are set out on six small maps as follows:—

A.—In this map are shown the various place-names, so that descriptions of the State may be followed by those not familiar with local topography.

B.—Shows the general relief, and is taken from maps prepared by Dr. L. Keith Ward, Director of Mines, South Australia. The scale of the series of sketch maps is shown in this figure.

C.—Shows the mean annual rainfall (isohyets) of the State, kindly supplied by Mr. E. Bromley, of the Commonwealth Meteorological Bureau, and is from the latest records. This map includes three parallels of latitude for comparative purposes.

D.—Gives the lines of mean annual evaporation. These are in the main estimates, but have been checked up by records which show that the evaporation at Adelaide is 54½ inches per annum from a free water surface, and at Alice Springs (across the northern border in Central Australia) the evaporation is 94¾ inches per annum.

E.—Shows the mean annual temperature. Between the isotherm of 60° and that of 65° the influence of the Mount Lofty Ranges brings in an "oasis" of coolness where the temperatures run from 55° to 60° (all these temperatures are Fahrenheit). On this map is also indicated the chief artesian and sub-artesian basins of the State.

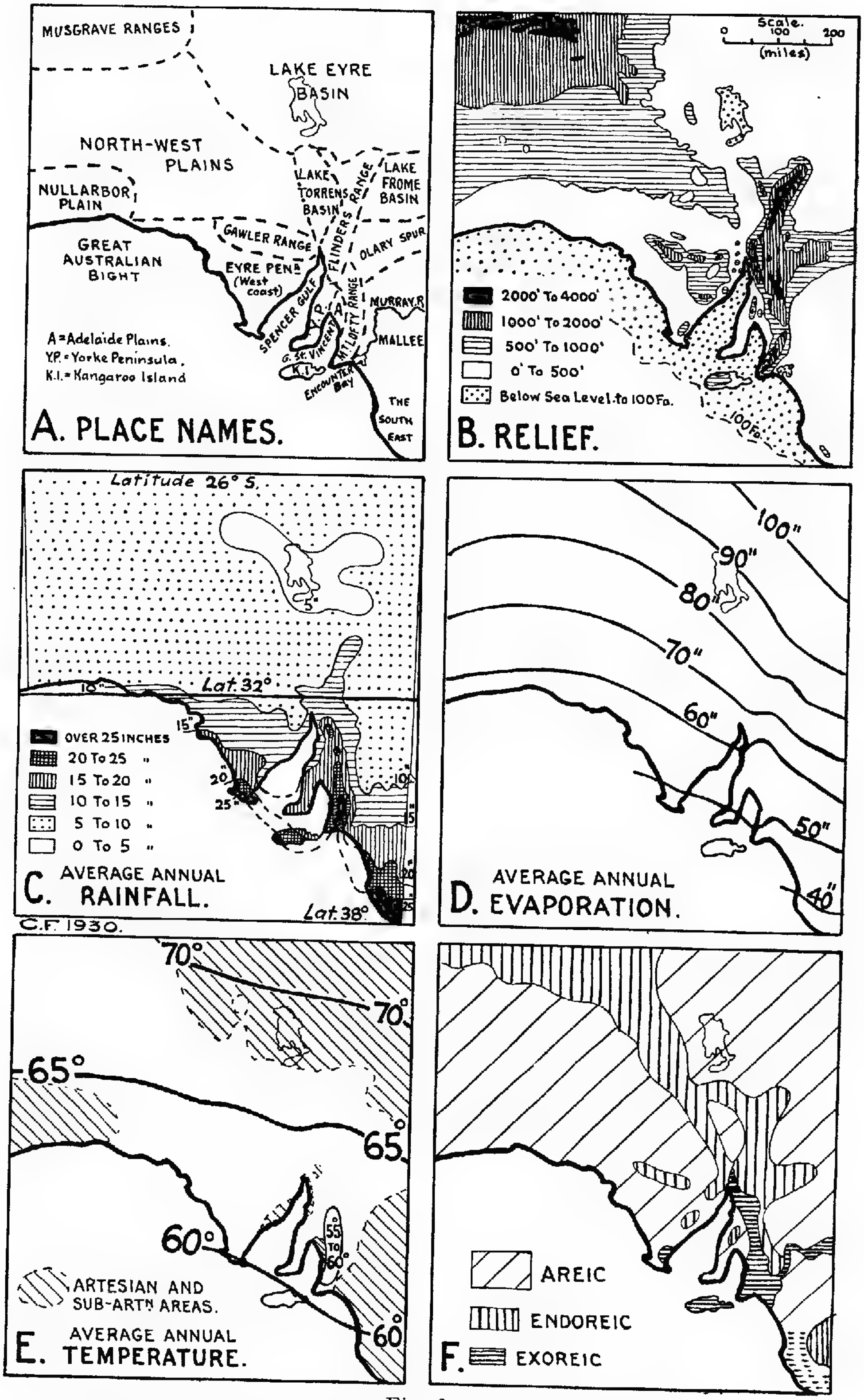

Fig. 3.
Six sketch maps presenting the facts regarding the commoner place-names, relief, rainfall, evaporation, and temperature of South Australia, with a division of the State into areic, endoreic, and exoreic areas.

F.—This figure, based upon the information given in the preceding figures, shows the position and extent of the areas of areism, endoreism, and exoreism in South Australia. A fourth type of drainage is indicated by broken lines in the extreme South-East where, although the rainfall is sufficient to establish exoreism under normal geological conditions, there are no flowing surface streams.

According to de Martonne's definitions, areic areas are those where there is no run-off. Through such an area, a river, such as the Nile or the Murray, may run, but its waters are derived from distant sources, and the area passed through is still areic, despite the presence of the river. In a similar way many of the rivers of the Lake Eyre Basin receive no additional water in the lower parts of their courses across the wide central plains. Such regions, though occasionally crossed by run-off from neighbouring highlands, are themselves without run-off; that is, they are areas of areism.

Taking due advantage of latest and most detailed information available, the writer finds that his map of South Australia very closely coincides with the details for South Australia as published in the article above quoted. On the whole, de Martonne was perhaps a little more generous than the circumstances permit. It will be seen from F, fig. 3, that the greater part of South Australia is areic—particularly the area north of lat. 32° S., and also the greater part of Eyre Peninsula and Yorke Peninsula.

The "South-East" presents a peculiar case. North and east from a low scarp that runs north-west from Naracoorte, there is a distinct run-off, with definite streams flowing towards the west (see fig. 5). Beyond this scarp, to the west, where there is sufficient rainfall to have developed a through system of drainage (exoreism), the following antagonistic factors exist. The peculiar arrangement of old dune ridges parallel with the coast and normal to the natural flow of surface water, the nature of the country (level-bedded porous Miocene limestone with incipient karst topography), and the extent of the underground drainage, have prevented the development of exoreism, although in winter time (the wet season), the water travels over the surface in wide-spreading sheets. A high proportion of water also travels underground and reaches the sea by means of coastal springs. It would be wrong to class this region as areic, or even endoreic. It is really a type of exoreism, but represents something different which de Martonne has not defined. The writer suggests that this type of drainage be termed "cryptoreic" (hidden drainage), to be applied only where the index of aridity is above, say, 30, with no surface streams developed. The areas referred to are shaded in fig. 3 F by broken horizontal lines.

Endoreism.—The areas of endoreism are shown in F, fig. 3, and by comparison with the rainfall, temperature, evaporation, and relief of the accompanying sketch maps it will be realized why they are so closely limited to the highland areas. In these highlands, such as the Flinders and Musgrave ranges, the development of drainage patterns of normal stream-cut type is marked, and points back to a Pleistocene pluvial period or series of periods that possibly corresponded with the glaciation of Kosciusko and Tasmania and with the suite of large and varied animal life (now extinct) of the interior. These stream courses will be dealt with in some detail in a later section. In many cases the water from the highlands continues across wide stretches of areic plains in times of exceptional rains; in 1930 wide sheets of water lay for upwards of two weeks on the usually arid Nullarbor Plains.

Exoreism.—This type of drainage, where the streams flow through to the sea, though normal in those countries of the world where the physiographic features have been most closely studied, is not normal in South Australia. The exoreic areas are shown in fig. 3, with horizontal shading, and they include only the Mount Lofty Ranges and portion of the South Flinders. Even in the parts mentioned, a high proportion of the water which flows from the Mount Lofty Ranges is lost where such streams as the Gawler, the Light, the Broughton, and the Burra Creek, cross wide alluvial plains.

(b) *The "Index of Aridity."*—De Martonne has given us a valuable method of estimating climate, by what is called the index of aridity. This is independent of the use of the indefinite term "desert," and is calculated on the following formula:—

$$Ar = \frac{P}{T + 10}.$$

Ar represents the "Index of Aridity," P is the mean annual rainfall in millimeters, and T is the mean annual temperature in degrees centigrade. Unfortunately, the formula so acts that the *less* arid the country the *higher* is the index of aridity.

Applying this index to the whole world, it is shown that areas with a high degree of aridity are also areas of endoreism, and particularly of areism. In other words, the moist regions of the world are regions of through drainage (exoreism), and the semi-arid and desert regions of the world are regions of endoreism and areism. The index of aridity in the Southern Hemisphere is lowest (driest) about latitude 30°. This applies to the other southern continents as it does to Australia.

The following are the indices of aridity for characteristic regions of South Australia:—

	Mean Annual Temperature.	Mean Annual Precipitation.	Index of Aridity.
Central Lake Eyre Basin	70° F	5″	4·1
Northern margin of wheat lands (10″ isohyet)	64° F	10″	9·1
Adelaide (metropolitan area) ..	63° F	21″	19·6
Southern ends of Peninsulas ..	60° F	28″	27·8

The highest index shown in the State is about 32, which corresponds with the generalization that exoreism is at its maximum for values above 35. The northern margin of our settled cultivated areas has an index of 9·1, which is within de Martonne's limit of areism (desert). The statements put forward in the paper referred to thus assist in a more satisfactory description of our State, and a more complete correlation of the physiographic with the climatic conditions.

The conditions in South Australia also generally agree with the statement of E. G. R. Taylor ("Oceans and Rivers," p. 26) that "In cool temperate climates the run-off approaches zero when the rainfall is only ten inches, while in subtropical regions 20 inches of rain, and in Torrid regions 40 inches of rain, is necessary to ensure flowing rivers."

It is unfortunately true, as stated by de Martonne, that while Asia, Africa, and Australia are the three continents with the least perfect drainage, with the greatest area of internal drainage, and with the most massive structure, Australia among all the continents holds the record for endoreism, namely, 64% of the total area, of which latter portion two-thirds is areic.

V.—THE SOUTH AUSTRALIAN HIGHLANDS.

(a) *The Mount Lofty Ranges.*—The features dealt with in this and the following sections have frequently been described in a general way. It is here proposed to deal with them purely from the point of view of the tectonic movements that have affected them, the rocks of which they are composed, and the erosion which they have subsequently undergone.

The broad outlines of the structure of the Mount Lofty Ranges have been described in Section I. They have also been dealt with, in some detail, elsewhere by the writer (Trans. Roy. Soc. S. Austr., vol. li., 1927, with several figures). In the popular local acceptation of the term, the Mount Lofty Ranges consist only of that abruptly-uplifted highland arc of ancient highly-resistant Cambrian and Pre-Cambrian rocks (quartzites, tillites, slates, limestones, schists, gneisses, and granites) that runs from Cape Jervis to the Torrens Valley, or perhaps northwards to the valley of the South Para River. Here there appears to be a striking radial (east-west) fault zone, and the ranges thence northward are of a much lower and physiographically older type. Genetically, however, and from the structural point of view, the Mount Lofty Ranges may be held to include the whole of the highland arc northward up to the neighbourhood of Georgetown, as well as its continuation in Kangaroo Island to the south-west (see fig. 2D.).

This highland area is severely block-faulted, in curving lines, parallel with the general outline of the horst, the blocks mainly dipping their old peneplain surfaces to the east and the scarp to the west. Regarded from the west, this uplifted arc reaches its maximum elevation at Mount Lofty itself, directly east of the city of Adelaide, thence sloping downwards both to the south and to the north. Radial faults also occur, normal to the margins of the horst, and it is likely that a considerable number of the transverse valleys of the ranges mask radial faults; this is apparently so in many of the "gullies" facing Adelaide. Several of the longitudinal valleys are in part tectonic, but the main lines of drainage are apparently antecedent, with tributaries strongly influenced both by later block-faulting and underlying rock structures.

The greater part, perhaps the whole, of the horst of the Mount Lofty Ranges has been stripped of a covering of level-bedded, easily-eroded, Tertiary (marine Miocene) sediments. It is generally agreed that differential uplift (block-faulting) and contemporaneous and subsequent erosion have formed the features as we know them to-day. Only one peneplain (pre-Miocene) and only one great uplift (dominantly Pleistocene, the "Kosciusko Epoch") have usually been considered.

This hypothesis, however, does not explain all the peculiarities of certain critical areas, such as the Torrens Valley on the one hand, and the coastal strip that runs from O'Halloran Hill to Myponga on the other. Some of the existing structures of these areas could perhaps be better explained by assuming two dominant stages of block-faulting, with two periods of peneplanation, the later planation being partly carried out in the softer Tertiary "overmass." This possibility was suggested to the writer by Professor Douglas W. Johnson, of Columbia University, New York, while travelling over the area in question. The theory has not been fully investigated, but a score or more visits have been paid to critical localities, and there is sufficient general support available to justify some elaboration of the suggestion.

In order to give definiteness to this modified hypothesis regarding the structure of the Mount Lofty Ranges, and to better permit of critical consideration thereof, fig. 4 has been drawn to illustrate the suggested succession of events. The sections in the figure are purely diagrammatic, and are lettered A, B, C, D, E; the hypothetical blocks are numbered 1, 2, 3, 4, 5.

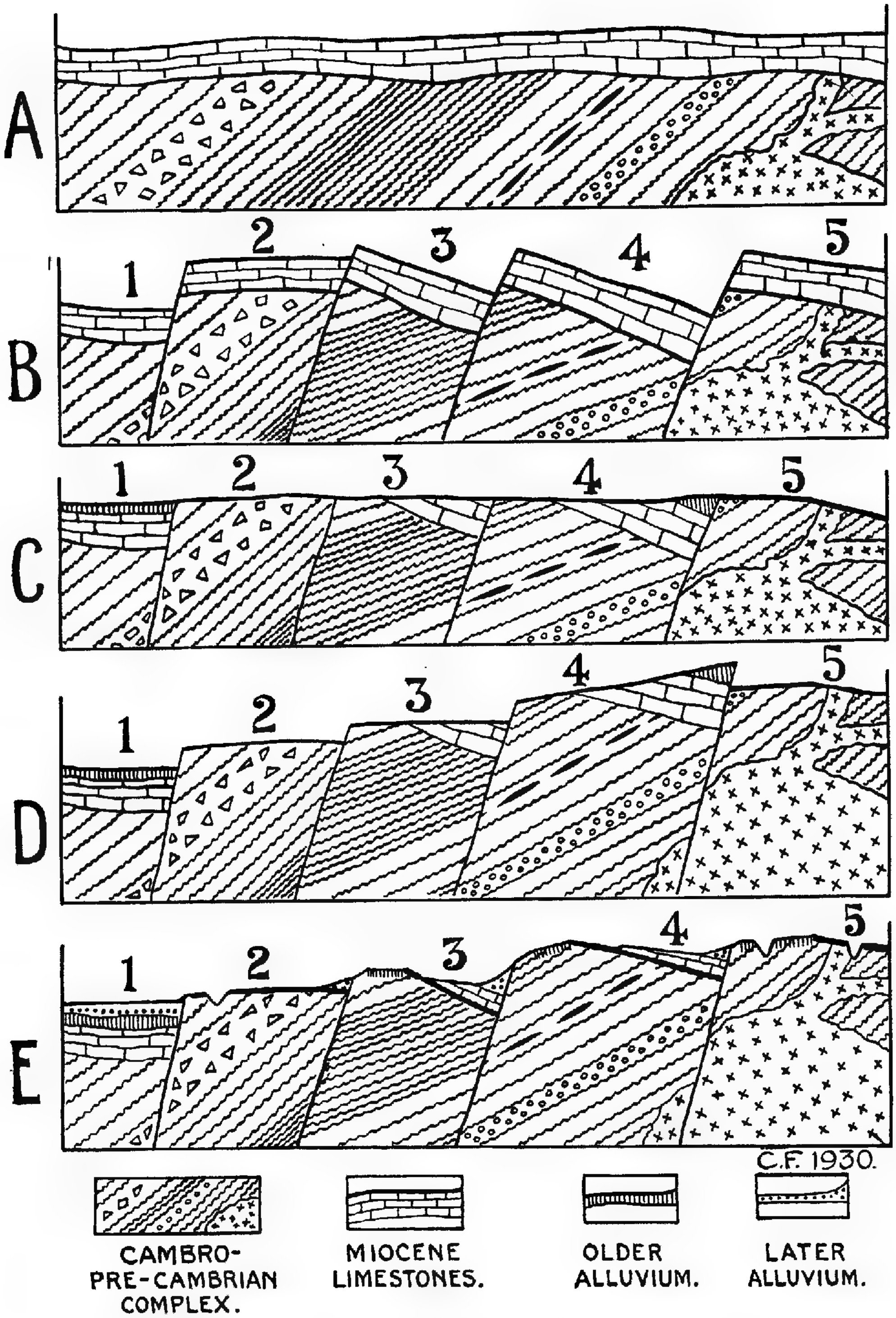

Fig. 4.

A series of sections drawn to illustrate the theory that at least two periods of Tertiary peneplanation are involved in the production of the present topography of the Mount Lofty Ranges, as described in the context.

In section A we have the prevailing highly-resistant Cambrian and Pre-Cambrian complex (quartzites, slates, tillite, gneisses, schists, and intrusive rocks), which was planed down to a remarkably widespread level surface in pre-Miocene times *(cf.* Davis's "Geographical Essays," Boston, 1909, chapters xvii. and xviii.). There were also some softer Permian tillites and Mesozoic sediments. but these do not affect the present discussion. The peneplain, which must have extended well to the south of the present limits of the State, became covered by the sea in Miocene time, when a series of marine limestones and clays were deposited, indicated as the horizontal overmass in section A.

In section B is indicated a phase of block-faulting, tilting, and differential uplift that may have taken place in the upper Miocene or lower Pliocene; this figure shows the "end product" of the tectonic phase, that is, as the blocks would have appeared at the conclusion of their displacement had there been no contemporaneous erosion.

In section C we have a second peneplain, the product of the contemporaneous erosion of the preceding uplift, plus a sustained period of planation extending to, say, the beginning of the Pleistocene. In this stage there may have been produced the mature landscapes of the upper Torrens (Mount Pleasant), etc. According to their tilting and relative uplift, the materials of the five blocks have been preserved to varying extents: Block 1, wholly preserved and covered by alluvium; block 2, the pre-Miocene peneplain stripped of its overmass and re-exposed (exhumed); blocks 3 and 4, the new peneplain truncating the Pre-Cambrian and the Miocene alike; block 5, the new peneplain formed on one portion of the block, while over the eastern half the easily-eroded overmass has been stripped off by erosion, exposing the older peneplain; thus two peneplains of different ages adjoin each other.

In section D is suggested a period of, say, Pleistocene uplift (the "Kosciusko Epoch"), mainly along the original fault lines; this section shows the final product of the uplift and tilting as it would have appeared had there been no contemporaneous erosion.

In section E we have: Block 1, the whole of the three series of rocks preserved, depressed, and covered by recent alluvium from adjoining higher blocks (Adelaide Plains); block 2, the first (pre-Miocene) peneplain exhumed, uplifted, and subjected to a fresh cycle of erosion (? Mount Osmond Golf Links); blocks 3 and 4, erosion of western scarp face with deposition of "fault-apron" alluvial on adjoining lower block (Burnside, Sellick's Hill, etc.); portion of second peneplain preserved (? O'Halloran Hill); portion of first peneplain exhumed by erosion of Miocene limestones (? McLaren Vale); remnant of Miocene limestones, alluvial-covered, towards the adjoining scarp (?Noarlunga and Port Willunga); block 5, youthful (Recent) valleys in both the first (pre-Miocene) and the second (? late Pliocene to early Pleistocene) peneplains. In section E the surface of the first (older) peneplain is shown by a thick black line, the surface of the second (younger) peneplain by a shaded line, and the remainder of the surface (thin line) is that of the third (present cycle of erosion that is involved in the period and area dealt with.

The preceding paragraphs, with the accompanying sections (fig. 4), present in brief the essential features of a modified hypothesis regarding the physiographic history of the Adelaide and Mount Lofty area.

Reference was made in a previous section to relatively late movements along fault lines in the Adelaide district. There are two or three lines of evidence that are of special interest:—Along the western boundary of the southern portion of the city of Adelaide, from the Newmarket Hotel to Keswick Railway Bridge, the incoherent Pleistocene and later gravels, silts, etc., have been faulted. The line of the fault scarp is still to be seen (notwithstanding roads, cuttings, and other artificial earthworks of various kinds), and despite long-continued erosion it persists as a distinct break in elevation—the most southerly portion of the Para Scarp. This suggests Recent movement along the Para Fault. The friable, dissected, horizontal, ferruginous beds of (?) Pleistocene age that remain against the main Mount Lofty Scarp on the south side of the Anstey's Hill road provide supporting evidence of this Recent uplift. Also, at Hallett's Cove, a triangular patch of very readily-eroded rocks (Permo-Carboniferous tillite, a thin band of ? Lower Pliocene marine limestone, and thick overlying ? Pleistocene mottled clays) have been: (a) preserved by down-faulting, and (b) uplifted and dissected by marine and sub-aerial erosion; this also suggests very late fault movements, well worthy of closer investigation.

Nothing further need be added, except to affirm that the mature landscapes of the upper Torrens, upper Onkaparinga, and other streams heading towards the Mount Pleasant area are difficult of explanation, unless we assume a long period of sub-aerial planation following the first uplift, some exhumation of the pre-Miocene surface, and some later tectonic influences, followed by the present cycle of erosion. The two or three western blocks that are truncated by the Torrens Gorge must have risen later, and their topography, antecedent, superimposed (Torrens, Para, etc.), and consequent with headward erosion (Morialta, Waterfall Gully, etc.), is in a youthful phase.

The ranges from Gawler northward to Gladstone are of a different character, and their story remains to be written. On some blocks there is evidence of late-youthful topography, but for the most part this productive region represents a "matureland" (Willis) of low hills and broad valleys, characteristically developed in the basin of the River Light.

Further north, the Mount Lofty Ranges widen and gently curve onwards into the Flinders Ranges (see fig. 2). To the north-east a broad, low "spur," which has been called the Olary Spur, runs away towards and through Broken Hill. This is, in fact, a broad uplifted plateau (1,000 feet to 2,000 feet), and it has a mature topography, while the structure along its boundaries indicates warping rather than faulting. As Howchin has pointed out, the stream courses are in many cases most uncertain and anomalous, and may change direction from one flood-time to another.

The proximal portion of this "spur," which is situated eastward of the area where the Mount Lofty Ranges merge into the Flinders Ranges, is really a maturely-developed, up-warped plateau, over 1,000 feet above sea level, with occasional higher ridges.

A characteristic feature of this area, and indeed of many other portions of the State, consists of wide plains, deeply filled with alluvial. Sometimes, as in the upper portions of the Broughton and Light Rivers, the local streams are drained to the sea (exoreic). In other cases, of which Pekina Creek is an example, streams run into deep alluvial basins, and are lost.

The statement that "Even the weariest river winds somewhere safe to sea," was written by a poet of a moister land than ours. Most South Australian rivers, however weary, do not reach the sea, but find their resting-places in wide and deep alluvial-filled basins—basins that have been filled up by the long-continued silting action of the rivers that still periodically flow into them, aided by deposits of wind-borne dust.

These widespread alluvial-filled basins are among the most significant features of the physiography of South Australia. They occur as the so-called central "lakes"—Torrens, Eyre, Frome, etc. They are the foundations of many of the fertile wheat plains of the northern areas, and will probably be found to have played an important part of the story of the physiographic development of the lower Murray River itself.

On the Peterborough Plateau, and along the Olary Spur, which is only partly within the area of 10-inch rainfall, we get marked evidences of arid and semi-arid physiography, namely:—

(a) Sustained wind-erosion with occasional rapid water-erosion.
(b) Stream courses of the wady type, sometimes erratic in direction, steeply gullied in their upper portions, ending in broad alluvial fans or wide alluvial basins.

(b) *The Flinders Ranges.*—Broadly speaking, the Flinders Ranges may be regarded as a repetition of the Mount Lofty Ranges. There is a similar horst structure, abruptly ending along fault scarps on east and west, a similar arc-shaped curve in the plan of the ranges, and a similar, but much more dominant and impressive north-easterly spur. (See fig. 2.) There is even a break between the cusp of the Willouran Ranges and the main range analogous to the break at Backstairs Passage in the south. The rock types embrace the same series of ancient and highly-resistant rocks, and the structures are fairly similar, though the block-faulted and tilted masses of the Flinders Ranges show also definite synclinal and anticlinal structures, as at Wilpena and Blinman (Howchin).

In spite of these similarities, the Flinders Ranges, as landscape features, are utterly unlike the Mount Lofty Ranges. One could not conceive, *a priori,* that there would be so striking a difference between the landscapes of the two ranges, which have structures so similar and rock types so alike. This difference, it would appear, is largely due to the fact that wind erosion is today a more important factor in the sculpture of the Flinders Ranges than it is in the moister Mount Lofty Ranges. Where the Flinders Ranges are abrupt, rugged, pinnacled, and (in places) naked of soil and vegetation, the Mount Lofty Ranges are softened and rounded in outline, and clothed with soil and vegetation.

The wind erosion phase of the Flinders Ranges is, nevertheless, imposed upon a drainage network formed by water. Water is still doing its work, but in the pluvial period that is believed to have been experienced here in lower Pleistocene time (Gregory, David, Howchin, etc.), the patterns of the ranges were decided upon, and the influence therein of rock structures, and to a lesser extent of rock types, is marked. The full story has not yet been worked out in detail, owing to the almost complete absence of mapping in these areas, but a study of exceptional interest here awaits some future worker.

The Yudnamutana Spur contains some of the wildest and boldest parts of the ranges. The strike of the Cambrian and Pre-Cambrian rocks, instead of running parallel with the range, as is usually the case, is most varied and unexpected. Dr. Ward and Mr. R. Lockhart Jack have plotted sufficient data to show that the strike and dip here are most confused, bearing witness to exceptional torsion, differential movement, and general disturbance. The same writers have shown that this Cambrian and Pre-Cambrian horst continues onward underground to the north, plunging below the Cretaceous beds, as revealed by bores in the artesian basin of the north-east.

(c) *The Musgrave and Everard Ranges.*—These ranges are little known structurally. Mr. R. Lockhart Jack (Geological Survey, S.A. Bull., No. 5), considers that faulting plays a considerable part in their structure. Their general direction is east-west. In the Musgrave Ranges granitic cores and bosses play an important part in determining the structures, with schists and gneisses in the Everards, but there is a marginal "festoon" of residual hills to the south that is formed from Ordovician sediments. The main granite masses are also slightly arc-shaped, concave to the north.

The ranges are in general low and scattered, with wide alluvial-filled plains or plateaus between. The main Musgrave mass rises more mountainously, and is crowned by the highest peak in the State, Mount Woodroffe, about 5,000 feet. The general valley pattern has been water-formed (see fig. 6), and some streams still run to the north, east, and south, from the main range, but are only occasionally called upon to function. In times of exceptional rain some of the run-off from the Musgraves reach the Lake Eyre Basin, via the Alberga.

The chief erosive agent in so arid an area is the wind, aided by a wide range of daily temperature variation. Rugged, bare, rock faces, sand-blast features, sand accumulations, bare talus slopes—all bear witness to the consistent, never-ceasing eroding and transporting power of the wind. The hill shapes bear witness, as do the stream patterns, to their formation under normal conditions of moist sub-aerial erosion. Also, as is common in the mountain and hill physiography of deserts generally, the structural features, almost unmasked by soil or vegetation except for the characteristic "sand burial" around their bases, bear definite evidence of their tectonic or plutonic origin.

(d) *The Gawler and West Coast Ranges.*—The Gawler Ranges are formed by a series of ridges, with many wide valleys, that run in an irregular way along what might be regarded as the northern boundary of Eyre Peninsula. These ranges are quite different in structure from any other of the ranges herein described, due to their formation from igneous rocks (felspar porphyries) which are classed by Ward as dykes, sills, and flows of pre-Cambrian time.

It is suggested that this relatively higher area is a westward continuation of the up-warp of the Peterborough plateau, emphasised by the greater relative erosional resistance of the porphyries, and that the same movements formed the relative depression to the north that is now the site of "Lake" Gairdner and other salt flats and "lagoons." Howchin regards this range as one of a very ancient and important series of east-west mountains, but the Gawler Ranges are certainly quite distinct, structurally, from the Willouran Ranges and Kangaroo Island, with which they have sometimes been bracketed. If the Gawler Ranges were not formed in an up-warp during the later Tertiary, then we may regard them as a residual monadnock ridge from the pre-Miocene peneplanation, possibly due to differential resistance, rounded off by ages of arid-land erosion.

(e) *The "Tent-Hills" of the Interior.*—In a broad belt of country extending northwards from Whyalla and Iron Knob to the northern boundary of the State, and roughly marginal in the north to the Great Artesian Basin, there is a series of flat-topped hills, locally known as "Tent Hills," or "Table-top Hills." Similar isolated hills occur elsewhere in the interior. The shape is striking, in that they are almost invariably flat-topped and steep-sided, with cliffs in the upper part of their outline and extensive screes below.

If all of these were, as some of them are, in level-bedded rocks of varying erosional resistance, we should have the typical mesas and buttes ("Zeugen," Walther) of Central Asia, Western United States, and elsewhere. But this is not the case; a wide variety of rock types and structures is found in these tent-hills. The typical and well-known hill named Crown Point, approximately the geometrical centre of Australia (Ward), is of contorted Permo-Carboniferous glacial till; those in the neighbourhood of Port Augusta may be of steeply-folded Ordovician sediments; others are of horizontal Ordovician sediments, some are of still older rocks of varied structure; most of these features are formed in Cretaceous or Tertiary sediments. In spite of the wide variety of structures and of erosional resistance, the type of hill does not vary greatly. The capping material, according to Ward (Trans. Roy. Soc. S. Austr., vol. xlix., p. 76), is a silicified sandstone or conglomerate, an arid land feature, and this capping is largely independent of the nature of the underlying rocks.

It appears to be undoubted that the level tops of the tent-hills are the relics of an uplifted peneplain, and that the intermediate plains and valleys that now separate these remnants were laid down by running water, but widened and deepened during long ages of insolation and wind erosion, with the occasional work of thunderstorms and floods. In the latter-day usage of the word, the lower level area might perhaps be called a second peneplain.

(f) *The Volcanic Hills of the South-East.*—The only volcanic hills of South Australia are found in the extreme south-eastern corner of the State, and are genetically associated with the great outburst of volcanic activity that occurred in central and western Victoria in the late Tertiary (? Pliocene to Recent). There are also some minor residual volcanic hills in Kangaroo Island. The South-Eastern group includes several small centres of eruption: Mounts Gambier, Schank, Muirhead, Burr, McIntyre, Edward, The Bluff, etc. (see fig. 5). It is likely that Mounts Gambier and Schank were among the latest of these volcanic foci to be in operation.

Mount Schank is a fine example of a symmetrical crater of tufaceous materials, partially collapsed. Mount Gambier consisted of three or more tufaceous cones, with subsequent large-scale collapse below the water-level of the sub-artesian basin that occurs here, forming a series of steep-sided and picturesque lakes. Several of the neighbouring volcanic hills, from The Bluff to Mount Muirhead, lie along a fault scarp, with which there may have been some genetic association; the evidence at The Bluff suggests that the faulting was, in part, subsequent to the vulcanicity.

VI.—PLAINS AND PLATEAUS.

The greater part of South Australia, as may be seen from fig. 3 B, consists of vast plains less than 500 feet in elevation, or of similar wide plains gently rising from 500 to 1,000 feet or more in elevation and consequently in places referred to as plateaus. Structurally, they require but brief description, though they vary greatly in mode of origin.

(a) *The North-western Plateau.*—This comprises the shaded area that occupies roughly the north-western quadrant of fig. 3B, excluding the Musgrave Ranges in the extreme north-west (also called the North-west Plains). These vast expanses are little known; parts of them are quite unknown. As far as our records show, they are an area of very ancient rocks, largely a crystalline complex, structurally stable, peneplaned by ages of sub-aerial erosion dominantly aeolian in the latest phases, of very low relief, and practically without watercourses. Along the eastern side, margining the Eyre and Torrens basins, there are some wide, sand-floored valleys, separated by the characteristic "tent-hills" already described. Elsewhere the surface is, for the most part, a series of monotonous parallel (N.W.-S.E.) stationary sand dunes, or rough gibber (stony) plains, varied with clay-pans, with here and there low granitic outcrops and accompanying rock-holes.

(b) *The Plains of the North-East.*—These include the Lake Eyre and Lake Frome basins, superficially resembling, but in all other ways contrasting with, the North-west Plateau. For the most part this area is one of almost level-bedded Mesozoic rocks; these belong to the Great Artesian Basin of Australia, and the whole appears to be, structurally, a sagged or sunken area, level-bedded in the interior and more or less up-warped towards the margins. The surface has a reticulation of stream courses, described in a later section (see fig. 6). Apart from these streams, with their accompanying billabongs and lagoons, which are in places causing fairly rapid siltation along their banks, the area is one of drifting (bare) or stationary (plant-covered) dunes, of gibber plains, or of mulga and salt-bush plains. It is difficult to say to what extent this area has undergone normal sub-aerial erosion; there is some evidence that it has actually been completely peneplaned once, with later uplift and a second fairly-advanced cycle of planation. The extent of the latest phase of aeolian erosion, as compared with the normal type of sub-aerial erosion, is not yet known.

(c) *The Nullarbor Plains.*—The location and size of these plains are shown in fig. 3A. This physiographic feature is *sui generis.* Here and there on this vast level, treeless, streamless, limestone expanse, there is indeed some variety to be found, but it does not present itself to the casual observer. The East-West (transcontinental) railway line, which traverses these plains, runs for hundreds of miles in a direct, unbending line. The area was a broad gulf in Miocene times, and may have been continuously so from the Cretaceous period. In post-Miocene times it was slowly uplifted, without any apparent warping or fracturing, except along and close to the coastal margin. Its northern margin is now 500-600 feet above sea level. The surface is mainly of rough limestone, covered by a general development of nodular and concretionary lime deposit, with intervening patches of shallow soil carrying low salt-bush and blue-bush. It is distinct from either of the two previously described areas of plain, being a plain of marine deposition, uplifted, without definite traces of planation. In times of exceptional rains, the water lies about in vast "lakes" until it percolates or evaporates away. There are some minor karst features, but these are few and far between.

(d) *The Mallee Plains.*—The Mallee area is usually defined on an ecological, climatic and production basis. Wood (Trans. Roy. Soc. S. Austr., vol. liii., p. 359) describes the area as bounded by the 8-inch winter isohyet on the north and the 20-inch winter isohyet on the south (map, page 361, *loc. cit.).* But all workers do not agree; see also Kenyon ("The Victorian Mallee," Govt. Printer, Melbourne, 1923) and Chapman ("Victorian Naturalist," January, 1922). For our purposes we may consider the Mallee Plains (see fig. 3A) as including: Eyre Peninsula (The "West Coast"), Yorke Peninsula (Y.P.), and that area of plains traversed by the Lower Murray Valley, which lies east of the Mount Lofty Ranges, and south of the Olary highlands, and bounded by the eastern border of the State. The southern boundary extends from the Coorong eastward to the Victorian border. The boundary between the Mallee and the "South-East" is not readily defined; there is no structural or physiographic change; as we approach areas of higher rainfall to the south, the characteristic "mallee" gives way to sheoak, stringybark, banksia, and bracken, and this merges into the different and characteristic plains of "The South-East."

Structurally, the Mallee Plains are areas of horizontally bedded Miocene and later limestones, elsewhere a peneplaned area of ancient crystalline (Pre-Cambrian) rocks that were once possibly covered with such Tertiary limestones, but have lost them by sub-aerial erosion. The plains are characteristically areic. Over the Mallee areas there is much recent alluvium and widespread deposits of reddish, wind-blown sands; in general, wide clayey or sandy valleys alternate with low calcareous or sandy ridges. Although the relief is so slight, there is quite a variety of land forms of economic interest, but not yet terminologically defined.

(e) *The South-Eastern Plains.*—As described in the previous paragraphs, these plains emerge from the more dry Mallee Plains to the north. They consist of level-bedded limestones (Miocene) with occasional low outcrops of underlying Pre-Cambrian bedrock. Towards the Victorian border, to the east, the limestones are many hundreds of feet thick. The limestone plain has been uplifted and faulted. At least two of these faults, parallel to the coastline, have affected the physiographic development of this area, and are still marked in part by low fault-scarps (see fig. 5).

Another remarkable feature of this area is a belt, nearly 50 miles in width, of successive dune and swale—ancient sand dune ridges that are now dignified

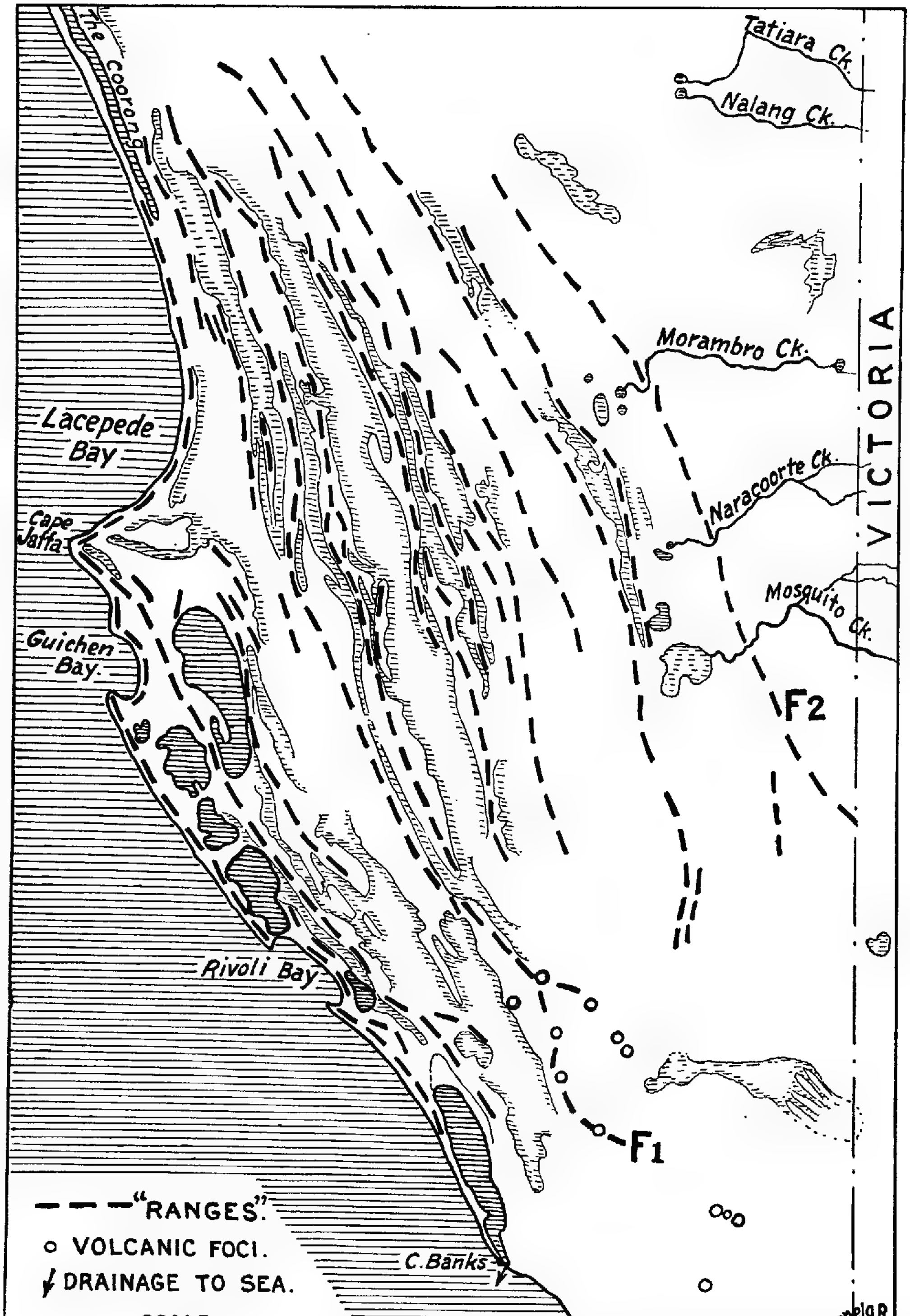

Fig. 5.
Sketch map of the south-eastern areas of South Australia, showing the series of ancient dunes, inter-dune swamps and flats, volcanic foci, fault scarps (F1 and F2), and the main visible outlets of the underground drainage.

by the name of "ranges" (Woakwine Range, Avenue Range, etc.). These dune ridges (N.W.-S.E.) run normal to the natural fall of the land (S.-W.), and thus interfere with the development of the natural drainage system. Owing to the soluble character of the limestones an incipient karst formation is developed in places, with dolines, collapsed caves, etc. A series of small volcanic cones in the more southerly part adds further variety to this region. A great part of the inter-dune regions consist of recent alluvial deposits, and there are also widespread swamps and lagoons.

Physiographically, this area of ancient dunes is one of extraordinary interest. It appears that the series of ridges shown in fig. 5, with their intervening swales and lagoons, represent a long-continued series of ancient "Coorongs," the most ancient being that which lies nearest to the Naracoorte scarp. The last-named feature may be noted in fig. 5, as the ridge (F 2) which is intersected by the Morambro, Naracoorte, and Mosquito creeks. Professor Douglas W. Johnson, of Columbia University, who has given special attention to these forms (*vide* "Shore Processes," chapter ix.), was attracted by the data in the possession of the writer concerning the stranded dune ridges of the South-East. It would appear that South Australia has in this area a physiographic feature of very high interest from both the scientific and the economic points of view, and one worthy of intensive study. A detailed study of the physiography of this area must have an important bearing on the "drainage problems" of the region.

From data kindly made available by Dr. Keith Ward, the writer has drawn five east-west sections across these dunes and swales. Applying to these the criteria laid down by Professor Johnson, the evidence favours a long period of steady uplift of the land.

(f) *The Plains of the Sunklands.*—These are: (a) in the Lake Torrens Sunkland, the Torrens Plains; and (b) in the Spencer-Vincent Sunkland, the Adelaide-Wakefield Plains, the Broughton-Pirie Plains, and the Arno-Cowell Plains. All these plains are built of thick deposits of recent fresh-water alluvium, in some cases many hundreds of feet in depth. In the Torrens Sunkland the alluvium is less well-graded, and the land is of a low economic value owing to the arid conditions. In the Spencer-Vincent Sunkland the three tracts of plain mentioned are of considerable economic value, owing both to the character of the soils, surfaces, and rainfall, and to the nearness to well-watered highlands and to markets. This is most true of the Adelaide-Wakefield Plains, and least so of the Arno-Cowell tract. The seaward margins of these alluvial plains are in some parts shallow and muddy, with fringing mangroves; in other parts there are broad sand dunes. The writer has previously described the sand dunes that run from Seacliff to Pelican Point, west of Adelaide, as a northward projecting "spit," built gradually forward from base to tip. Further investigation shows that this is so only in the more northerly part; most of these dunes are simple parallel dune ridges. (See "Shore Processes and Shoreline Development," chapter ix.)

General Note re Plains.—This brief survey has shown that, both from the geological and the structural aspects, the six areas of plains described, which appear so much alike on first inspection are, on close analysis, distinctly different from one another. Each of these geological and structural facts has its corresponding economic reactions. When consideration of these plains extends to their climatic conditions and economic values, the differences are even more pronounced.

VII.—DRAINAGE SYSTEMS.

(a) *General.*—By far the greater part of South Australia is streamless (areic). In all our vast area of 380,000 square miles, there can scarcely be said to be one permanent running stream carrying water that has fallen within our boundaries. It might be thought, therefore, that an account of the drainage systems could be dismissed with but brief mention and description. There are several reasons why this is not the case:—

(i.) Where running water is rare and rainfall low, all streams become of greater importance. In a land where water is the great need, every source of supply must be known and exploited.

(ii.) In the arid areas of the State the rainfall is not only low, but it is unreliable. In an area of average 5-inch rainfall, that amount of rain may fall in a single day under monsoonal conditions. Thus devastating floods occur in the driest areas, and special types of arid-land watercourses have developed—typical "wadys" in the foothills; wide, sandy-floored, braided stream-courses in the plains. These have their own physiographic and economic interest.

(iii.) Prior to the present arid cycle of the interior, and possibly prior to the last great tectonic uplifts that affected this area, there was one or more pluvial periods in Central and Southern Australia. Stream courses were then developed, as described by Professor Howchin in his accounts of the "lost rivers" of the interior. (See A.A.A.S., Melbourne, 1913, p. 174, and elsewhere).

(iv.) Finally, there lie within the boundaries of South Australia the last 400 miles of the course of the great River Murray, the Father of Australian Rivers. The Murray has been fancifully compared with both the Nile and the Mississippi, and with both of these it has characters in common. But, much as rivers the world over resemble one another, the Murray is really a river of its own kind—with characters all its own, with its own scenic charm of form and colour, with unique economic potentialities and problems. All this is particularly true of the narrowly-restricted South Australian Murray Valley, rather than of any other part of the course of that great river.

(b) *The Lake Eyre Basin.*—In the general maps of South Australia the outlines of the various drainage net-works, as preserved by the Lands Department and other surveyors, are usually rendered almost undecipherable by the necessary addition of roads, tracks, mountains, and other cartographic data.

It was, therefore, considered worth while, to assist in the independent consideration of these important drainage networks, to prepare sketch maps of various drainage areas clear of the embarrassment of other details.

As already described, the Lake Eyre Basin lies in an area of low and unreliable summer (monsoonal) rainfall. Lake Eyre itself lies within the 5-inch rainfall line, the most arid portion of Australia (note 10-in. isohyet, fig. 6). In the north centre of the area is a large patch of drifting sand-dune desert, where there are no stream courses whatever. For the rest we have a series of streams, chief of which are the Finke, Diamentina (or Diamantina), and Cooper's (Barcoo) Systems, which run only in times of heavy flood. Characteristically, they are wide, sandy-floored streams, wandering almost aimlessly over the plains, but in places depositing considerable depths of silt along their banks (4 feet in about 40 years at Burke's Tree, Innamincka, *vide* Proc. Roy. Geog. Soc. S.A., Session 1927-8, p. 14).

For the greater part of the year such streams are dry, but along their courses, in some places, valuable "waterholes" persist throughout the dry years. Adjoining such waterholes most of the "station" (ranch) settlement of these areas takes place; in other places, potable water may be obtained in the sands of the dry bed.

Apart from the apparently "aimless" courses of these streams, their braided character, their clay-bottomed waterholes, and the canal-like character of their

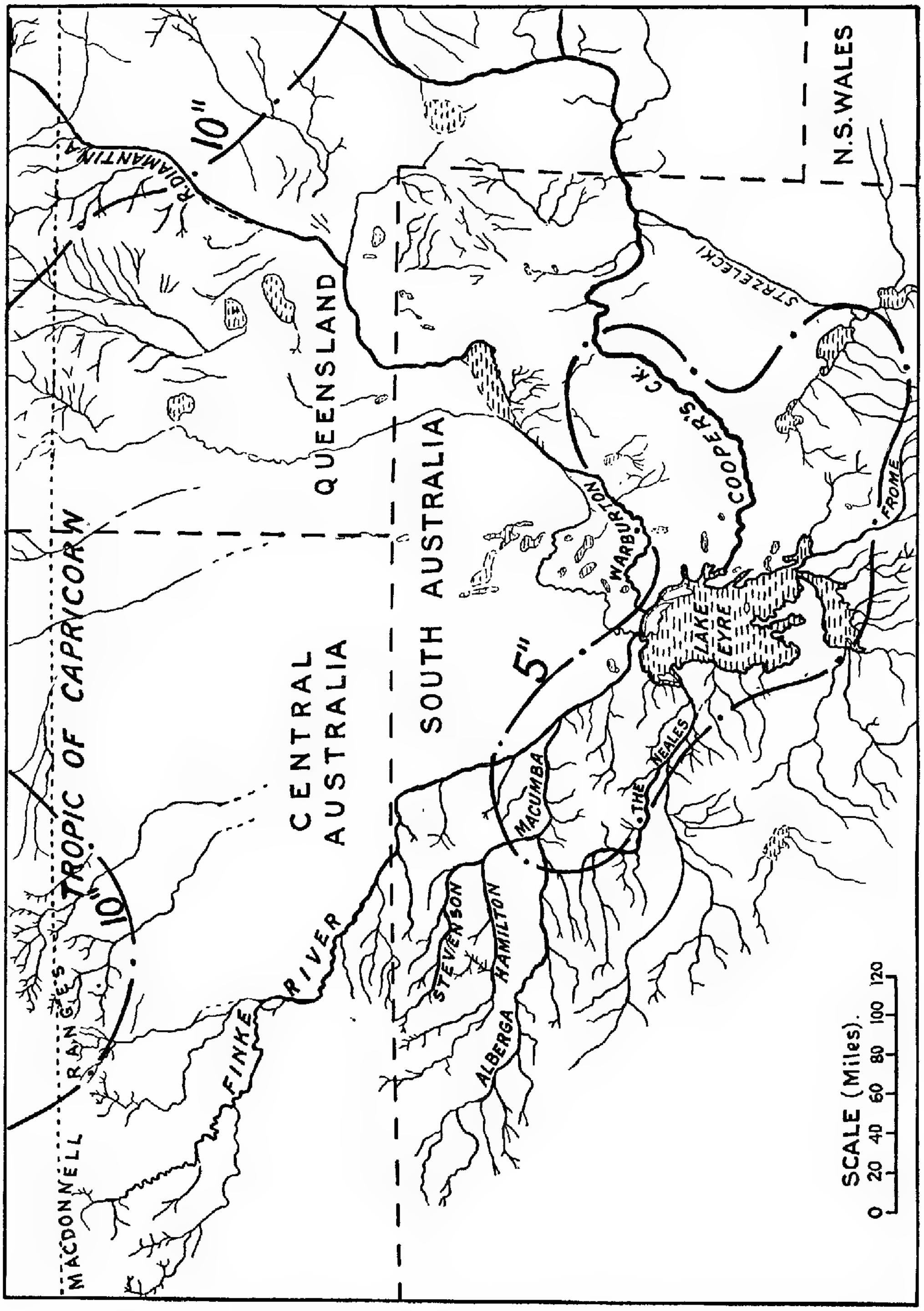

Fig. 6.

Sketch map of portion of four States, to show the characteristic, widespread endoreic system of the Lake Eyre basin. The 5-inch and 10-inch isohyets are shown; Lake Eyre itself is 30-40 feet below sea level.

beds in some of the lower reaches, there are one or two other features worthy of mention. One of these is the number of "tributary" streams, apparently with a well-developed system, that no longer reach the parent stream unless in exceptional floods; these perhaps point back to the pluvial period before mentioned.

Another noteworthy feature is the remarkable stability of billabong channels, such as Strzelecki Creek; Howchin thinks this was the original course of the Cooper. A third feature is the occurrence of "lagoons" throughout the area—basins that have gradually become silted up with the sediment carried by these

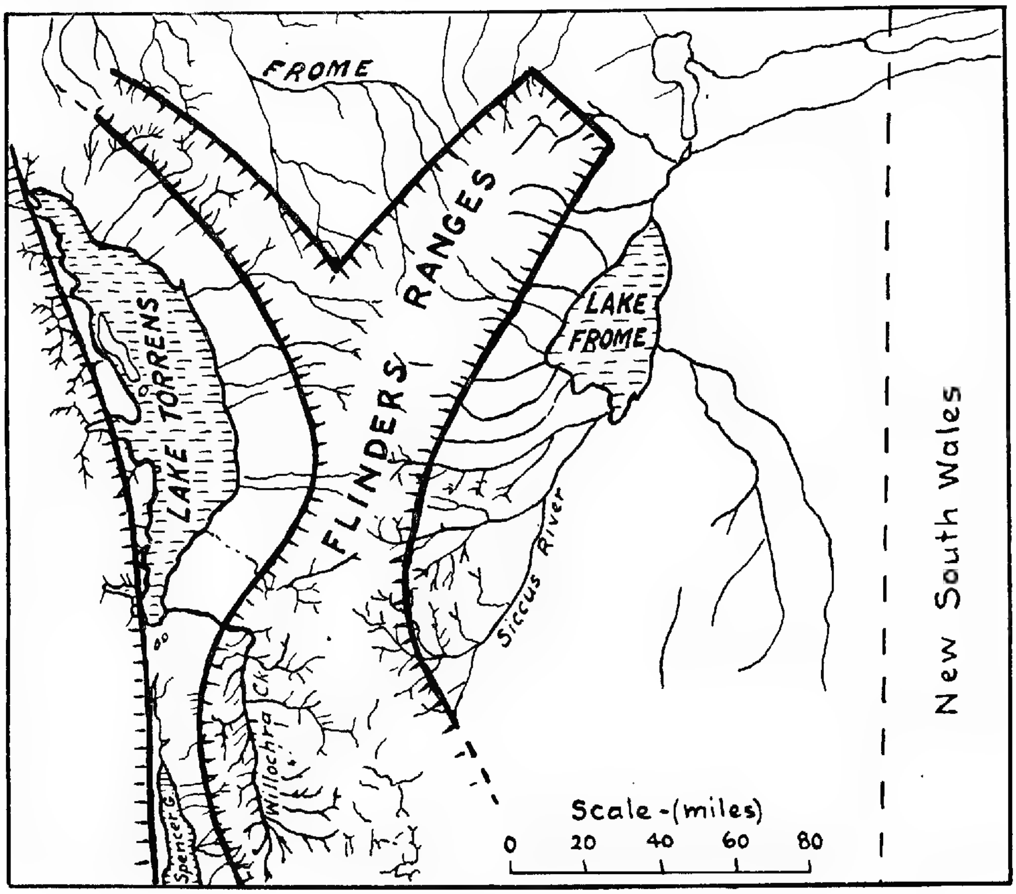

Fig. 7.
Sketch map to show the North Flinders Ranges, with the Lake Torrens and Lake Frome drainage networks. The chief faults are marked by bold lines shaded on the side of the uplift, the almost straight Torrens Fault on the west, and the two curving fault series bounding the Flinders Horst. Except on the ranges, the rainfall is everywhere less than 10 inches per annum.

streams in flood time. The central "lakes," such as Lake Eyre itself, come under this heading.

Dr. Keith Ward has pointed out that the definite and regular stream pattern of these rivers is found only on the areas of Cretaceous or older rocks. On the sandy plains, braided and ill-defined courses are the rule. Where the Hay, Hale, and Todd reach the outcrop of the Jurassic intake beds, their surface flow ceases. As suggested by Winnecke in 1886, this is probably also the case with the Finke

River, which no longer (in Dr. Ward's opinion) unites with the waters of the Macumba. See also Madigan's account of the aerial reconnaissance of this area (Trans. Roy. Geog. Soc. of A'asia, S.A. Branch, 1930 volume).

The most important physiographic fact regarding the Lake Eyre drainage basin is, that it is largely tectonic in origin. We may follow Howchin in his hypothesis that it was not always as it is now, but that this "basin" once continued in a wide valley towards the south, with great streams, in either one or more valleys, emptying into the ocean towards what is now Gulf St. Vincent. Howchin has shown that enormous deposits of fluviatile drift occur in various parts of the State, and suggests that during the pluvial period great river courses did continue southward. Certain it is that a contemplation of the geology and tectonics of the southern part of the Lake Eyre Basin leaves one with the impression that a great drainage system has here been frustrated, stopped, dammed back (see fig. 6). This is particularly the case when one considers the remarkable termination of Strzelecki Creek in a chain of lakes, lying normal to the stream course, along the base of the lately (? Pleistocene) uplifted mountain masses there. This abnormal physiographic feature had a pronounced influence on the history of the exploration of the interior, greatly puzzling the early explorers.

(c) *The Lake Torrens and Lake Frome Basins.*—Much that has been said of the Lake Eyre drainage system applies also to the Lake Torrens and Frome systems. Indeed, the Lake Frome drainage is really connected up with the Lake Eyre System in that chaotic, futile, and uncertain manner that one finds where, owing to the level character of the region and the mode of origin of the streams, the latter have played but a small part in forming their courses and "valleys."

These drainage systems are purely consequent upon, and closely reflect the facts of, the later tectonic movements of the northern Flinders Ranges. In the centre there has been the uplift of the horst of the Flinders, with the downsinking of the Torrens Sunkland to the west, the latter being terminated on the western side by the Torrens Fault. To the east there is the less well-defined Lake Frome Sunkland, which rises gently towards Broken Hill and the Olary Spur.

It would appear that the streams are mainly subsequent to, and consequent upon, these movements. It is true that within the Flinders Ranges the stream valleys cut across the beds and act independently of structures in many cases, suggesting that their courses were begun on the old peneplain surface of the rising Flinders. In other cases, as at Wilpena Pound, the rock structures have greatly affected the stream courses. It is likely that a study of the Siccus River will provide information of special interest regarding the physiographic history of the area.

The appearance of the Hookina and Parachilna gorges leads one to suspect a later and more rapid uplift of a segment of the western horst, as in the lower Mount Lofty Ranges. A pluvial period has been postulated to account for the normal drainage network established here, but it is impossible to gain any details from the few and imperfect maps available. Another field of more than ordinary fascination here awaits the physiographer.

(d) *The Willochra Creek.*—The map (fig. 8) shows the drainage network, and the surroundings, of the most economically important of the northern streams. The Wilpena and the Siccus basins are wholly pastoral. Agriculture comes in to some extent, and precariously, in the Hookina Basin (Hawker), while the Willochra Basin is of importance both agriculturally and pastorally. This figure shows also the relation between the upper part of Spencer Gulf and the lower part of Lake Torrens, in that particular portion of the central sunklands of the State that most nearly resembles a "rift valley" (here called the "Port Augusta Corridor").

It is in this locality that the great northern and southern arcs of uplift meet, and the uplifted mass is much wider from west to east than elsewhere, extending across the Carrieton-Peterborough plateau. Both the Hookina and the Willochra lie almost wholly within the uplifted blocks, and both streams, after abrupt turns to the west, make their way through narrow gorges in the ancient, resistant highland

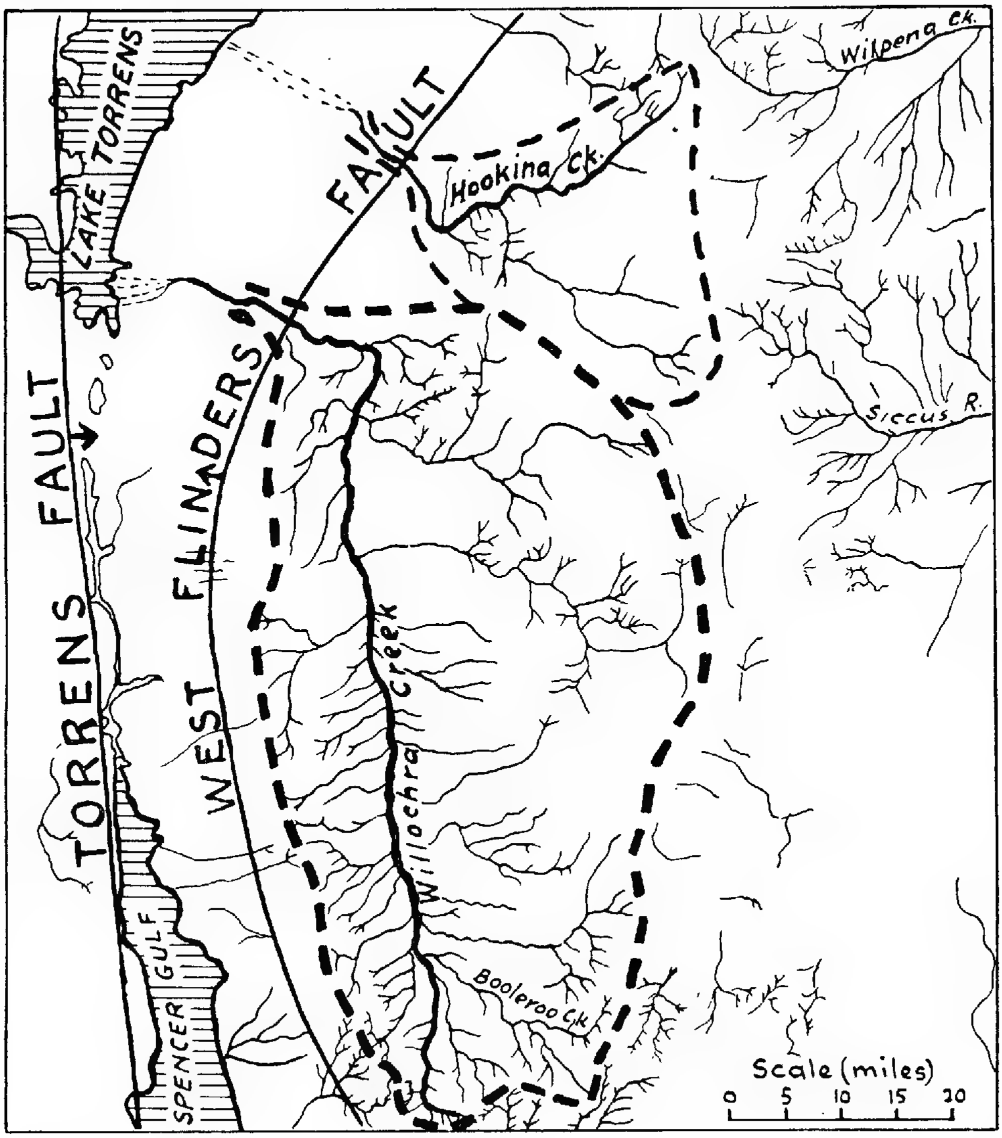

Fig. 8.

Sketch map showing the Willochra and Hookina Creeks, their drainage networks, and their relations to the high western scarp of the Flinders Ranges. The basins are outlined by broken lines. The surface of Lake Torrens is about 100 feet higher than the waters of Spencer Gulf.

rocks to the alluvial plain of the Torrens Sunkland, and thence to Lake Torrens. The western portion of the highlands here is a long strip of mountain range, of the extremely resistant, ancient, folded, and igneous rocks; this strip is unusually high, deeply dissected, and remarkably narrow (see fig. 8). It is probable that this segment of the horst has (as has been suggested for similar western segments of this great horst elsewhere along its length) been uplifted later and more rapidly than the main body; hence the narrow gorges of the lower Willochra and Hookina Creeks.

The wide valley of the upper Willochra Creek, above its passage through the ranges south-west from Hawker, must be partly tectonic in origin. The rela-

Fig. 9.

Sketch map to show the drainage network of the Broughton River. The basin is enclosed by a broken line. The probable old course to Pirie Creek is shown at A.

tively depressed ancient block that forms the foundation of this valley is covered with a deep and broad expanse of alluvium, material collected in the surrounding ranges by the tributaries of the Willochra and distributed over the valley floor as we find it today.

The rainfall of the area shown in fig. 8 may be approximately gauged from the abundance, or otherwise, of stream courses shown in the map. The rainfall is less than 10 inches per annum where streams are rare or absent, up to 15 inches where streams are more abundant, and up to 20 inches in the south (Booleroo Creek, etc.). The uplifted level plain of the upper Willochra has high potentialities, dependent upon a rainfall that varies in amount and reliability as one goes

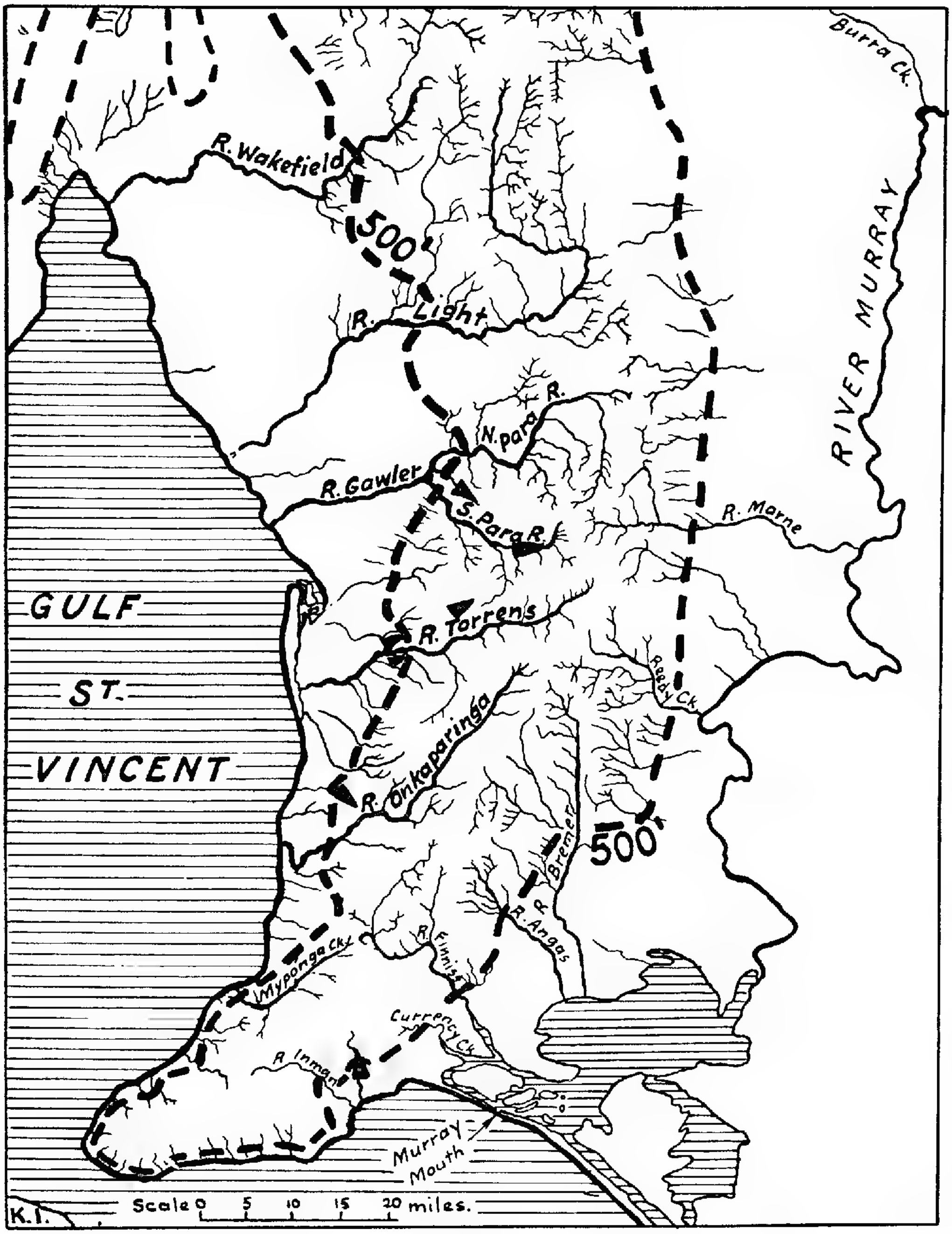

Fig. 10.

Sketch map of portion of South Australia to show the stream courses of the southern Mount Lofty Ranges. The 500-foot contour line is shown, and the chief reservoirs are indicated by black triangles.

from south to north. At one season these wide plains may be rich with waving wheat crops, at another they are vast sheets of moving water, and yet again, and more often, bare brown dust and mirage.

(e) *The River Broughton.*—This stream passes through one of the most productive wheat and wool areas of the State. As shown by fig. 9, it has a drainage pattern of a curious and interesting type, testifying to the influence of varied successive factors in its history. The north-south "ridge-and-valley" structure of the lower ranges hereabouts is remarkably well shown in Crystal Brook, Rocky River, Bundaleer Creek, the Hutt and Hill Rivers, etc. Whether these important structural features are due to "tilted blocks" (which is commonly believed), or to differential erosion of hard beds along their strike (which is also possible), has not been determined. The main course of this stream is strikingly different from most of its tributaries, and it may possibly be antecedent.

A wide area of deltaic plain, from Port Broughton to Port Pirie, has been deposited by this vigorous stream. In times of high flood, portion of the waters of the Broughton flow once more into the old Pirie Creek (the harbour of Port Pirie) near Solomontown. It is a fortunate fact for the harbour of Port Pirie that this stream deserted its old estuary, thus greatly minimising the difficulties of siltage and the cost of dredging at that important port.

(f) *The Light, Gawler, Torrens, Onkaparinga, etc.*—The portion of South Australia that is shown in fig. 10, namely, that part which lies between the eastern shores of Gulf St. Vincent and the last stretch of the Murray River (from Morgan to the Mouth), is the most favourable part of the State for the study of normal sub-aerial erosion. The legal name of this area, no longer used, is "Sturtia." It is the only extensive exoreic area in the State, and even then, as may be seen in the figure, many small streams die out on the alluvial plains. It is to this area that the greater number of the people of South Australia look for their water supply; it is in the upper valleys of these streams that most of the storage reservoirs are, and will be, built.

Much has been written regarding certain of these streams, particularly the Torrens and the Onkaparinga, and it is likely that we are approaching a general agreement regarding the manner of their origin, and of their age. It may be seen from fig. 10 to what a great extent the structure of the ranges has influenced the character of the stream-pattern; this is in favour of a consequent origin for the streams.

On the other hand, we have the facts that the ranges are in general higher on the western side and with dominant north-south structure lines; yet most of the basins drain to the west.

The hypothesis that appears to best meet this difficulty is that there have been two stages of uplift, as elsewhere outlined, that the stream courses are in part tectonic, in part consequent, and in part antecedent. Under this hypothesis, it is conceived that the streams were formed on the rising limestone overmass at the time of the first uplift (fig. 4). The block structures of the ranges imposed something of a tectonic character on the valleys, and when these streams had reached the maturity of the second peneplain, they were antecedent in relation to the Pleistocene uplift, hence the gorges, etc. There may also have been capture by the stronger western streams in both the Light and the Para basins.

Within the hills themselves the relief is high and the problems are many. A general fact is the contrast between the young topography of the stream valleys in the western part of the ranges, and the gentle, mature topography in their upstream areas. This applies more particularly to the country around Mount Pleasant, which represents a stage of erosion, in very resistant crystalline and

Archaean rocks, far older than that of any other part of the southern Mount Lofty Ranges. Here again is evidence of two distinct and widely-separated stages of uplift.

The "toe of the peninsula," from Myponga Creek and Inman Valley south-west to Cape Jervis, is a wonderland of physiographic interest that is almost untouched. The influence of rock types and rock structures of the most diverse kinds is to be seen here. Ancient pre-Permian landscapes are exposed, and incorporated into present-day features. Howchin has shown that the Finniss, Inman, and Hindmarsh Valleys have in part exhumed a pre-Permo-Carboniferous glacial landscape, and are thus in part super-imposed on the buried pre-Cambrian rocks. Fault coasts, marine erosion, valleys and ridges in extreme youth and high relief, have combined to keep this area in an almost unsettled state, and it remains a most promising place wherein to search for keys for the unlocking of the structural secrets of the Mount Lofty Ranges.

(g) *The Lower Murray Valley.*—It is not proposed to enter into the physiographic history of the Lower Murray in any detail; on this matter the writer has been collecting detailed geological and geographic information for other purposes. It is appropriate, however, to discuss in a broad way, some of the factors that may have determined the present course of the river. Tate's threefold division of the Lower Murray Valley still holds good, though it may be noted that the first observer, Charles Sturt, also detected the critical importance of Overland Corner. (See also Geological Notes, South Australian Almanack, 1841.)

Tate's divisions are: (1) The Lacustrine, from the Mouth (Encounter Bay) up to Wellington; (2) The Gorge, in marine Tertiary limestones from Wellington to Overland Corner; (3) A much wider valley, cut through lacustrine beds, from Overland Corner to the border of the State.

Professor Howchin (Trans. Roy. Soc. S. Austr., vol. liii., 1929, p. 167) presents valuable evidence, and discusses various possibilities regarding the physiographic history of the Lower Murray. If we consider only the precipitous, cliff-bordered, mile-wide gorge in the level-bedded Tertiary limestones between Overland Corner and Wellington, it is impossible to regard this as dating back to the close of the period of Miocene deposition and the beginning of the subsequent land emergence. It is difficult even to picture this gorge as one dating from the early Pleistocene, when one considers the mighty valleys carved out in harder rocks by lesser rivers during Pleistocene time. Not that any worker has definitely suggested that the Murray Gorge is either Miocene or Pleistocene in age. Although it has been called an old river, on account of its very low grade, it has many of the characteristics of youthfulness.

The Pleistocene (fluviatile and lacustrine) beds through which the river valley runs above Overland Corner, and whose sands and gravels have been so widespread over the area, may indeed have covered the whole of the Mallee limestones, and in a great estuarine pre-Lower-Murray period they may have extended well to the west over the area where the Mount Lofty Ranges are now. It was only by depression below base level, with a probable covering of alluvial sediments, that the Murray limestones could have been preserved.

Meanwhile the waters of the Darling, Murrumbidgee, Lachlan, and other contributors sent down their silt to the great central area, somewhat more vigorously and consistently than the Frome and Cooper do to the Lake Eyre depression to-day.

With the continuation of the general uplift that included the formation of the Mount Lofty Ranges, the limestones of the Murray plains commenced slowly to come into the picture; but there were as yet no limestone beds sufficiently

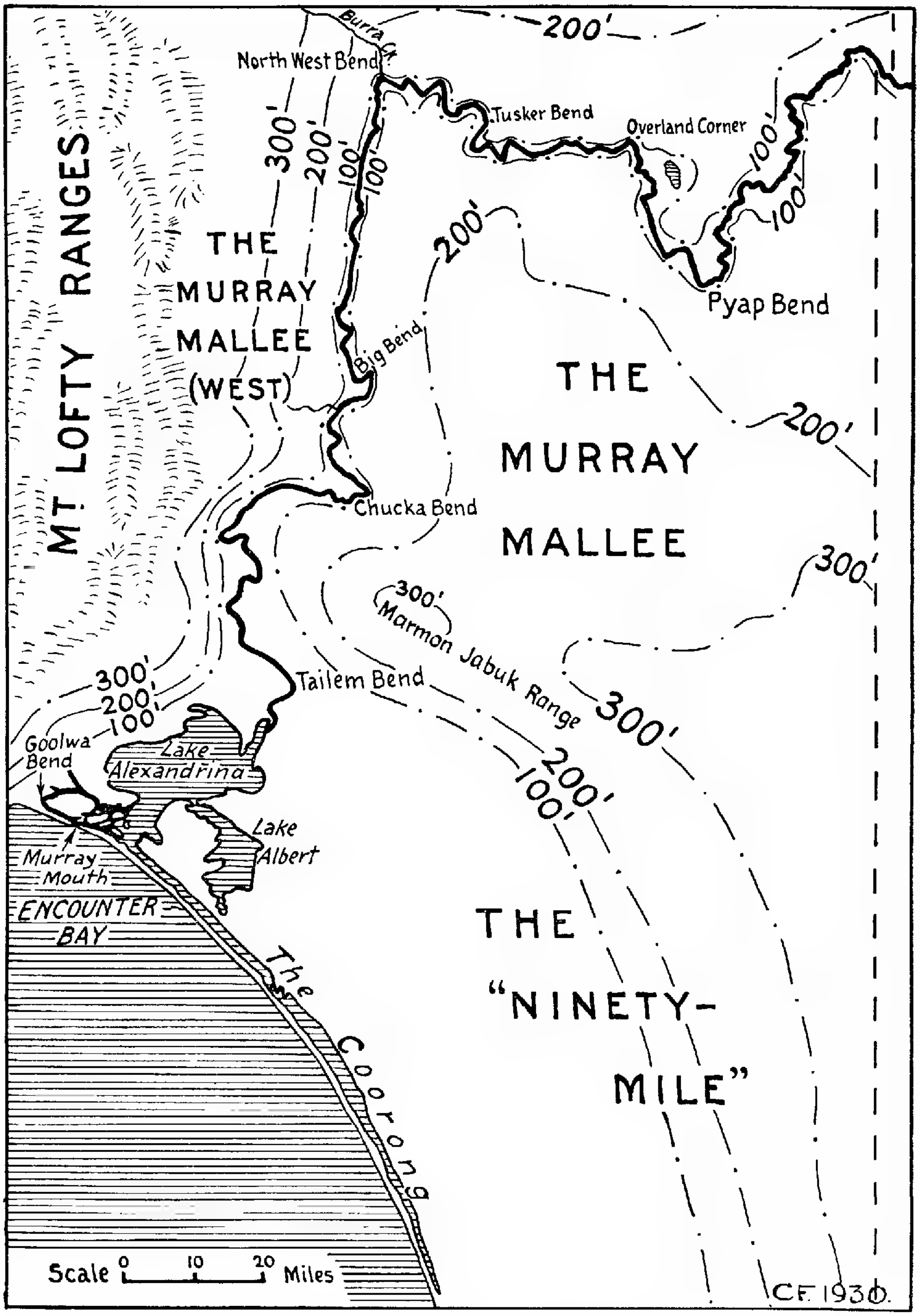

Fig. 11.
Plan of the Lower Murray River, showing the course of the stream, the lakes, and the Coorong; also the more significant (approximate) contours of the adjoining country.

uplifted to enable a gorge to be cut into them. The uplifting of the Murray River limestones appears to have been remarkably uniform, and one may travel along the river cliffs for miles and miles without noting any appreciable deviation from the horizontality of the beds. Nevertheless, careful observation shows that there were certain irregularities in the movements of uplift, the evidence and the effects of which are distinctly to be seen today:—

(i.) The uplift was greater near the Mount Lofty Ranges to the west, and the beds underlying the Murray Mallee were warped gently downwards towards the north and the east.

(ii.) There was a general emergence of the whole limestone area, and of its covering burden of fluviatile and lacustrine sediments.

(iii.) Parallel to the eastern Mount Lofty Faults, there occurred some faults or warps in the Tertiaries themselves; there is good evidence that one of these runs almost N.-S., east of Sedan, 100 feet high, still visible as a gentle scarp. Another parallel warp downwards to the east is believed to have marked the present course of the Murray between Morgan and Chucka Bend. As may be seen at the North-west Bend, this warp involved a 5° dip due east in the otherwise horizontally-bedded limestones.

(iv.) There was a third more gentle easterly dip at Overland Corner, a feature of very high importance, and with excellent field evidence.

(v.) At the same time a fold or upwarp took place parallel with the present coastline, north-west—south-east; this may be seen as a scarp at Struan and Naracoorte (see fig. 5, F2), and it continues north-west into what is known as the Marmon Jabuk Range and onwards (see contour lines in fig. 11). Because of this upward fold the Miocene Tertiaries, etc., already given a gentle plunge to the east, were also given a gradual dip to the northward.

While these changes were taking place, the waters of the great contributing rivers of New South Wales and Victoria had combined to form the Lower Murray. With uplift, this stream commenced to cut into its own alluvial beds, and in the more uplifted areas (to the west and south) completely destroyed them.

East of the Overland Corner dip, the soft alluvial overmass has not yet been stripped away, and still protects the buried limestones. But the river in these softer rocks is enabled to swing and sweep in an almost unrestricted way, and we thus get, above Overland Corner the wide valleys and fertile slopes that are of such great economic importance to the State in the Cobdogla, Berri, and Renmark areas.

During the process of side-swinging in the incoherent fluviatile beds, the river has moved both south and north. On the north there is no limiting factor, but on the south, near Loxton, and between Loxton and Overland Corner, the down-cutting river met with the more resistant, gently-plunging, submerged Tertiary limestones, and thus was deflected northward from the Great Pyap Bend, and directed north-west to the place where the river had become entrenched in the limestones at Overland Corner. Possibly the farthest upstream point where the underlying marine limestones are seen is at very low levels at Kaesler's Cliffs, below the old Bookpurnong Woolshed landing, where J. F. Stasinowsky, of Loxton, collected a whale's scapula, large molluscan casts, etc.

In the gorge that is wholly limestone, from Overland Corner downstream, swinging and sweeping are more difficult, but the work is carried steadily on, and the remarkably even parallelism of the sides of the gorge testifies to the general evenness of the erosive work done here. The minor tilt or warp that ran through Morgan, which was possibly reflected in the one-time overlying lacustrine and fluviatile beds, would be sufficient to deflect the river and to send it on that otherwise inexplicably sudden turn to the southward. Thus we have an explanation for the sharp change of direction of the river at North-west Bend, whence the precipitous mile-wide gorge runs almost due south for about 50 miles, keeping parallel to the tectonic lines of the Mount Lofty horst, and (it is suggested) following the line of a surface feature due to a structural break in the Miocene limestones and later sediments of the area.

Apart from a minor deflection at Big Bend, where barely hidden Cambrian rocks may have influenced the course of the stream, there is no important change of direction until the river meets the upwarped (or upwarping) ridge that is in part indicated by the Marmon Jabuk Range. This would perhaps account for the wide swing westerly from Chucka Bend (see fig. 11) that carries the river round to Tailem Bend, where it again follows the normal fall of the country towards the sea.

CONTRIBUTIONS TO THE ORCHIDOLOGY OF PAPUA AND AUSTRALIA.

By R. S. Rogers, M.A., M.D., F.L.S.

[Read May 8, 1930.]

Mediocalcar (§ Brevicalcar) papuanum, Rogers, n. sp. Rhizoma teres, repens, elongatum, radicans, vaginis fibrosis tubulosis obtectum, radicibus elongatis filiformibus breve pilosis subrectis. Pseudobulbi minuti, teretes, ad 2 mm. lati, brevissimi, cum rhizomate arte adnati, unifoliati, parte libera discoidea. Folia coriacea, glabra, elliptico-lanceolata vel oblongo-lanceolata, apice obtusa, leviter bilobulata cum mucrone minuto interposito, basi in petiolum brevem contracta, carinata, multistriata, circiter 5-6 cm. longa, 0·7-1·7 cm. lata. Inflorescentiae uniflorae (semper?), circa 4·5 cm. longae, pedunculo bracteis magnis amplis acutis foliaceis imbricatis obsesso. Bractea floralis adpressa, minuta, acuta, pedicellum amplectens. Flores in genere majusculi, basi extrinsecus coccinei, labello luteo. Ovarium cum pedicello gracillimum, circa 1·1 cm. longum. Sepala usque ad tertiam partem apicalem in tubum urceolatum antice leviter ventricosum connata, subacuta, circiter 1 cm. longa, latiuscula, 5-nervia. Petala libera, sepalis aequilonga sed multo angustiora, erecta, linearia, 3-nervia, subacuta. Labellum ad columnam suberectum, circa 9 mm. longum, unguiculatum, pedi columnae adnatum, unge basi utrinque alato, supra medium in laminam late ovalem saccatam dilatatum, infra medium 5-nervia, apice acuminatum. Calcar rotundatum, brevissimum. Columna labello brevior, in pedem perbrevem producta, versus apicem alata. Anthera cucullata. Pollinia 8.

Plant epiphytic. Rhizome terete, creeping, elongated, radicant, covered with fibrous tubular sheaths; roots elongated, filiform, almost straight, shortly pilose. Pseudobulbs minute, terete, up to 2 mm. in diameter, very short, firmly adnate lengthwise with the rhizome, unifoliate, the free part disc-like. Leaves leathery, glabrous, elliptical-lanceolate or oblong-lanceolate, obtuse at the apex, slightly bilobulate with a minute mucrone interposed between the lobules, contracted at the base into a short petiole, carinate, multistriate, about 5-6 cm. long, 0·7-1·7 cm. wide. Inflorescences single flowered in my specimen, about 4·5 cm. long, the peduncle completely covered with large voluminous acute foliaceous imbricate bracts increasing in size from below upwards. Floral bract adpressed, minute, acute, clasping the base of the pedicel. Flowers rather large for the genus, red on the outside at the base with a yellow labellum. Combined ovary and pedicel very slender, about 1·1 cm. long. Sepals connate in the lower two-thirds forming an urn-like tube slightly ventricose at the base in front, subacute at the apices, about 1 cm. long, rather wide, 5-nerved. Petals free, as long but much narrower than the sepals, erect, linear, 3-nerved, subacute. Labellum about 9 mm. long, adnate to the foot of the column by a rather wide claw, claw auriculate at each side of the base, suberect, thereafter somewhat oblong 5-nerved, dilated above the middle into a deeply concave widely oval saccate lamina, acuminate at the apex. Spur very short for the genus, rotund, sac-like. Column shorter than the labellum, produced into a very short foot, winged on each side of the stigma near the apex. Anther cucullate, bilocular; pollinia 8, two super-imposed pairs on each side.

Papua. Owen Stanley Range on Nomi-Ake Divide, Salawakel at 7,000 feet. C. E. Lane-Poole, No. 526, November 23, 1923.

Of the 39 species of this remarkable genus published up to the present, only one (*M. Lawesii*, Schltr.) has been reported from Papua. The most westerly representative is found in Amboina, and another has recently been described by J. J. Smith from the neighbouring island of Serang (Moluccas). The most easterly species is *M. paradoxum*, Schltr., from Samoa, and the most northerly is *M. ponapense*, Schltr., from the Caroline Islands. All other known species are indigenous to New Guinea.

The flowers of the new species appear to be closely related to those of *M. monticola*, Schltr., but the plant differs very materially in the number and shape of the leaves, and in the characters of the pseudobulbs, as well as in certain floral details.

Spathoglottis alpina, Rogers, n. sp. Terrestris, erecta, subvalida, usque ad 60 cm. alta. Pseudobulbi ovoidei, circa 2 cm. longi, 1·25 cm. dia metro, vaginis fibrosis omnino absconditi, circa 3-foliati. Radices elongatae, flexuosae, fibrosae. Folia erecta, anguste elliptico-lanceolata, acuminata, glabra, costata, basi sensim in petiolum costatum angustata, usque ad 60 cm. longa, medio circa 1·1-1·6 cm. lata. Inflorescentiae circa 2, racemosae, erectae, foliis multo breviores, puberulae, pluriflorae. Flores purpurei, extus velutini, majusculi, circa 3·6 cm. diametro. Segmenta perianthii patentia. Sepalum dorsale ellipticum, obtusiusculum, 7-nervium, circa 1·8 cm. longum, 0·6 cm. latum. Sepala lateralia subacuta, 7-nervia, circa 1·8 cm. longa, 0·55 cm. lata. Petala ovalia, subobtusa, 9-nervia, sepalis tenuiora, circa 1·7 cm. longa, 0·8 cm. lata. Labellum sessile, alte trilobatum, explanatum circa 1·25 cm. longum, inter apices loborum lateralium circa 1·4-1·6 cm. latum; lobus intermedius flabelliformis, marginibus integris, 7-nervius, basin versus sensim contractus, circa 1·0 cm. longus, infra apicem 4-5 mm. latus, imo basi 1·0 mm. latus, apice inapiculato rotundato admodum obtuso, basi inter lobos laterales callo bilobato carnoso conspicuo molliter verrucoso ornatus, circum basin calli sparsim hirsutus; lobi laterales anguste oblongo-falcati, obtusiusculi, intermedio lobo, late divaricata, multo breviores, circa 8-9 mm. longi, 2 mm. lati. Columna glabra, erecta, gracilis, leviter incurvata, circa 1·2 cm. longa, apicem versus anguste alata, pede fere obsoleto, basi callis duobus pyramidalibus carnosis instructa. Ovarium cum pedicello gracile, teres superne sensim dilatatum, puberulum, usque ad 4 cm. longum.

Plant erect, rather vigorous, attaining the height of 60 cm. Pseudobulbs ovoid, about 2 cm. long, 1·25 cm. in diameter, entirely hidden beneath fibrous sheaths, 3-leaved. Leaves erect, narrowly elliptical-lanceolate, acuminate, longitudinally ribbed, gradually narrowing at the base into a long-ribbed petiole, attaining the length of 60 cm. Inflorescences racemose, about 2, erect, much shorter than the leaves, puberulous, several-flowered. Flowers purple, velvety on the outside, rather large, about 3·6 cm. in diameter. Perianth segments spreading. Dorsal sepal elliptical, rather obtuse, 7-nerved, about 1·8 cm. long, 0·6 cm. wide. Lateral sepals subacute, 7-nerved, about 1·8 cm. long, 0·55 cm. wide. Petals oval, rather obtuse, 9-nerved, of thinner texture than the sepals, about 1·7 cm. long, 0·8 cm. wide. Labellum sessile, deeply three-lobed, when spread out about 1·25 cm. long, between the apices of the lateral lobes about 1·4-1·6 cm. wide; intermediate lobe flabelliform, margins entire, 7-nerved, gradually contracted towards the base, about 1·0 cm. long from its junction with the side lobes, 4-5 mm. wide just below the apex, 1·0 mm. wide at the very base, the apex rounded, quite blunt inapiculate, provided at the base almost between the lateral lobes with a bilobed fleshy conspicuous softly warty dark callus with a few sparse hairs around the base of the callus; lateral lobes narrowly oblong-falcate, rather obtuse, widely divaricate, much shorter than the middle lobe, about 8-9 mm. long, 2 mm. wide. Column glabrous, erect, slender, slightly incurved, about 1·2 cm. long, narrowly winged towards the apex, foot rudimentary, provided with two glabrous pryamidal fleshy calli at the attachment to the labellum. Ovary with pedicel slender, terete, gradually widening into a narrow ovary above, puberulous, 3-4 cm. long.

Papua. Nomi River, on the edge of a limestone precipice, altitude 7,000 feet, C. E. Lane-Poole, No. 529, November 23, 1923.

The genus *Spathoglottis* is richly represented in the Island of New Guinea, which may be regarded as its centre of dispersion, but only a few forms have hitherto been reported from British Papua, *viz.*:—*S. stenophylla*, Ridl., *S. papuana*, Bailey, and its var. *pubeiflora*, Rogers and White, and *S. Lane-Poolei*, Rogers.

Schlechter, who has paid special attention to the genus under natural conditions, states that the species diminish markedly in number as we ascend the mountains. The new species is apparently rather closely related to *S. parviflora*, Kränzl., another alpine form, but differs from it in the shape of the intermediate lobe of the labellum and also in other floral details.

Phreatia (§ Bulbosae) robusta, Rogers, n. sp. Pro genere robustissima, ad 33 cm. alta; basi foliorum senilium basibus persistentibus obsessa. Pseudobulbi circa 2 cm. lati. Folia aliquot, equitantia, glabra, erecta vel subpatentia, linearia, ad 33 cm. longa, circa 2·5 cm. lata, superne subconduplicativa, apicibus obtusiuscula subinaequaliter bilobulata; costa media carinata, utrimque nervis minoribus pluribus. Inflorescentiae glabrae, folia aequantes vel excedentes, laxe multiflorae, semper (?) nutantes. Bracteae subulato-acuminatae, circa 4-6 mm. longae. Flores minimi, numerosissimi, in racemo elongato. Ovarium circa 2 mm. longum, clavatum in pedicello tenuiore circa 2·5 mm. longo. Perianthii segmenta eleganter reticulata, 1-nervia, plus minusve erecta. Sepalum dorsale erectum, late ovatum, concavum, subacutum, sepalis lateralibus angustius, circa 1·2 mm. longum, 0·75 mm. latum. Sepala lateralia libera, erecta, oblique ovata, circa 1·2 mm. longa, circa 1·0 mm. lata, subacuta, cum pede gynostemii mentum brevissimum rotundatum formantia. Petala erecta, elliptica vel ovalia, sepalis minora, circa 1·0 mm. longa, circa 0·6 mm. lata. Labellum sublate unguiculatum, cum pede gynostemii tenaciter articulatum, integrum, cuneato-lunatum, apice minute papillosum leviter recurvum, 3-nervium, basi concavum minute bicallosum, latera columnae amplectens. Columna brevissima, dorso convexa, basi in pedem latum producta, clinandrio alte excavato. Anthera operculata, incumbens, dente conspicuo in margine posteriore clinandrii mobile affixa. Pollinia 8, pyriformia, apicibus materia viscida cohaerentia. Rostellum erectum, antheram aequans, bipartitum, laciniis chelatis; discus non viditus. Stigma transverse ovale.

Plant very robust for the genus, my specimen 33 cm. high, with a thickened pseudobulb about 2·0 cm. wide, and covered at the base with the persistent bases of old leaves. Leaves several, equitant, glabrous, rather thick, linear, erect or somewhat spreading, the lamina subconduplicate, traversed by a prominent midrib with several minor nerves on each side, apex rather blunt and unequally bilobed, up to 33 cm. long, 2·5 cm. wide. Inflorescences glabrous, equal or sometimes exceeding the leaves in length, loosely multiflowered, always (?) nodding. Bracts subulate-acuminate, about 4-6 mm. long. Flowers minute, very numerous, in an elongated cylindrical raceme, pedicellate. Ovary about 2 mm. long, clavate on a delicate pedicel about 2·5 mm. long. Segments of perianth delicately reticulate, 1-nerved, more or less erect. Dorsal sepal erect, widely ovate, concave, subacute, narrower than the lateral sepals, about 1·2 mm. long, 0·75 mm. wide. Lateral sepals free, erect or suberect, obliquely ovate, about 1·2 mm. long, 1·0 mm. wide, subacute, decurrent on the foot of the column so as to form with the latter a very short rounded mentum. Petals erect, elliptical or oval, smaller than the sepals, about 1·0 mm. long, 0·6 mm. wide. Labellum rather widely clawed, firmly attached to the foot of the column, entire, cuneate-lunate, 3-nerved, the wide crescentic apex minutely papillose and slightly recurved, clasping the sides of the column, concave at the base, with a minute rounded callus at the proximal end of each outer nerve on the disc. Column very short, stout, semiterete, produced at the base into a rather wide foot. Clinandrium deeply excavated. Anther operculate, incumbent, movably attached by a filament to a rather conspicuous tooth on the posterior border of the clinandrium. Pollinia 8, pyriform, their apices attached by transparent glutinous strands apparently to the rostellum. Rostellum erect, equal to the anther in height, bipartite, the two divisions chelate; disc not seen. Stigma transversely oval.

Queensland. Near Cairns, collected by A. Beck. Flowered Botanic Gardens, Brisbane, January, 1930. Forwarded by C. T. White, Government Botanist.

Owing to the intensive study and publications of certain botanists, particularly Dr. Schlechter, Dr. J. J. Smith and Mr. H. N. Ridley, the genus *Phreatia*, Lindl., has suddenly increased during quite recent years from a very few to approximately 225 species. It is widely distributed from India, across the Malay Archipelago, Papuasia, Moluccas, Celebes, Philippines, Formosa, Australia, New Caledonia, New Hebrides, Fiji and other Pacific Islands. New Guinea alone claims not less than 119 species, and this must be regarded as its probable centre of dissemination. It is, however, but poorly represented in Australia. Up to the present only two species have been recorded on our census, *viz.*: *Phreatia limenophylax* (Endl.), Bentham, and *P. Baileyana*, Schltr. [= *P. pusilla* (Bail.)], Rolfe. Both of these, like the majority of species belonging to this genus, are extremely dwarfed plants. The former was originally discovered by Ferdinand Bauer on Norfolk Island, and was carefully illustrated by him in a plate now in possession of the Vienna Herbarium. It was described by Endlicher under the name of *Plexaure limenophylax*. Subsequently, when writing the sixth volume of the Flora Australiensis, Bentham became the innocent victim of a discreditable deception by H. G. Reichenbach, which led him to publish his belief, that the mainland plant, found by Dallachy at Rockingham Bay, Queensland, was identical with Bauer's plant from Norfolk Island. This belief was founded upon error, an error which was accepted and followed by Pfitzer and many eminent botanists until the true facts of the case were published by F. Kränzlin in 1911 in his prefatory remarks to the "Dendrobiinae," part II., page 12, and again in his monograph on the genus *Phreatia* in the same work, pp. 20 and 21, where he also publishes Bauer's original illustrations.

In describing the Rockingham Bay plant, Bentham states that he had not seen the pollen-masses as the flowers were too advanced. He makes no further reference to the column. Kränzlin is of opinion that this plant was an *Oberonia*. I have had the opportunity to examine "the best" of Dallachy's specimens in the Melbourne Herbarium. It was collected in 1870, and was in a state of bad preservation. In the most promising of the three flowers still attached, the upper portion of the column and, of course, the pollinarium, were absent. There was no indication of a column-foot or of a mentum. This lends colour to Kränzlin's suggestion that the plant was not a *Phreatia* but a species of *Oberonia*, a conclusion which he reached for other reasons. Taking all the circumstances into consideration, it is at least a very doubtful member of the genus to which it has been ascribed and should be deleted from our census. Fresh material from Rockingham Bay may yet place the matter on a scientific basis.

The new species does not appear to bear any very close relationship to other members of the genus. Its very wide leaves and large size and small flowers readily exclude the vast majority. A few species are comparable in size, but all of these appear to differ considerably in habit or floral details.

Calochilus saprophyticus, Rogers, n. sp. Herba saprophytica, pallida, robustiuscula, circa 20-25 cm. alta. Rhizoma in tubero magno incrassato illi *Gastrodiae* simile. Caulis luteus, erectus, a basi vaginis duobus membranaceis imbricatis. Bracteae 2, luteo-carneae, subulatae, circa 7 cm. longae. Folium imperfectum, carneum, basi robustiusculum, canaliculatum, in speciem lanceolatum. Racemus 3-10-florus, bractea lutea subulata circa 4 cm. longa subtentus. Flores pallidocrocei labello subflavo-purpureo, majusculi, pedicellati. Sepalum dorsale erectum vel incurvum, late lanceolatum, circa 1·4 cm. longum, in medio 4 mm. latum, subacutum, cucullatum, 5-nervium; sepala lateralia patentia, falco-lanceolata, circa 1·4 cm. longa, sepalo dorsali angustiora. Petala erecta, pallido-crocea cum nervis pluribus badiis longitudinalibus, acuta, falco-lanceolata, circa 9 mm. longa, basibus circa 3·5 mm. lata. Labellum sessile, subrhombiforme, apice brevissime ligulatum, circa 1·3 cm. longum (sine ligula), basi glabrum cum lamellis duobus elevatis cyaneis metallicis parallelis anticis saepe furcatis, disco marginibusque longe barbatum. Columna brevis, latiuscule alata, carnosa, basi biglandulosa. Anthera incumbens, subobtusa, longiuscula. Stigma subtriangulare, viscidissimum.

A pale saprophytic plant, rather robust, about 20-25 cm. high, with a large thickened tuberous rhizome similar to that of *Gastrodia*. Stem yellow with two membranous imbricate sheaths at the base. Bracts 2, yellowish-pink, subulate, about 7 cm. long. Leaf incomplete in my specimens, rather fleshy and stout in its lower part, channelled, apparently lanceolate. Raceme 3-10-flowered, subtended by a yellow subulate bract about 4 cm. long. Flowers stalked, rather large, pale saffron-coloured with exception of the reddish-brown striped petals and the yellowish-purple labellum. Dorsal sepal erect or incurved, widely lanceolate, about 1·4 cm. long, 4 mm. wide in the middle, subacute, cucullate, 5-nerved; lateral sepals spreading, falco-lanceolate, about as long as but narrower than the dorsal sepal. Petals erect, a pale saffron traversed by several dark brown longitudinal stripes, falco-lanceolate, about 9 mm. long, about 3·5 mm. wide at the base. Labellum spreading, sessile on an oblong base, somewhat rhomb-shaped, very shortly ligulate at the apex, about 1·3 cm. long (without the ligule, latter 2-4 mm. long), glabrous at the base, with two (sometimes more) raised deep blue metallic parallel plates often bifurcated in front and produced into long hairs, the lamina and its margins covered and fringed with purplish hairs. Column short, widely winged, a purple gland at the base of each wing, convex at the back, fleshy. Anther rather long, incumbent, subobtuse, greenish-yellow. Stigma triangular, just below the anther; no caudicle present.

Victoria. Cravensville, A. B. Braine and F. J. Supple, October 21, 1918, and November 7, 1920. Mr. Braine states that it was growing in an almost shadeless place.

The very characteristic habit of this species readily separates it from its congeners. In structure, the flowers approach rather closely to those of *C. campestris*, R. Br., but they differ not only in colour, but also in the shape of the petals, which are much narrower and very much more acute; likewise in the extremely short ligule as well as other details of the labellum.

Including the new species, the genus now comprises a small, well-defined group of nine members. Eight of these are confined to the Commonwealth and New Zealand, and one is indigenous to New Caledonia.

Thelymitra Sargentii, Rogers, n. sp. Gracilis, glabra, ad 45 cm. alta, basi caulis vagina membranacea cylindrica laxa circa 5-6 cm. longa. Folium lanceolatum, acuminatum, basi vaginans, ultra medium scapi attingens. Bracteae caulinae 2 vel 3, subulatae vel acuminatae, basibus vaginantes. Racemus laxe multiflorus, circa 9-14 cm. longus. Flores 10-14 majusculi pro genere, lutei cum punctis badiis, illis *T. fuscoluteae* similes. Ovarium subconicum, circa 1·0 cm.

longum, graciliter pedicellatum; pedicellus circa 1·3 cm. longus. Segmenta perianthii elliptica, subacuta, patentia vel subpatentia, circa 1·6 cm. longa, circa 0·5 cm. lata. Columna elongata, erecta, apice incurva, circa 8 mm. longa, lutea, punctata, latiuscule alata, supra antheram alte producta, apice trilobata; lobus medius incurvus, dorso nudus, alte emarginatus, margine ceteroquin integro; lobi laterales dense papillosa-barbati, adscendentes, lobum intermedium excedentes. Anthera mucronata, vix medium columnae superans. Stigma scutiforme vix ad medium antherae attingens.

A glabrous slender plant, reaching a height of 45 cm., a loose cylindrical membranous sheath at the base of the stem about 5-6 cm. long. Leaf lanceolate, acuminate, sheathing at the base, reaching beyond the middle of the scape. Cauline bracts 2 or 3, subulate or acuminate, vaginate at the base. Raceme loosely multiflowered, about 9-14 cm. long. Flowers 10-14, rather large for the genus, yellow with brown dots, resembling those of *T. fuscolutea*. Ovary subconical, about 1·0 cm. long, on a slender pedicel about 1·3 cm. long. Perianth segments elliptical, subacute, spreading or suberect, about 1·6 cm. long, 0·5 cm. wide. Column elongated, erect, incurved at the apex, about 8 mm. long, yellow, spotted, rather widely winged, produced high above the anther, 3-lobed at the apex; middle lobe incurved, not crested on the back, deeply emarginate, the border otherwise entire; lateral lobes ascending, densely papillose-bearded, higher than the central lobe. Anther with a recurved mucrone, scarcely higher than the middle of the column. Stigma shield-like, hardly reaching the level of the middle of the anther.

Western Australia. Bruce Rock, O. H. Sargent, October, 1929; Bencubbin, R. E. Edmonsen, October, 1929; Dalwalinu, Colonel Goadby, October, 1929.

The new species is closely related to *T. villosa*, Lindl., and *T. tigrina*, R. Br., The former is easily distinguished by its very *broad villous leaf,* horizontal lateral lobes and crested middle lobe of the hood. The latter is a much smaller and more slender plant with a *narrow linear leaf,* and flowers about half the diameter of *T. Sargentii.* The middle lobe of the hood is 3-partite and crested. More remote relatives are *T. fusco-lutea,* R. Br., and *T. stellata,* Lindl. Both these species may be readily recognised by the deeply dissected margins of the column-hood with its curious clavate dorsal appendage and the characteristic elongated recurved terete apex of the anther. The former species has also a very broad glabrous leaf. The colour of the flowers, and the fact that the lateral lobes of the column are not tufted with long cilia, removes our plant from other members of the section *Cucullaria* where the prevailing colour is mauve or purple.

Thelymitra D'Altonii, Rogers, n. sp. Gracilis, circa 15 22 cm. alta. Folium glabrum, canaliculatum, longitudine costata, subacuta, basi scapi vaginans; lamina linearis, spiralis, inferne late dilatata. Caulis gracilis, glaber, erectus; leviter infra medium bractea amplectens, subulata circa 2·5 cm. longa. Flos solitarius in meis speciminibus, cyaneus; ovarium subviride, obconicum, subgracile, circa 8 mm. longum. Sepala luteo-viridia, cum lineis cyaneis conspicuis latiuscule virgata, ovato-elliptica vel ovato-lanceolata, subacuta, concava, circa 1·0-1·1 cm. longa, 4·5-5·0 mm. lata. Petala sepalis breviora et tenuiora, cyanea, lineis atro cyaneis late virgata. Columna caerulea, circa 6 mm. longa; lobi laterales late elliptici vel orbiculares, lutei, plano-convexi, breve stipitati, post antheram erecti, circa 1·0-1·5 longi; lobus intermedius multo brevior vel obsoletus. Anthera crocea, incumbens, conspicuissima, oblonga vel oblongo-cuneata, apice truncata vel obtusissima, bilocularis. Stigma prominentissimum sub anthera, orbiculare vel transverse ovale, subpedicellatum, discoideum, concavum.

Victoria. Hall's Gap, Grampians, C. W. D'Alton, October, 1922; Mr. A. B. Braine and Miss May Braine, September 26, 1929.

Plant slender, 15-22 cm. high. Leaf glabrous, channelled, longitudinally ribbed, subacute, sheathing at the base of the scape; lamina linear, spiral, widely dilated below. Stem slender, quite glabrous, erect, a subulate clasping bract about 2·5 cm. long slightly below the middle. Flower solitary, expanding in sunlight, subtended by a short subacute sheathing bract (about 0·75 cm. long) just below the ovary. Ovary greenish obconical, rather slender, about 8 mm. long. Segments of perianth not dotted or variegated, the labellar segment narrower than the rest. Sepals lighter coloured than the petals, yellowish-green with about 7-9 conspicuous rather wide dark-blue longitudinal stripes, ovate-elliptical or elliptical-lanceolate, subacute, concave, about 1·0-1·1 cm. long, 4·5-5·0 mm. wide. Petals shorter and of thinner texture than the sepals, deep blue traversed by darker longitudinal stripes. Column rather stout, entirely blue, about 6 mm. high to apex of anther; lateral lobes of hood bright yellow, broadly elliptical or orbicular in outline, plano-convex, shortly stipitate, erect behind the anther, about 1·0-1·5 cm. long; middle lobe much shorter or obsolete, without any dorsal crest. Anther bright yellow, incumbent, very conspicuous, oblong or oblong-cuneate, truncate or very obtuse at the apex, bilocular. Stigma very prominent, situated just below the anther, large, orbicular or transversely oval, almost pedicellate, concave, disc-like.

After very careful consideration, it has been thought necessary to describe this dainty little plant separately. It is evidently a near relation of *T. spiralis*, Lindl., and *T. variegata*, Lindl., two ill-defined and possibly composite Western Australian forms, and may ultimately be regarded as a variety of one of them. In the present state of our knowledge, however, it is impossible to say which, as one or other of the plants known under the above names may in the near future require further subdivision.

In his Swan River Appendix to vol. xxii. of the Botanical Register, 1839, p. 50, Lindley published two new species of *Thelymitra (Macdonaldia)*, which he named *T. variegata* and *T. spiralis*. These short descriptions lack details of diagnostic importance, but for convenience I quote them here:—

1. *T. "variegata;* floribus purpureis, sepalis petalisque linearibus acuminatis, cuculli laciniis lateralibus lanceolatis subcarinatis intermedia obsoleta, anthera carnosa obtusa elongata loculis brevibus semicircularibus membranaceis."
2. *T. "spiralis;* folio radicali spirali caulino solitario ovato, caule unifloro, floribus purpureis, cuculli laciniis lateralibus carnosis dolabriformibus intermedia obsoleta, anthera obtusa apice papillosa."

It will be noted in these descriptions that the leaf is undescribed in *T. variegata*, but stated to be spiral in the other; the flowers are purple in both; the intermediate lobe of the hood is absent or rudimentary in both, and there is no reference to the presence of a crest in either; the lateral lobes in *T. variegata* are lanceolate and subcarinate, in *T. spiralis* they are fleshy and hatchet-shaped. The name *variegata* implies a character (presumably in the flowers) which receives no reference in either description.

Bentham retained only the former species, describing the leaf as much dilated at the base with a lamina linear and often undulate; the flower dark-coloured and variegated; lateral lobes of column nearly 4 mm. long, obtusely oblong, connected behind the anther by a *crest*. He does not regard the spiral leaf as a constant or specific character. Presumably Bentham had access to Lindley's types, but it is not known whether these were in a good state of preservation or to what extent they were supplemented by other material. R. D. Fitzgerald, who illustrated on the spot plants which he believed to belong here, shows the lateral appendages as falco-elliptical or falco-oblong. It is by no means easy to reconcile these varying descriptions. In my own material from Western Australia, the flowers are sometimes punctate or variegated, sometimes not; the lateral appendages vary considerably from oblong to elliptical, but are always more or less elongated, in one specimen reaching the length of 5 mm. It is difficult to avoid the conclusion that Bentham and other authors have included more than one species under the same name. The matter can only be cleared up by a plentiful supply of material, which it is hoped will be forthcoming next season.

Mr. D'Alton, who has worked so energetically in the elucidation of the flora of the Grampians, sent me a specimen of the new orchid eight years ago, but owing to the hot weather and long journey it did not arrive in a condition suitable for critical examination. I am indebted for my present supply of satisfactory material to Mr. and Miss Braine. In his letter Mr. Braine states that they collected 17 specimens, in all of which the flower was solitary. The contrasting colours in the flower are most delightful, and in this respect no other member of the genus known to me rivals it in beauty.

Prasophyllum Hartii, Rogers, Tr. Roy. Soc., S.A., li. (1927), p. 8. Var. **parviflorum,** Rogers, nov. var. Differt a forma typica floribus minoribus globosioribusque; petalis lineari-falcatis, incurvatis, sepalo dorsali brevioribusque; parte apicali labelli acutius flexa.

Victoria. Singapore in Wilson's Promontory, Miss E. Devonshire, November 9, 1928; Port Albert, A. J. Tadgell, November 21, 1928.

This very distinct variety is readily recognised from the typical plant, by its more slender form; by its much smaller and more globular flowers, its differently-shaped petals which are also incurved and shorter than the dorsal sepal; likewise by the more acutely flexed apical portion of the lip. Except that it possesses the extremely characteristic labellum of *P. Hartii*, it might very reasonably be regarded as a distinct species.

Microtis magnadenia, Rogers, n. sp. Subgracilis, elata, ad 45 cm. alta. Folium basi vaginans; lamina elongata, ad basin inflorescentiae attingens. Inflorescentia circa 13 cm. longa, laxe multiflora. Flores pro genere magni, virides, subdissiti, satis pedicellati, suberecti. Sepalum dorsale erectum, latum, concavum, semiglobosiusculum, minute apiculatum, circa 3 mm. longum, 2·75 mm. latum. Sepala lateralia late lanceolata, libera, circa 3 mm. longa, divergentia, horizontale patentia sub labello. Petala erecta, late linearia, fastigata, subtruncata, sepalis paulo breviora. Labellum sessile, in ambitu oblonga, apice retusum, marginibus lateralibus crenulatis, plus minusve horizontale patens, circa 3 mm. longum, circa 1·75 mm. latum; apicem versus callo magno conspicue elevato pallido subviride subconico, basi duobus callis magnis confluentibus conspicue elevatis atroviridibus. Columna teres, longiuscula; anthera semiglobosa, minute apiculata, auriculis comparate grandibus. Viscidium lucidum prominens.

A tall, somewhat slender plant, sometimes 45 cm. high. The sheathing portion of the leaf unusually low down on the stem, the lamina elongated and reaching to the base of the inflorescence. The inflorescence about 13 cm. in length, loosely multiflowered. Flowers green, rather distant, large for the genus, with moderately long slender pedicels, suberect. Dorsal sepal erect, rather wide, nearly hemispherical, very concave, minutely apiculate, about 3 mm. long, 2·75 mm. wide. Lateral sepals free, rather widely lanceolate, slightly channelled on upper surface, *not recurved*, about 3 mm. long, divergent, horizontally spreading beneath the labellum. Petals oblong-linear, tapering, very blunt at apices, erect, a little shorter than the sepals and not concealed by the latter except at the base. Labellum sessile, when spread out oblong in outline, retuse at the apex, the anterior margin otherwise regular and slightly upturned at the corners so as to give a rounded appearance, lateral margins crenulate, spreading more or less horizontally, about 3 mm. long, 1·75 mm. wide; the lamina provided with a very large pale greenish *conspicuously raised* subconical callus near the apex and two very large *conspicuously raised* confluent dark green calli at the base. Column rather long for the genus, terete; anther hemispherical, minutely apiculate, auricles relatively large. The viscidium conspicuous and glistening.

New South Wales. Lake Wonboyn, near Prince's Highway. Collected by Mrs. A. S. Dwyer, November 28, 1929. Forwarded by Mrs. Ethel M. V. Eaves, Caulfield, Victoria.

This is a large *Microtis,* and in its general habit is most nearly related to *M. porrifolia,* Spreng. It differs, however, from that species in the shape of the lateral sepals and in the fact that these are neither recurved nor revolute but horizontally spreading. The calli on the labellum are also quite distinctive. They are *very large and very conspicuously elevated* above the level of the laminar surface. The anterior one is light-coloured, and the basal ones are dark green. These large glands at once attract attention, and this character has been embodied in the specific name of the plant.

Caladenia rigida, Rogers, n. sp. Terrestris, gracilis, hirsutissima, usque ad 23 cm. alta. Caulis rigidus, hirsutissimus, basi vagina membranacea cylindrica, prope medium bractea laxa subulata circa 1·5 cm. longa. Folium anguste lanceolatum, hirsutissimum, circa 6-9 cm. longum, basin scapi amplectens. Bractea floralis adpressa acuta circa 1·3 cm. longa, pedicellum amplectens. Flos solitarius, mediocris, glaber, albus, lineis porphyreis ornatus. Sepala similia sed dorsale ceteris brevius, apicibus longe clavata glandulosa pubescentia, parte inferiore dilatata, 5-nervia, in medio linea longitudinali porphyrea; sepalum dorsale erectum vel incurvatum, circa 2·2 cm. longum; sepala lateralia rigide porrecta, circa 2·7 cm. longa. Petala lanceolata, acuminata, retroflexa, 5-nervia, in medio linea longitudinali porphyrea. Labellum breve unguiculatum, in ambitu ovato-lanceolatum vel oblongo-lanceolatum, apice acutum, explanatum circa 1·2 cm. longum, inferne ad columnam erectum deinde recurvum, marginibus lateralibus in parte posteriore tenuiter pectinatis apicem versus breve denticulatis; lamina longitudinaliter concava, callis linearibus obstipis 4-seratis dimidio apicali nuda. Ovarium hirsutissimum, cylindrico-conicum, circa 9 mm. longum, pedicello gracillimo, circa 1·0 cm. longo. Columna erecto-incurvata, circa 1·1 cm. longa, in dimidio superiore latiuscule alata, basi bicallosa. Anthera bene mucronata. Stigma discoideum, concavum, sub anthera.

A slender terrestrial plant, reaching a height of 23 cm. Stem rigid, very hairy, with a membranous cylindrical sheath at the base, near the middle a loose subulate bract about 1·5 cm. long. Leaf narrowly lanceolate, very hairy, about 6-9 cm. long, clasping the base of the scape. Floral bract adpressed, acute, about 0·6-1·3 cm. long, clasping the pedicel. Flower solitary, of medium size for the genus, glabrous, white with reddish-brown longitudinal lines. Sepals similar, but the dorsal one shorter than the others, dark reddish-brown clavate glandular-pubescent at the apices, dilated below, 5-nerved, traversed in the middle by a reddish-brown longitudinal line; dorsal sepal erect or incurved, about 2·2 cm. long; lateral ones rigidly porrect, about 2·7 cm. long. Petals lanceolate, acuminate, retroflexed, 5-nerved, with a reddish-brown longitudinal line down the middle. Labellum shortly clawed, ovate-lanceolate or oblong-lanceolate in shape, acute at the apex, about 1·2 cm. long when spread out, erect against the column below, then recurved, lateral margins in the posterior part deeply and finely pectinate, shortly denticulate towards the apex; lamina longitudinally concave, the calli linear bent forwards in four rows, bare in the apical half. Ovary very hairy, cylindrical-conical, about 9 mm. long; pedicel very slender, about 1·0 cm. long.

Column erecto-incurved, about 1·1 cm. long, rather widely winged in its upper half, two yellow oval calli at the base. Anther markedly mucronate. Stigma disc-like, concave, just below the anther.

South Australia. Golden Grove, Mrs. Rogers, September 12, 1908; Macclesfield, Mrs. Rogers, September 15 1929; Hermitage, Kersbrook and other parts of Mount Lofty Ranges.

The new species, although very different in colour is, nevertheless, very closely related to *C. reticulata,* Fitzg., from which it differs structurally in the details of the labellum.

Caladenia bicolor, Rogers, n. sp. Gracilis, usque ad 21·5 cm. alta, basi vagina membranacea cylindrica. Folium hirsutum, anguste lanceolatum, circa 10 cm. longum, basin scapi amplectens. Caulis erectus, rigidiusculus, hirsutus; paulum supra medium bractea lanceolata laxa circa 1·8 cm. longa; bractea floralis angusta, acuta, amplectens, ad ovarium non attingens, circa 1·5 cm. longa. Flos solitarius, magniusculus, subflavus cum badiis virgis notationibusque. Sepalum dorsale erecto-incurvatum, circa 3·8 cm. longum, circa 3 mm. latum, dimidio inferiore dilatatum deinde in caudas teretes dense glanduloso-hirsutas contractum, in medio linea badia longitudinali; sepala lateralia similia, porrecta, circa 4·0 cm. longa. Petala lanceolata, retroflexa, circa 3·5 cm. longa, sepalis cetera similia. Labellum anguste unguiculatum, ovatum, circa 1·4 cm. longum, circa 8·5 mm. latum, apice obtusum, inferne ad columnam erectum, deinde recurvum, maginibus badiis in parte posteriore integris versus apicem breve serratis; lamina longitudinaliter concava, in dimidio posteriore lutea cum lineis conspicuis badiis divergentibus, in dimidio apicali badia nuda; callis linearibus obstipis, 6-seriatis. Columna erecta, incurva, circa 1·2 cm. longa, prope antheram late alata, basi bicallosa. Anthera obtusa, emucronata.

Western Australia. Swan River and Muresk, Mrs. W. E. Cooke, September 13, 1907.

Height up to 21·5 cm. Leaf hairy, narrow-lanceolate, sheathing at the base, about 10 cm. long. Stem hairy, a free lanceolate bract a little above the middle; the floral bract narrow, sheathing, acute, about 1·5 cm. long, not reaching the base of the ovary. Flower solitary, rather large, yellowish with deep reddish-brown stripes and markings. Dorsal sepal erect, incurved, about 3·8 cm. long, nearly 3 mm. in widest part, linear, traversed by a conspicuous reddish-brown line in its lower half, then contracted into a terete cauda covered with dense short reddish-brown glandular-tipped hairs. Lateral sepals similar but rather longer (about 4 cm. long), spreading. Petals lanceolate, retroflexed, about 3·5 cm. long, in other respects similar to the sepals. Labellum on a very slender claw, ovate, about 1·4 cm. long, 8·5 mm. wide, at first erect against the column, then recurved to an obtuse tip; margins dark reddish-brown, entire except near the apex where they are very shortly serrate; the lamina longitudinally concave, the proximal half yellow with conspicuous reddish-brown divergent stripes, the recurved apical half dark reddish-brown and bare; calli linear, with fleshy heads, golf-stick type, arranged rather indefinitely in six rows, extending to about the middle. Column erect, about 1·2 cm. long, with hatchet-shaped wings on either side of the stigma, and more narrowly below. Anther obtuse, without a mucrone.

This species rather closely approaches *C. radialis,* Rogers, but differs in its relatively shorter petals, and in the presence of two oval calli at the base of the column. Likewise the calli have more fleshy heads in the new species, are more regularly arranged, and are not densely crowded towards the centre of the lamina as is the case in *C. radialis.*

OBSERVATIONS ON THE SOUTH AUSTRALIAN SPECIES OF THE SUBGENUS, "WALLABIA."

PART II.

By Hedley Herbert Finlayson, South Australian Museum.

[Read November 14, 1929.]

Plates I to III.

Macropus (Wallabia) ruficollis typicus.

This, one of the oldest known of the kangaroos and wallabies, and one of the most widely distributed, has been the subject of more general and anatomical study than any other, except *M. giganteus*.

The name used above, although long established, was called in question by Cabrera in 1919 (1), who pointed out that Desmarest had applied it to an insular representative of the species, the mainland animal being specifically distinguished as *M. rufogriseus*. In referring to the species as represented in South Australia, Wood Jones (2) followed Cabrera.

Since, however, the two names were applied simultaneously by Desmarest, and since the King Island animal in question is doubtfully separable, even subspecifically, from that of the mainland, there is no risk of any confusion of identities.

The objections to the use of the name *ruficollis* would thus appear to be slight, and the case is one in which convenience arising out of long usage might well be given greater consideration than the formal application of a rule.

Distribution and Habits.—In the eastern coastal districts of the mainland the species[(1)] is represented throughout a tract of country nearly 1,000 miles in north and south extent—its northern limit apparently lying in the Upper Dawson Valley of Queensland at about 25° south latitude, and its southern limit in the Otway Peninsula at about 39° south.

Throughout this tract its distribution clearly follows, with few digressions, the foothills of the Great Divide and its associated ranges, and this may be regarded as its typical habitat, but a westerly excursion from the Otway Ranges has been responsible for the occupation, not only of the Grampians, but of much of the timbered plain country of Western Victoria and South-Eastern South Australia as well.

Although at the present day it is the only member of the subgenus *Wallabia* which may be said to be well established in South Australia, its status here is merely that of a western outlier of a species which is typically eastern in origin and occurrence. It is thus much less characteristic of this State than the Toolache, whose whole evolutionary history has apparently been worked out here and whose range was exceedingly circumscribed.

The tract of country occupied in South Australia by *M. ruficollis typicus* is coterminous with that of the subgenus as defined in Part I. of this paper and corresponds closely also with that of *M. greyi*. At the present time it is not found west of the River Murray, but formerly was well represented there, occupying much of the county of Sturt, where, however, it was apparently con-

(1) In South Australia it is known to the settlers as the "Brusher," commonly contracted by the present generation to "Brush." The aboriginal word in the lower South-East is "Carlo."

fined to the river flats and foothills, and its failure to occupy the Mount Lofty Range proper has already been noticed.

Not only its distributional limits, but the density of its representation correspond roughly with that formerly obtaining for *greyi*—there being a rapid falling off in numbers on passing north from the well-watered and well-grassed country of the lower South-East to the much less favourable conditions of the mallee lands. Its presence in this latter type of country is remarkable, as it constitutes an environment widely different from that of its typical habitat in the east, and in no other part of its range does it appear to invade similar country.

Although the same boundaries equally define the limits of the range of both *M. greyi* and *M. ruficollis typicus* in South Australia, the sharp division of the country into distinct habitat zones of widely different character is responsible for a very strong contrast in their local distribution and occurrence.

Whereas *M. greyi* was to be found exclusively on the most open grass country, almost devoid of timber and even undergrowth, the natural station of *ruficollis* was the heavily timbered country. This, as already pointed out, is itself of two distinct types: Red and blue gum forests growing on comparatively rich soils and free from undergrowth, and the stringy bark "ranges" which are interspersed throughout the wide sandy heaths and which, while sharing with the latter the typical heath flora of dwarf leptospermums, xanthorrheas, and casuarinas, possess in addition the bracken fern. The "ranges" are thus provided with a plentiful and frequently dense undergrowth under the timber.

Formerly, when settlement was little advanced and had caused little interference with the fauna and its distribution, it is stated to have occurred on both types of country, but much more plentifully on the former, and since these smooth-barked gum forests make a much closer approach to the general character of its habitat in the east, this would seem very probable. In some localities the term "scrub-brush" was applied to distinguish the wallaby of the ranges—these animals being generally poorer in condition, and frequently infested with lice.

To-day, owing to the destruction of much of the timber, and to the closer settlement of the country, it has disappeared altogether from the gum and grass country, but, unlike the Toolache, to which the changed conditions spelt extinction, it has fallen back on the rougher country, and, in spite of persecution, has most successfully adapted itself to the more rigorous conditions of the scrub.

The contrast in habitat of the two species extends to, and is no doubt correlated with, similar differences in many details of their habits, structure, and temperament, and the effect of abrupt changes in environment in giving direction to their more characteristic specializations is plainly apparent.

Unlike the Toolache, semi-gregarious and very local, the Brusher is a wide-ranging, almost solitary, species, with no noticeable tendency to the formation of colonies, being fairly uniformly distributed throughout all country suited to its needs. Its occupancy, to-day, is, in many places, very sparse and perhaps intermittent, but in almost any stringy bark range it is possible to find evidence of its recent presence; whilst, in the case of the Toolache, much of the black rush and tussock country, which forms its peculiar habitat, appears never to have been utilized by it.

For the greater part of the year the normal social unit is a trio, a male and female, accompanied by last season's young, but the attachment of the male to the trio is loose and intermittent, and a large proportion of the older males would appear to be always solitary.

It is true that small parties are occasionally met with on especially attractive feeding grounds, and on winter afternoons similar parties of twelve or more may sometimes be surprised basking in a clearing on the sunny side of a range, but these associations are quite temporary. When disturbed, the individual members disperse on their own initiative and in many directions without giving evidence of being dependent on a leader, as is the case when a "mob" of one of the gregarious species is put up.

In its feeding it is essentially a browser. The beautiful groves of *Banksia marginata,* which occur as occasional oases in the heaths, and which are generally free from undergrowth and lightly grassed, are attractive to it, and where crops are grown in close proximity to its cover it makes itself as unpopular to the settler as the kangaroo, but at the present day, at any rate, it seldom makes forays out into the open grass country, and, practically, the whole of its feeding is done in the ranges and on the edges of the heaths.

Here the bulk of its food is derived from the young shoots and leaves of the typical heath species enumerated above, and examination of the stomach contents of a considerable number of specimens plainly indicates that the dwarf *Xanthorrhea semiplana* is, quantitatively, the most important of these.

In general disposition it is exceedingly shy and secretive. It is rarely seen about during the daylight hours, unless driven from its camp, but lies up during the day in the densest cover, frequently in a bracken-filled hollow.

It appears to have an instinctive dread of open situations, and when feeding in such places is exceedingly alert and suspicious and far more difficult to approach than the black-faced kangaroo whose feeding grounds are similar.

Its love of dense cover may be due (in summer at least) as much to a desire for coolness and shade as to an instinctive seeking after security, since it displays a marked intolerance to heat.

In captivity it is obviously distressed by a degree of exposure to the summer sun, which has little effect on *M. greyi* or *M. giganteus.*

In summer, a period of cool and dull weather will sometimes tempt it out to feed during the afternoon, and in winter, after protracted cold and wet conditions, it will come abroad to avail itself of momentary sunshine, but ordinarily its departure from a strictly nocturnal habit involves only the hour before sunset and the hour after sunrise.

As regards reproduction, it is frequently stated by settlers and others that the "breeding season" is in the early spring, and the statement is found also in books on marsupials. The term "breeding season," however, is one of rather vague connotation as applied to marsupials, and popularly is applied indifferently to the time of union of the sexes, and to the completion of the pouch-life when the fully-developed young first begins to lead an independent life. The latter is apparently the more usually accepted definition, locally.

It is probably true that the majority of "joeys" leave the pouch permanently during the warm weather of September and October, but irregularities are so frequent and so considerable that no hard and fast rule can be laid down, but as with most macropods, young, at all stages, from the naked embryo to the fully-furred but still dependent "joey," are found in the pouch at all seasons of the year.

These irregularities arise partly from the absence of a definite pairing season, the sexes uniting, apparently, without regard to the time of the year, and partly also, no doubt, to individual differences in the length of the period of gestation, such as are well authenticated in kangaroos, but even more to individual differences in the rates at which young develop in the pouch.

When put up before dogs on the edge of a heath the speed of the Brusher is considerable for the first 100 yards, or so, but it is soon blown, and if it can be kept in the open its capture presents little difficulty to the average kangaroo dog.

Its immediate endeavour, however, when alarmed, is to make back into the cover of a range, and here, amongst the timber and in the tangle of undergrowth, its dodging and doubling are so adroit as to baffle the smartest and most persistent of dogs.

When so engaged its movements are comparatively noisy, but if it takes alarm while under cover, it is capable of making its way through the undergrowth with remarkable speed and in almost complete silence. Indeed, its "sneaking" abilities are phenomenal, and a 50-lb. buck, standing normally 4 feet high, will slip through a dense bracken thicket, not only without once exposing himself, but with scarcely a tremor of the surface greenery to mark his path. The habit of interrupting its flight momentarily to look back at the source of alarm, so common in species living in open country, is seldom to be observed in the Brusher.

If it is surprised in thick cover, however, and is uncertain of the direction of the approaching danger, its apprehensions will sometimes induce it to make a series of vertical leaps, which increase its range of vision by carrying it momentarily above the level of the undergrowth. As it lands and "takes off" from the same spot each time it betrays its position in an unmistakable way, and the habit is thus equally fatal.

As regards its position in the fauna of the State, it would appear that although greatly reduced in numbers from that formerly obtained, it is now, for the present, at least, holding its own. Although nominally protected for part of the year, it is persecuted constantly with dogs, both in season and out, partly for the "sport" involved in its killing, partly for its handsome pelt.[2]

It survives this persecution, partly by virtue of those qualities which have already been touched on in discussing its habits, but, chiefly, through the existence of great tracts of rough, unsettled country, in which it can disperse and so avoid that concentration which proved the undoing of the Toolache and Forrester.

It is exceedingly hardy and adaptive, and if there were sufficient local sentiment in its favour to insure the enforcement of existing regulations, it might continue to occupy its present status almost indefinitely. As matters stand, however, its future status is by no means assured, and the gradual increase of rural populations and the subdividing and fencing of the poorer country will undoubtedly destroy the present equilibrium and lead to its ultimate extinction.

In captivity it does remarkably well, and could be established in sanctuaries without difficulty.

External Characters.

The only previous work on the South Australian representative of *M. ruficollis typicus* is that of F. Wood Jones (2) who, however was unable to deal with external characters *de novo*, owing to lack of material, the species being at that time unrepresented in the local Museum. This lack has now been rectified, and an adequate series, both of fresh material and of skins and skulls from all parts of its range in the State, has been available for examination.

A close comparison of 15 typical South Australian examples, with material from Victoria, New South Wales, and South Queensland, has brought to light no differences so considerable or so constant as to indicate the existence here of a sub-species or definite geographical race. Hence, as the animal in the Eastern States has been the subject of frequent notice in the older literature, an extended description of its external characters along conventional lines is unnecessary.

Existing descriptions of this, as of so many other marsupials, have been influenced by the curious obsession which ascribes to the pelage an overwhelming

(2) Although probably several thousands are killed annually, very few are publicly marketed in this State. A few are sold in Melbourne, but the greater number are used locally by amateur rug-makers.

importance in description, and in reviewing and amplifying some points in these descriptions, an opportunity is taken of introducing the results of field observations and flesh measurements. These, while admittedly of little assistance in museum identifications, would seem to have some place in describing a mammal, as distinct from a skin.

In the present genus, where species are so closely related, they would appear also to afford the chief avenue of approach to an understanding of their mutual relationships and the nature and purpose of their specializations.

M. ruficollis typicus has been stated (3) to be the largest of the wallabies, but I find that the average linear dimensions of aged males, both here and in Victoria and New South Wales, are considerably exceeded by males of *parryi* and *agilis*. In weight, however, it is the equal of these two species, but falls short of that of the very massively built *ualabatus typicus*.

The disparity in the size of the sexes is marked (Table I.).

In general build it has been said to be slender and graceful, and this is true insofar as it can be applied to most wallabies, but in considering the sub-genus, as a whole, it is plain that *ruficollis* forms, in this regard, a connecting link between two natural groups—*agilis* and *ualabatus*, on the one hand—both stoutly built, thick-limbed forms, which are ordinarily given to rather deliberate movement in a habitat which is frequently swampy; and, on the other hand, *irma, greyi, parryi,* and *dorsalis*, in which the form is slim and attenuated, and the movements swift and free.

Its limbs are relatively short and stout, and this with a short neck and well-developed forequarters, give it a decidedly compact and sturdy appearance.

When seen moving in the open, its carriage appears low and its bearing careless. The head is held very low, almost on a level with the base of the tail, and the back is thus strongly arched (pl. ii., fig. 1). The tail is convex to the ground surface, though less so than in the kangaroos, and at each stride it makes a swinging movement in vertical plane. Its hops are short and relatively high, and this, with the rounded back and long curved tail, imparts a curious bobbing characteristic to its progression, totally different from the free, long stride of the Toolache.

The head (pl. i.) is large, with a deep, blunt muzzle abruptly truncated at the rhinarium and making, in this respect, some approach to the exaggerated condition present in *M. greyi*. Although its detailed characters and measurements are fairly constant, the facial expression varies greatly with age and sex. In females, the profile of the muzzle between the rhinarium and eye is markedly concave; in males, straight or even slightly convex.

The eyes are large, very dark brown and heavily fringed with lashes; but the facial vibrissae generally are but moderately developed.

The ears are thicker and more fleshy than in the other species. They are very bluntly rounded at the tip, and their margins form an even continuous curve, unbroken by any notching on either side. The inner naked portions of the conch are yellowish-pink. The ears of the female are relatively longer than in the male, and in both sexes they are shorter, in proportion to general bodily size, than in all other species, except *ualabatus typicus*.

In both sexes the arms are rather strongly developed in both segments, and the hands are large and strongly clawed; although, as is usual, these features are much accentuated in the male. The power of grasp is strongly developed, and in the use of its hands it is more versatile than many other wallabies. In feeding, for example, leaves and branchlets are not seized directly in the teeth, but are first taken in the hand and either broken off or drawn towards the mouth. When on the move the arms are loosely pendant from the shoulders (pl. ii., fig. 1)—the hands are thus brought close to the ground, and are frequently brought into play in changing direction and in avoiding obstacles.

In the relative development of the toes, and in the structure of the foot, there is a general uniformity amongst the brush wallabies, but the size of the pes shows considerable specific variation. In *ruficollis typicus* the pes is comparatively small and delicate for so large and heavy a wallaby, and in adults of both sexes is exceeded in length and stoutness by that of *parryi* and *agilis*. The foot length of males is about equal to that of *ualabatus typicus*, but the foot as a whole is very much smaller and weaker, adaptations to semi-swampy conditions having developed in that species the broadest foot in the genus. The sole is broadly naked throughout its length and shows little of the narrowing as it approaches the interdigital pad, characteristic of *irma* and *greyi*. The nails of both fourth and fifth toes are large and strong, and at least in the district under consideration, are commonly sharply pointed.

The tail is very long and slender. It is always longer (both absolutely and relatively) in adult males than in females, and in both sexes is longer than the head and body.

When compared with other species, its absolute length is exceeded only by *parryi*, but the ratio tail: head and body is higher in *irma* than in either, the values being: *irma*, 1·36; *parryi*, 1·34; and *ruficollis*, 1·27.

The basal thickening is moderate, and beyond it the tail retains its thickness almost unchanged for the proximal two-thirds of its length, the distal one-third tapering rapidly to the tip.

A conspicuous character of the tail is its marked lateral compression. At the mid-point of its length, the vertical diameter commonly exceeds the transverse by 50 per cent. Small callosities are sometimes developed on the ventral surface, usually corresponding to the site of chevron bones, but a more constant feature is a sparsely-furred or even naked calloused patch on the upper surface of the base of the tail. It varies in size and conspicuousness, and is apparently formed as a result of the curious habit which many of the macropods have of resting in a squatting position with the tail pulled forward between the legs, the dorsal surface of the thickened part of the tail being then in contact with the ground and subject to considerable pressure.

Although the examples examined, both South Australian and Eastern, agree fairly well with existing descriptions, there are minor points of divergence which may be noticed.

The face markings have been said to be inconspicuous. They are certainly much less prominent than in *irma*, *parryi*, and *greyi*, but a cheek stripe is always plainly to be seen, and is frequently well marked (pl. i.).

The inner aspect of the hind limb, along the whole length of the tibia and metatarsus, is clothed with short, soft, white fur, which is abruptly and strongly contrasted with the grey or rufous grey of its outer surface, and in flat skins especially this constitutes a prominent marking.

The dark brown or black toes are also abruptly contrasted with the white foot. This is a constant feature in South Australian specimens, but is frequently still more marked in animals from southern New South Wales, where the line of demarkation is as abrupt as in *irma*.

The tail in South Australian specimens is short-haired throughout. There is a slight lengthening and darkening towards the tip, but the black dorsal crest, containing hairs 30-40 mm. long, frequently seen in New South Wales animals, is never developed here.

The seasonal change in the pelage[3] is marked, and produces greater colour changes in the coat than in any other large wallaby. In the mid-summer coat the dorsal aspect becomes a light silvery grey, and the rufous suffusion fades to a pale yellowish ochre on the neck and forequarters and almost disappears from the rump region. The hairs of the mid-dorsal region are about 30 mm. long, and are relatively coarse and harsh to the touch.

With the advent of the cold weather, two distinct changes take place. There is first a great development of rufous under-fur over the whole dorsal and lateral surface, which increases the softness and density of the coat and restores the bright red colouration of the forequarters and neck. At this time, also, rufous areas are developed on the face and crown of head, which are grey in summer; and the backs of the ears, which were then black in their distal half, now become much paler and more heavily clothed.

The shade of red which is exhibited by the under-fur varies in different individuals, and in different parts of the same individuals, from Ridgway's "orange rufous" to "Sandford brown." It is usually most brilliant round the lower lumbar region and base of tail where, however, it is less conspicuous than on the shoulders owing to the development of longer, darker hairs.

The long hairs of the dorsal region are of two kinds: the more numerous and shorter possess a broad, pure white subterminal band, while the others are much longer (50-55 mm.) and black throughout their length. The shorter-banded hairs largely determine the prevailing tone of the summer pelage, but by mid-winter the long black hairs are developed in such numbers that the whole dorsal coat loses its silvery appearance and becomes a much more sombre, coarsely grizzled grey.

The ventral surface undergoes little seasonal change, but is clothed throughout the year with long, fine hairs, silvery white at the tip, dark grey or even black at the base. The pouch area in the female, and the scrotal area in the male, are fringed by hairs which are pure white throughout. In mid-winter the hairs of the lower ventral surface attain 80 mm. in length.

The young, on leaving the pouch, have a short, smooth coat, totally unlike that of the adults, both in colour and texture. The fur is a very fine, soft down of a curious olive shade, the dorsal surface varying from Ridgway's "olive-brown" to "wood-brown." The tail is much darker on its upper surface than in adults, and both hip and cheek stripes are more marked.

In the adult the hair tracts of the dorsum are uniformly caudad, except for an occipital reversal, which is centred between the ears, and which produces a well-marked coronal crest.

The condition on the ventral surface is more complex. The main centres of distribution appear to lie in or near the armpits from which the hairs are directed inwards to the chest, forming in the mid-line a prominent opposed ridge, downwards, to form the main caudad ventral tract, and upwards, to form a strongly-marked gular reversal which is opposed to the caudad directed mental area.

(3) The degree of seasonal change varies, and this is responsible for considerable individual differences in coat colour, but no mainland example which I have examined makes any close approach to *M. ruficollis bennetti*, of Tasmania. The habitat of the variety *bennetti* is stated by Thomas (3) to extend to Victoria, but this is almost certainly an error. Skins from the most southerly points of the Victorian mainland, *e.g.*, the Otway Peninsula and Wilson's Promontory, are not darker than average South Australian specimens.

On the lower part of the belly the condition varies. In the male the scrotum is always the site of a radiation which may give rise to a reversal reaching as far as the xiphisternum, but which is usually much less in extent. In the female there is usually a very well-marked ridge of opposed hairs occupying the mid-line between the cloaca and the lower margin of the pouch, which is probably significant in directing the newly-born embryo upwards towards the mammary areas.

Minor reversals are present on the inner aspect of the limbs.

Cranial Characters.

A series of 20 sexed skulls from measured individuals, representing a wide range of developmental stages, has been examined.

The proportions of the adult skull as exemplified by the conventional measurements are, for the most part, in close agreement, and its main outlines and contours fairly uniform. Especially characteristic, though not absolutely constant, are its small transzygomatic breadth, its short globular brain case, and the large projecting premaxillary spine.

In the size and shape of its individual bones, however, and in many minor details of structure, the skull of *ruficollis* is very variable, and such features as provide fairly reliable criteria of identity in the other species are very misleading in this. An element of uncertainty is thus introduced into identifications based on cranial characters alone, and in particular aged examples of *M. parryi,* and the present species may easily be confounded.

The nasal bones are particularly variable and simulate in their differing phases, shapes which are normal in every other species. Their posterior expansion varies to such an extent that the ratio, length: posterior width, may be as low as 2·12 and as high as 3·05. The naso-frontal suture may be almost strictly transverse, as in *billardieri,* or may deeply invade the frontals as in *agilis.*

Similar differences are met with in the inter-temporal region, which in skulls at similar stages of dentition exhibit very different degrees of constriction, the shape of the frontal area being correspondingly modified. The supra-orbital edges are stated by Thomas (3) not to develop post-orbital processes, but four of the male skulls, the measurements of which are given, do so to a degree which I cannot match in a series of 14 *parryi* skulls, where that condition is supposed to be characteristic.

Four main palatal vacuities are nearly always present, arranged in two pairs on either side of the mid-line. In each pair the anterior gap is about twice as large as the posterior, which is situated nearer the mid-line and is separated from its fellow by a narrow oblique septum. The pattern thus produced is fairly constant and is not closely approached by any other wallaby of the same size.

It is in the dentition, however, that the skull exhibits its greatest peculiarity. The upper incisors, especially $I.^3$, are excessively large[(4)] and powerful, actually exceeding in this respect some of the kangaroos, and being relatively the largest premaxillary teeth in the whole genus.

On the other hand, the permanent premolar is small, and if the teeth have not been profoundly modified by wear, this combination of large incisors with a small P^4 serves at once to distinguish *ruficollis* from all its congeners.

(4) Their maximum dimensions, however, are only observed in very immature skulls, as the rate of attrition is very high, and by the time P4 has irrupted, the vertical diameters of all three have been much reduced.

TABLE I.

Dimensions of M. ruficollis typicus (in m.m.).

(*S.A. specimens only.)

Specimen Number.	Adult Males. 113	127	230	176	208	Adult Females. 117	132	174	175
Total length*2	1670	1636	1760	1540	1630	1430	1332	1405	1380
Tail*3	935	933	975	882	884	768	748	713	693
Tail base (girth)	204	210	230	191	202	191	154	172	178
Chest (girth)	439	429	—	429	382	302	300	360	328
Manus (length)	—	60	—	60	60	30	42	40	46
Nail of third digit	24	25	—	23	22	20	22	18	20
Pes	242	222	255	222 c.a.	242	220	210	208	217
Fourth toe	88	83	102	85	96	88	83	83	85
Nail of fourth toe	32	35	34	36	32	33	33	29	34
Ear*4	83 × —	--	85 × 45	76 × 44	87 × 50	83 × —	82 × 43	76 × 44	75 × 45
Humerus	—	126	140	140	121	96	76	88	88
Ulna radial length	—	175	204	178	178	—	140	121	127
Femur	—	205	210	—	203	191	178	—	—
Tibia	—	300	334	—	302	286	267	—	—
Weight in lbs.	46	37	53	—	36	31	24	24	23.5

*1. All measurements were made by the same observer (H. H. F.) on recently killed animals.
*2. Taken with a flexible tape, following the curves of the mid-dorsal line.
*3. Flexed at right angles to the trunk, and measured from the posterior margin of the cloaca.
*4. Vertical height from notch to tip × greatest transverse breadth.

TABLE II.

Skull Dimensions of M. ruficollis typicus.

(In Millimeters.)

Specimen Number.	Adult Males. 42	41	34	127	176	230	113	A	208	Adult Females. 174	175	132	117
Greatest length	148	147	144	144	141	148	140	144.5	139	127	--	129	134
Basal length	133.5	135	131	128	128.5	137	130	130	128	113	—	114.5	121
Zygomatic breadth	67	68.5	69	66	69.5	71	72.5	69	67	62	64	63	66
Nasals, length	60.5	61	60	54.5	57	61	59	50	55	53	49	45	51
Nasals, greatest breadth	22.5	22	21	22	19	20	22	21	22	18	22	20	24
Nasals, overhang	16	12	16	11.5	15	16.5	15	12	11.5	12	—	7	14
Depth of muzzle	35	30.5	29	28	29	29	32	28	27	23.5	—	23	25
Constriction	19	18	19	20	16	20	19	17	18	17	18	17.5	15
Palatal length	87	91	85	85.5	84	90	85	85	82	75	—	79	82
Palatal breadth, Inside M^2	21	23.5	25	24	21.5	24	22	22	21.5	21.5	21	20	21
Palatal foramina	6	7.5	8	7	6	8.5	6.5	6.5	8	7	—	8	7
Diastema	36	37	34	34.5	33	40	33.5	35	35.5	31	—	31	31
Basi cranial axis	39	39.5	38	39	38	34*	ca. 39	41	38	34	32.5	35.5	35
Basi facial axis	97	97	95	92	93	103.5	c.a. 93	91	92.5	82	—	82.5	88
Facial index	248	246	250	236	244	-	239	222	243	240	—	233	250
Molars 1-3	21.5	21.5	24	23	24	21	22.5	21	24	23.5	23	21	21.5
P^4	—	—	7	6.5	6	6.5	7	—	6	6.5	7	5.5	7

*Sphenoids fused.

Dimensions of unworn incisors in an immature skull.

Vertical height ×	I^1	10 × 5
Antero-posterior	I^2	6.5 × 3.5
Length of enamel	I^3	7 × 10

References.

1. Angel Cabrera: "Genera Mammalium, Monotremata, and Marsupialia." Madrid, 1919.

2. F. Wood Jones: "Mammals of South Australia, 1923-1925."

3. O. Thomas: "Catalogue of Marsupialia and Monotremata in the British Museum, 1888."

DESCRIPTION OF PLATES I. to III.

Plate I.

Fig. 1. *M. ruficollis typicus* (aged male), showing characters of head.

Fig. 2. *M. ruficollis typicus* (young female), showing characters of head.

Plate II.

Fig. 1. *M. ruficollis typicus* (male), showing details of carriage when on the move.

Fig. 2. *M. ruficollis typicus* (female).

Plate III.

Figs. 1, 2, and 3. Respectively the lateral, superior and palatal views of the skull of *M. ruficollis typicus* (aged male).

NOTES ON AUSTRALIAN POLYPLACOPHORA.

By Edwin Ashby, F.L.S., M.B.O.U., and Bernard C. Cotton, Assistant Conchologist, South Australian Museum.

[Read November 14, 1929.]

No. I.

The Genera Callochiton, Eudoxochiton and Eudoxoplax discussed.

Introduction.

E. Ashby (Proc. Mal. Soc. Lond., xviii., pt. 2, p. 89, 1928), without having seen an example, listed *Callochiton castaneous* Wood, as *Eudoxochiton* because its coloured figures so closely resembled *Eudoxoplax inornatus* Ten. Woods. Iredale and May, in proposing the genus *Eudoxoplax* for the reception of *Chiton inornatus* Ten. Woods (Proc. Mal. Soc. Lond., xii., pt. 2 and 3, p. 99, 1916), found "it to differ appreciably from *Callochiton* and approach very closely to *Eudoxochiton*. . . . and may later be regarded as a subgenus of *Eudoxochiton*."

Discussion.

Careful examination of *Callochiton platessa* Gould, *C. castaneus* Wood, *Eudoxoplax inornata* Ten. Woods, and *Eudoxochiton nobilis* Gray, warrants the following conclusions:—

(1) The radulae of the four species show no generic difference.

(2) The sculpture of the tegmentum is similar (but for some minor variation in the granulation), and under 65 magnification all show the same minute striated pattern.

(3) The general shape of the valves, and also the sutural laminae, are similar.

(4) The latter are joined across the middle line by a forward extension of the articulamentum.

(5) The insertion plates in all valves are "multi-slit and propped."

(6) The girdle, in juveniles, is clothed with closely packed "needle scales."

All are consistent characters of the genus *Callochiton*.

Differences.

(a) In *Eudoxochiton nobilis* Gray, the "needle-scales" are slightly more irregularly placed, broader and stouter (characters which alone are of only specific difference). The girdle, however, has also large, hollow, flat-sided, grooved, dark coloured spicules, apparently deep seated; characters which in combination with the above may be of generic significance.

(b) In *Eudoxoplax inornata* the slittings in all valves are more numerous, and the propping is more strongly marked, giving the teeth a serrate appearance; a difference, not in character, but merely in degree of sculpture.

(c) In *Eudoxochiton nobilis* besides their increased slitting, the teeth are also laminate, the spongy character of the eaves extending between the laminae.

We consider *Eudoxochiton* a valid genus, because of its peculiar laminate and spongy teeth, and the deep-seated, scattered spines in the girdle armature. The three species, *inornata, castaneus* and *platessa,* are *Callochitons,* and the first two may be regarded as representing the section *Trachyradsia* Dall of this genus.

Pilsbry (Man. Conch. xiv., p. 52, 1892) places *C. castaneus* Wood in the subgenus Stereochiton (Carpenter M. S., Dall, Proc. U.S. Natl. Mus., p. 286, 1882), type *C. castaneus,* distinguished by the great extension of the girdle and absence of girdle scales in the adult form. Pilsbry, p. 83 (l.c.), treats *Trachyradsia* (Carpenter M. S. Dall, l.c., p. 323, 1878) as a section of *Ischnochiton;* but (Man. Conch. xv., p. 68, 1893) as a subgenus of *Callochiton* (dating from 1878) with *C. fulgetrum* as type. He places *Stereochiton* Dall, 1882, as a synonym, to which we now add *Eudoxoplax.*

Note.—Sykes (Proc. Mal. Soc. Lon., i., pt. 3, pp. 32-136, 1894), considered *C. fulgetrum* R. V., as a syn. of *C. castaneus* Wood.

No. II.

A species of Callistochiton new to South Australia.

Callistochiton mawlei Iredale and May was until recently known only from South East Tasmania, but was later recorded from Portland, Victoria (Victorian Naturalist, xliii., p. 357, 1927), and Ashby has since collected four examples at Cape Northumberland, South Australia.

No. III.

Lepidopleurus mathewsianus Bednall and its synonymy.

Lepidopleurus mathewsianus was described as of Bednall in a conjoint paper by W. T. Bednall and E. H. V. Mathews (Proc. Mal. Soc. Lond., v., pt. 2, 1906). As the single example found by Mathews (said to come from Gulf St. Vincent) was lost, specimens from Marino in the same gulf, regarded as conspecific, were supplied by Ashby, so that Marino may be regarded as the type locality. We find that *L. niger* Torr (Trans. Roy. Soc. S. Austr., xxxv., p. 105, 1911) from Hopetoun, Western Australia, is conspecific, having compared the holotype of Torr's species (kindly lent by him) with the tototypes of *L. mathewsianus. L. niger* was described as "much broader in proportion to its length" than *L. mathewsianus.* This was due to the fact that the head valve was absent from the type specimen. as is manifest in the illustration (Trans. Roy. Soc. S. Austr., xxxv., pl. xxv., fig. 5a.).

Terenochiton erratus Hull (Austr. Zool., xli., p. 159, 1923), from King George Sound, Western Australia, should also be added to the synonymy. The paratype (kindly lent by Basset Hull) is white, whereas most of the examples from Marino, S.A., are dirty white or buff coloured. South Australian specimens show a wide variation in the shape of the posterior slope of the tail valve. In *T. erratus* this is steeper than most specimens of *L. mathewsianus* found in South Australia, but some examples from Marino and Port Lincoln are like the Western Australian specimen.

We compared *Lepidopleurus glauerti* Ashby and *L. badius* Hedley and Hull with *L. mathewsianus,* and with each other, and consider them both distinct species.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.

No. 28.

By J. M. Black.

[Read April 10, 1930.]

Plate IV.

Gramineae.

Triodia longiceps, nov. sp. Gramen rigidum glabrum pallidum, plus quam metrale; folia longa, subulata, apice pungentia; ligula brevissima, pubescens; caulis nodi pauci, puberuli; panicula angustissima, 25-50 cm. longa, ramis inferioribus erectis, 5-10-spiculatis; spiculae angustae, primum lineares, 9-20 mm. longae, 9-21-florae; glumae vacuae glabrae, 4-5 mm. longae, apice acutae vel emarginatae, nervo mediano solo conspicuo; glumae floriferae circiter 4 mm. longae, apice in 2 lobos, minutos obtusos et mucronem medianum breviorem desinentes, ad basin annulo pilorum cinctae, ceterum fere glabrae; palea margines glumae floriferae paululum excedens.

Finke Gorge, Hermannsberg, Central Australia; coll. J. B. Cleland. Local name, "Bush Spinifex." Differs from *T. irritans* in the longer, narrower spikelets with more numerous flowers, the shorter 1-nerved outer glumes, the glabrous flowering glume with a ring of erect hairs round its base, and the much longer panicle. When in flower the spikelet is barely 3 mm. broad and linear in shape; the small membranous wings of the palea slightly exceed the edges of the flowering glume, so that they appear more conspicuous than in other *Triodias*. The new species is perhaps confined to Central Australia. (Plate iv., figs. 5-8.)

Bromus macrostachys Desf. This Mediterranean grass, conspicuous by its twisted and divaricate awns, has been found growing on waste land near the Waite Agricultural Research Institute, Glen Osmond.

Proteaceae.

Hakea ulicina R. Br., nov. var. *latifolia*. Folia plana, oblongo-cuneata, 3-18 cm. longa, 4-13 mm. lata, pungenti-mucronata, 3-nervia, interdum nervis tenuioribus intermediis instructa, ita ut 5-7-nervia videantur.

Ninety-Mile Desert, near the Coorong; coll. E. Ashby. The broader leaves, prominently 3-nerved, and sometimes with additional fainter intermediate longitudinal nerves, bring this form near *H. dactyloides* Cav., a species inhabiting eastern New South Wales and Gippsland, but the pedicels of our variety are always, as in the type, quite glabrous. The fruit is sometimes 25 mm. long.

Leguminosae.

Acacia lineata A. Cunn. This slender, viscid shrub appears to be fairly common in the Murray scrub near Karoonda. The linear phyllodia have a prominent nerve on each face close to the upper margin, and the lower margin is also thickened and nerve-like, leaving a narrow, flat channel between the two longitudinal ridges. The real nerves (as will be seen from fig. 4 of the accompanying plate) are three—two opposite the upper margin and one opposite the lower margin—all concealed within the hardened cellular tissue of the phyllode. Our specimens, from Karoonda, agree perfectly with some from Dubbo, New South

Wales. The form found near Port Lincoln and Tumby Bay has but one nerve, which is removed from the upper margin so as to be almost central, and the lower margin having no prominent nerve there is no longitudinal channel. This plant was considered by Bentham to be merely a form of *A. lineata*, but Mueller raised it to specific rank as *A. imbricata*, probably because the crowded, almost erect phyllodes have an imbricate appearance. Maiden took the same view, which is perhaps the correct one, but unfortunately our specimens from Eyre Peninsula are few and imperfect. It is worthy of note, however, that the illustration in the *Botanical Magazine* of the type from New South Wales shows some of the phyllodes as having the nerve almost central. (Plate iv., figs. 1-4.)

Swainsona dictyocarpa, nov. sp. Planta parvula (speciminibus nostris 3-6 cm. altis), glabra absque paucissimis pilis sparsis appressis basifixis; foliola 3-7, ovato-oblonga, 5-12 mm. longa, 3-4 mm. lata, supremum inferioribus aliquanto longius; stipulae parvae, lanceolatae; racemi 2-6-flori, foliis longiores; pedicelli 2 mm. longi, minute puberuli, duplo longiores quam bractea scariosa ciliolata; flores (siccati) caerulei; calyx 5-6 mm. longus, dentibus lanceolatis intus puberulis, tubo glabro paulo longioribus; bracteolae minutae, subulatae; vexillum circiter 12 mm. longum latumque, levissime bicallosum; carina obtusa, sine sacculis, alas subaequans; ovarium glabrum; stylus fere totâ longitudine barbatus, apicem versus rectus; legumen immaturum turgidum, subcylindratum, 12 mm. longum, 5 mm. crassum, glabrum, valde reticulatum, secus suturam haud impressum.

Bitter Well, Coondambo (north of Lake Gairdner), October 29, 1929; coll. J. B. Cleland. Differs from *S. viridis* in the leaflets less cuneate in the lower part and narrower towards the summit, the stipules narrow and scarious, instead of broad and green, the bracts scarious and only half as long as the pedicels, instead of green and as long as they; the wings as long as the keel or a little longer, instead of shorter, the ovary glabrous and the pod shorter, thicker, much more prominently reticulate and not impressed along the suture. Differs from *S. oligophylla* in its almost glabrous character, the narrower stipules, the calyx with much shorter teeth and without hairy longitudinal nerves, and in the glabrous ovary and glabrous reticulate pod. From both it differs in the terminal leaflet longer than the lateral ones.

Swainsona canescens (Benth.) F. v. M. Specimens collected by Professor Cleland on Coondambo Station have the calyx 9 mm. long, of which the acuminate teeth occupy almost 6 mm. The standard appears to have always a greenish blotch at base, as mentioned by Bentham in connection with his Western Australian specimens, and the keel has always the two characteristic rounded calli at the tip.

Tephrosia sphaerospora F. v. M. has been found by Professor Cleland on Andamooka Station, west of Lake Torrens. Hitherto it has only been known from the country north of Cooper's Creek.

Trifolium Bocconei Savi. Inman Valley, Balhannah, Penola; November, 1929. A new record for our State. This clover is a native of southern Europe, extending as far north as the Cornish coast.

Trigonella ornithopodioides (L.) DC. Kalangadoo and Penola; coll. E. S. Alcock, November, 1929. This European clover-like plant occurs in pasture, and Mr. Alcock describes it as useful feed. It has also been collected at Blackwood, and was recorded in Victoria several years ago.

ZYGOPHYLLACEAE.

Zygophyllum fruticulosum DC. nov. var. *brevilobum*. Variat foliis linearibus, $1\frac{1}{2}$-2 cm. longis, ad apicem brevissime et obtuse bilobatis, ita ut folia emarginata simulent; sepalis lanceolatis, 5 mm. longis petala lutea obovata subaequantibus.

Seventeen miles north of Tarcoola, October 30, 1929; coll. J. B. Cleland. Has a very distinct appearance owing to the rather long linear leaves, which appear notched at summit, owing to the two very short, obtuse lobes. The small flowers are near those of var. *eremaeum,* but the sepals are very acute and the petals obovate and obtuse. One capsule had attained 8 mm. in length, but was still unripe.

Elatinaceae.

Bergia perennis F. v. M. McDouall Peak Station, south of Stuart Range; coll. J. B. Cleland, October 31, 1929. This little woody plant is new for South Australia proper, but was recorded by Tate in the report of the Horn Expedition (published 1896) as having been found by Kempe at Hermannsberg and by Tietkens at Mount Sonder, both in the MacDonnell Ranges, Central Australia. It was first collected by Mueller on Sturt's Creek, North Australia, in 1856. The short stems of our specimens appear to be prostrate. This species differs from *B. trimera* in its perennial character, solitary axillary flowers, 5 sepals and petals, 10 stamens, shorter obtuse leaves, scarious stipules with long cilia and five styles and capsule-valves.

Myrtaceae.

Darwinia micropetala has been found recently by Mr. E. Ashby at Salt Creek, Coorong.

Compositae.

Centaurea repens L. A troublesome weed in vineyards along the Murray. The heads are spineless, but the plant is perennial, with creeping roots. It is a native of Central Russia, Asia Minor, and Persia, and was recorded in Victoria in 1907, but has only been found recently in our State. A synonym is *C. Picris,* Pallas.

DESCRIPTION OF PLATE IV.

Figs. 1-4. *Acacia lineata.* 1, flowering branch. 2, two phyllodia with twin heads. 3, bud. 4, transverse section of phyllodium.

Figs. 5-8. *Triodia longiceps.* 5, upper part of panicle. 6, two flowering glumes and paleas in position. 7, flowering glume spread open. 8, palea.

ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY: CENTRAL AUSTRALIA.

No. 6—PHYSIOLOGY AND MENTAL OBSERVATIONS ON THE AUSTRALIAN ABORIGINES.

By R. Pulleine and H. Woollard.

[April 10, 1930.]

Introduction.

The remarks which follow are to be regarded as a preliminary attempt to assess quantitatively, if possible, the sensory acuity and the inborn ability of the aborigine.

Notwithstanding his reputation of being able to see the tracks of man and animals where the unpractised white man can see nothing, the investigations of Rivers, McDougall, and others on the sensory acuity of primitive peoples render it improbable that this and similar ability depend on any inherent superiority of the organs of special sense.

The estimates of his intelligence which have currency at the moment are impressions and have only that validity which the experience and care of the observer commands. In a recent book on the Australian Bush the author describes the aborigines as rude, backward, unintelligent, unable to learn civilized arts; their beliefs are crude; their practices are repulsive; their corroborees ugly and indecent.

A reviewer dealing with the above book by Miss Fullerton quotes the following from Dr. Ramsay Smith:—"Children in school can be educated like white children and to the same extent. . . . Some speak English chastely and beautifully. Some train themselves in music. Some show great mechanical ingenuity and read and understand books on mechanics and physics. . . . To anyone who knows how the blackfellow, even in a single lifetime, reacts to new influences, moral, intellectual, and mechanical, the facts seen to upset all theories of cranial capacity, cerebral functioning, and mental operations."

It is obvious that a just estimate of the ability of the aborigine can only be obtained by some kind of measurement properly applied over a wide enough field. We believe the time has arrived when something of the sort can be attempted.

It has been repeated again and again that the aborigines of Australia represent the most primitive variety of man still existing. This may be true, but it is hard to find the basis for such a sweeping assertion. Writers who make this statement have in mind, most probably, his failure to discover any kind of agriculture, and his inability to make any provision for the future. This latter is all the more surprising, for the nature of his environment demands such provision. The number of aborigines in the country when it was first settled will never be certainly known, but estimates rarely exceed 150,000—a biological index which indicates a failure to gain any control over the environment. However, it is not our purpose to deal with the cultural aspects of the aborigine, but it might not be amiss to point out that it has long been a commonplace that complex civilizations owe much, if not all, to the migration and diffusion of culture. Elliot Smith and Perry have collected abundant evidence to show that the same is true in a large measure of primitive cultures also. The backwardness of the aborigine may be due to his "splendid isolation," which has been complete for thousands of years.

If we glance for a moment at those aspects of the aborigine which are nearer to our own purposes, we find the basis of the above assertion, that he is so very primitive, equally dubious. Physical anthropology would regard a race as primitive if it showed many characters that indicated affinity with fossil man, *e.g.*, Neanderthal, or *Pithecanthropus erectus*, or even with the great apes. Huxley long ago suggested that there was a special resemblance between the Australian aborigine and the skull of Neanderthal man. Recent work, such as that of Berry, and especially Morant, has shown that there is no evidence for this statement. The aborigine is only one among a number of primitive races, and is by no means the most primitive of these. Detailed dissections of his body, and in particular of his face, feet, and hands, have failed to reveal any particular kinship with fossil or anthropoid forms. The central nervous system might be expected to throw particular light on this problem. Elsewhere one of the authors has published a systematic account of the brain. Suffice it here to say that the brain is small, has frequently a sulcus which appears rarely in the European brain, but the general fissuration and the development of the areas underlying the higher mental processes show some excess in the visual area and some deficiency in the temporal region.

Though phylogenetically the size of the brain and the complexity of animal behaviour go hand in hand, yet it remains a fact that many investigations made on different varieties of men have failed to show any correlation between the size of the head and intelligence. For instance, a square head is of the shape to give a greater cranial content than a long head, yet measurement and experience have failed to show any differences in ability.

Thus it appears that if we wish to find further support for the idea that the aborigine is the most primitive of existing races, some further tests must be applied.

Mental Measurement.

For the measurement of the acuity of the various sense organs, methods have been evolved which are now almost traditional. No discussion of these is needed at this place. It will suffice to mention our procedures in the appropriate section.

For the measurement of the intelligence we have the various systems of intelligence tests. Despite the vast amount of work done with these tests and the experience that has been gained, it cannot yet be said that they are thoroughly established. Opinion varies from whole-hearted acceptance to the assertion that no one knows what intelligence is, and therefore, no one can know what tests measure it and what tests don't.

An essay such as this cannot attempt any critical summary of the value and the limitations of such a method of enquiry. Two considerations justify the use of such intelligence tests for our present purposes. In the first place, there is no other method which pretends to give a quantitative measure of ability as distinct from the effects of training and education. In the second place, if we were to wait until every objection had been met, such time might elapse that this dwindling people might have disappeared altogether. It is desirable, not only on scientific grounds, but also from practical reasons, to attempt to measure the ability of these people.

For ourselves, we are persuaded of the essential rightness of the present theory of intelligence formulated by the English school of psychology—a school objective and mathematical, inspired by Galton and whose present most brilliant exponent is Spearman. Spearman's theory implies that intelligence is revealed in the solution of problems, the ability to perceive and educe the relations between things apprehended. Tests which demand for their solution the perception and education of relations do, therefore, measure intelligence. And most so-called intelligence tests imply these things. By an analysis of the results of various intelligence tests, Spearman observed that the correlations between the tests themselves exhibited a definite order of hierarchy. This led to his now famous tetrad equation, whose principle may be briefly expressed as follows:—

$$\frac{r(A, P)}{r(B, P)} = \frac{r(A, P)}{r(A, Q)}$$

where A, B, P, Q represent any four capacities not obviously akin. The main significance of this hierarchy is that we are led to infer that all the functions of the human mind, the simplest and the most complicated, are probably processes within a single system. As Burt has pointed out, the contrary assumption of a radical dichotomy between the general mammalian foundation of the central nervous system and the specifically human capacity of general intelligence, proves a serious barrier to the advance of the biological standpoint of individual psychology.

Spearman's work has suggested that ability consists of two factors—a general factor G, which is innate and unaffected by environment, and specific factors S, which are more subject to training and education. General ability enters into most mental performances in some degree. Tests which depend on mere sensory discrimination do not involve much of G. Memory, in so far as it is mere reproduction, involves no G, but the more it makes use of association the more of G enters into it.

It is true that this theory of Spearman's has been severely criticised and his mathematics have been rigorously questioned. Pearson and Moule have lodged a definite verdict of not proven on mathematical grounds. We must confess, however, that apart altogether from its mathematical basis, we find the theory most persuasive on general grounds, and, if true, it would establish the fundamental validity of the method of intelligence tests.

For any tests to work satisfactorily it is, of course, essential that the person to whom they are applied should understand them and should try to do his best. The latter qualification seems abundantly present in the aborigines, for all who have attempted any kind of investigation on these friendly and engaging people, have found them most anxious and willing to co-operate and do their best.

The Binet-Simon test, as propounded by Burt in his book, forms the group of tests most widely used and for which most experience has been obtained. It would be desirable to use these. They demand, of course, some rudiments of education, and have been adapted to children from three to fifteen years of age.

It so happens that the mission school at Koonibba has assembled a group of pure-blooded aboriginal children under the charge of a schoolmaster, who has classified them and is teaching them according to the standards of our elementary schools. Thus the children form a suitable group for such an investigation.

Physiological Tests.

Our enquiries amongst the aborigines of the Koonibba station followed a variety of ways. We performed a number of physiological tests; some estimate was made of sensory acuity; from the natives themselves, and from the personnel of the station we tried to obtain some idea of what they were capable of doing; and, finally, we attempted to obtain a measure of intelligence by our own improvised methods. Our intelligence testing was merely preliminary. We hope to follow it up systematically at some future date.

Measurements of Blood Pressures and Pulse Rates.

These estimations were carried out on full-blooded natives by the usual instruments and methods. The pressures were measured while the subjects were seated after they had been resting for about ten minutes, and after they had been put at ease by talking and watching other measurements being carried out. The systolic pressure was estimated by the tactile method, the diastolic by the auscultatory. The difference between these represented the pulse pressure.

The results are included in the following table:—

MALES.

Age.	Sys. P.	Dias. P.	Pulse P.	Pulse R.
25	108	55	53	65
25	120	88	32	74
13	118	78	40	82
30	166	110	56	96
30	138	92	46	88
20	132	102	30	68
25	102	60	42	60
25	128	90	38	68
25	128	90	38	68
30	120	80	40	76

FEMALES.

Age.	Sys. P.	Dias. P.	Pulse P.	Pulse R.
20	136	80	56	84
23	116	58	58	96
16	140	98	42	96
22	130	90	40	100
25	128	94	34	120

In addition to the results expressed in the above tables, figures were obtained for full-blooded aborigines of ages outside those limits. These have been excluded from the determination of the average because of the effect of age in altering the value of these pressures. Investigations carried out on groups of subjects such as soldiers of the British Army, University undergraduates in England and America, and other enquiries, have shown in general that the systolic and diastolic pressures are low in childhood, that they rise at puberty, and in adolescence from the seventeenth to twenty-eighth year there is a further rise. Thereafter these pressures remain constant until about the fortieth year, when another rise begins with advancing years.

Throughout these various periods the product of the pulse rate and the pulse pressure tends to remain constant, the more rapid pulse compensating for the low pulse pressure of childhood. Moreover, the three measurements, systolic pressure, diastolic pressure, and pulse pressure tend to preserve a ratio of 3 : 2 : 1 to one another.

From all the various observations that have been made, running into many thousands and comprising different classes and ethnic groups, the commonest values for systolic pressure, diastolic pressure and pulse pressure are: S = 120, D = 80, P P = 40.

For the Australian aborigine the average for ten full-blooded males between 15 and 30 years of age is:—

Systolic pressure	=	126
Diastolic pressure	=	84·5
Pulse pressure	=	41·5

For females of the same order the corresponding figures are:—

Systolic pressure	=	127·6
Diastolic pressure	=	82
Pulse pressure	=	45·6

It will be seen that these figures present no sharp differences from those obtained elsewhere, and the same ratios hold. Generally the female systolic pressure is slightly below that of the male, but the measurement of 717 Filipinos of average age of 25 years, by Conception and Bulatoa, gave 115 for the males and 116 for the females.

Owing to practical difficulties, any measurement made on living pure-blooded aborigines must necessarily be confined to small numbers. It is no use lamenting this fact. One has simply to make the best of it. Ray made some measurements on Central Australian pure-blooded aborigines. He took the mean of all his subjects, irrespective of age, and for the males (44) arrived at the following figures:—

Systolic pressure	=	125·3
Diastolic pressure	=	79·07
Pulse pressure	=	46·3

For 13 females the figures were:—

Systolic pressure	=	116
Diastolic pressure	=	73·5
Pulse pressure	=	42·5

Ray remarks that these figures almost exactly coincide with the figures for healthy Europeans, but are 5-10 mm. below that for healthy white Australians.

Thus we may well conclude that the aborigine exhibits no deviation in circulatory pressures from the inhabitants of, say, England and America. This statement needs two qualifications—the numbers are too small, and the computations have not been analysed in accordance with proper biometric practice. The second qualification arises out of the first.

There are observations on the basal metabolism of full-blooded aborigines now available which perhaps give a little further interest to these figures. The figures obtained show the basal metabolic rate as 10% to 20% below the accepted average values. Since the basal metabolic rate is ultimately an expression of the rate of energy production of the active protoplasmic mass, it might be expected in the absence of any evidence of endocrine deficiency that this lower rate might be reflected in the values of circulatory pressures. It has already been remarked that they are of the same order as those obtained from healthy subjects of similar age elsewhere. Read has suggested a formula which gives values for the basal metabolic rate whose error is less than 10% for 60% of the cases tested. The formula is as follows:—

$$\text{B.M.R.} = 0{\cdot}683\ (\text{D.R.} + 0{\cdot}9\ \text{P.P.}) - 71{\cdot}5.$$

Applying this formula to the above figures, we get for the males examined a value for the B.M.R. = 5·5, approximately. This means that basal metabolic rate would be 5% and more above the mean basal metabolic rate. Thus we are led to a result different from the direct estimations. There is plenty of evidence that blood pressures and pulse rates are correlated with B.M.R., and, as a matter of calculation, the factor 0·683 represents the correlation co-efficient of these with the B.M.R. Apart from the inherent error of the method, the figures for pulse rate and pulse pressure do not represent real basal values. Moreover, it assumes a linear relation between pulse rate and pulse pressure which may not be true. Nevertheless, it is of interest to review the circulatory pressures and rates in relation to metabolic rates. And it is surprising that they should not both tend in the same direction.

Autonomic Reactions.

Adrenalin and the Sympathetic Nervous System.—When adrenalin is instilled into the conjunctival sac of a healthy individual, no effect on the pupil is produced. In certain diseased states, however, a dilatation or mydriasis follows the application of the drug. In this way adrenalin can be used to give a measure of the excitability of the sympathetic nervous system, a quality we might expect to exhibit some variation with race. Unfortunately we discovered too late that we had brought very little adrenalin, and only three tests were carried out. These were all negative, and as far as they go it is inferred that the aborigine reacts in the same way as the white to this test.

Atropine and the Vagal Autonomic Fibres.—By the same reasoning, atropine can be used to bring out the activity of the vagus nerve. The vagus nerve inhibits the heart rate, but this effect can be removed by the giving of atropine which paralyses the nerve endings of the vagus in the heart. In doses of $^1/_{100}$ gr. its effect is confined to the endings of the vagus, the sympathetic nerve fibres are unaffected and there is no action in the cardiac muscle directly. When the vagal effect is removed the rate of the heart beat may remain unchanged or be increased. The effect which occurs depends on whether the vagus effect, or the vagal tone as it is called, is high or low. In dogs, for instance, the heart beat is considerably quickened, the vagal tone being high; in cats the effect is less; and in rabbits and frogs there is no change whatever.

In man it has been found that the inhibitory effect of the vagus on the rate of the heart is absent in the child, gradually appears with age, reaches its maximum at about 25 to 30, and thereafter declines. In old age the increase in the number of beats may be not more than four per minute.

We tested this reaction in a number of full-blooded aborigines by giving them, by mouth, $^1/_{100}$ gr. of atropine dissolved in water. The pulse rate was then counted at intervals of five minutes. The following results were obtained:—

MALES.

Age.	Normal P.R.	P.R. after Atropine $^1/_{100}$ gr.	Incr.	Time.
25	74	94	20	15 mins.
25	60	80	20	15 ,,
25	68	92	24	20 ,,
25	65	88	23	17 ,,
35	69	88	19	15 ,,
40	72	78	6	15 ,,
?	80	94	14	17 ,,
? very old		No change		

FEMALES.

Age.	Normal P.R.	P.R. after Atropine $^1/_{100}$ gr.	Incr.	Time.
16	96	98	2	15 mins.
17	88	96	8	5 ,, After 12 mins. rate fell to normal.
20	No change			
23	96	102	6	(Back to original rate in 18 mins.)
22	No change			
60	No change			

From these results it will be apparent that there is a constant acceleration in adult males round about 20, and the effect diminishes with age. This is in accordance with results obtained on the general population of the community.

The few results obtained for the females seem to suggest that in them the vagal tone is much less. It is to be noted that in most cases they are youger than the males, and that in each case the normal pulse rate is higher. Either there was some emotional reaction to the procedure, of which we saw no other manifestations, or sympathetic tone is higher. This holds when allowance is made for age. Thus, in spite of the qualifications of the fewness of observations that must be made, there appears some reason to suppose that there is a sexual difference in the reaction to the atropine test.

Ophthalmoscope Examination.

Before proceeding to some sensory tests, we might record here the result of examining the fundus of the eye with the ophthalmoscope. The normal eye of the young aborigine may be described as clear, even brilliant. The eyelashes are long and silky, and the conjunctiva is unpigmented except over the bulbus oculi, where there are scattered masses of pigment. Pigment occurs along the horizontal meridian of the eye, and this seems to increase with age. The eyes of the old aborigines, owing to dust, flies, smoke, and the like, have invariably some chronic conjunctivitis which gives the eye a dirty appearance. The iris has a very uniform dark brown colour, and the pupil responds very readily to light changes.

The fundus of the eye was examined at night with the ophthalmoscope, the pupils having been dilated by homatropine and cocaine. In eleven subjects the following details were noticed. The general appearance, instead of showing evidence of a marbled pigmentation, was of a dull silver or pewter colour with a white or silvery reflex to light. The optic disc was flat or slightly cupped, its margin being in part or wholly pigmented. The macula appeared in a silver field as a cherry red spot, and the fovea appeared like a spark in the middle of the macula. The silvery reflex of the retina spread out to the periphery, and the familiar red reflex seen in Europeans was absent or only appeared as a faint pink in one case. The vessels showed up in relief, and were entirely free from pigment along their lines of distribution.

Acuity of Hearing.

A metronome was set to a one-second beat. It was placed on a slightly sloping bank, and all the people to be examined, along with the examiner, were placed out of hearing of the metronome. They then advanced towards the source of the sound, stopping when they heard it. The distances at which each could first hear it were then measured by means of a steel tape. There was considerable variation in the results so obtained. The highest auditory acuity was found in a white boy, the son of the schoolmaster.

Visual Acuity.

Cohn's "E" test was used, the size being D = 1·0 of the metric test commonly used for testing the acuity of vision at 5 metres. This "E" was drawn on white Bristol board with Chinese ink, and a duplicate was supplied to the examinee. A card with the "E" on it was fixed on the north wall of the schoolhouse at a height of five feet, and could be turned in the four principal directions. The illumination was constant at all tests, which were carried out between ten and eleven each morning. The subject of the test was placed at a measured distance from the test card, and was required to place the "E" on the card he carried in the same position as the one he observed. The distance was recorded when three consecutive tests were correctly performed. This and the previous method (hearing test) were practically the same as those used by Seligman in his observations.

The test object, placed in a bright light, could be orientated at 24 feet by ourselves. With two exceptions, it could be properly orientated at twice this distance by the aborigines, and in one case at three times this distance. However, the farm manager and his small daughter (white) equalled the best of the aborigines. Though the average visual acuity is very high in the aborigines, it does not exceed the limits that can be reached by whites.

Some Acuity Tests.

No. of Testee.	Metronome.	Orientation of "E."
35	180 yards	— feet
37	135 „	63 „
45	135 „	— „
46	135 „	75 „
42	90 „	66 „
40	90 „	54 „
49	90 „	— „
48	90 „	— „
47	90 „	51 „
44	90 „	42 „
38	90 „	63 „
39	90 „	57 „
41	90 „	45 „
43	90 „	48 „
19	90 „	— „

The farm manager orientated the "E" at 73 feet.

Tactile Acuity.

We proposed to measure this in the ordinary way by applying compass points to the flexor surface of the forearm and measuring the minimal distance at which the two points could be discriminated. In practice we found the test very difficult to carry out. It was difficult to be sure that the subjects understood what was expected of them. Their replies were so discrepant that no rule could be established. Our results are, therefore, very imperfect. We, however, gained the very definite impression that their tactile acuity was of the same order as for whites generally.

The Discrimination of Colour.

Two tests were applied. In the first the subject was asked to name or trace the figures in the Stilling test book for colour blindness. This book is so arranged that one or two figures are constructed by an appropriate arrangement of coloured dots. The figures are immersed in a background of coloured dots. The colours are so chosen that if the subject has any form of colour-blindness certain figures will be invisible to him. Conversely, certain figures are so presented that they can only be seen by a colour-blind person. The book formed an excellent test. Practically the whole range of the spectrum is used as a test in discrimination. The subject can either name or trace the figures and comprehends easily what is required. Thus it could be used with quite illiterate persons.

Some forty full-blooded aborigines of both sexes and widely different ages were tested by this book. In all cases the figures were identified or traced with ease, and so it can be asserted quite definitely that the aborigine is sensitive to the colours of the spectrum to the same extent as ourselves, and colour blindness can only be an occasional event. No case was discovered in our 40 tests.

The second method we used was the discrimination of coloured wools. Skeins of wool were chosen which comprised some twenty different shades of green, red, blue, and yellow. The method we adopted was to select one of the primary colours and then ask the subject to select from the group every skein which he thought contained the same shade of colour. A few performed the test well and chose nearly the maximal number of corresponding skeins. The white children on the station could perform the test quite easily and perfectly. In testing the aborigines difficulties arose. Some did not seem to understand clearly what was required. Some understood but would quickly desist when a few corresponding shades had been chosen. When questioned, these showed clearly that they appreciated differences in shade of colour. It was an interesting and frequent observation that when a limiting hue was reached, such as a skein containing a faint trace of yellow, and the question of adding it to a group or not arose, the aborigine became greatly troubled. He would add it to the group and then take it away, and repeat this several times, and finally resign the test in despair. They behaved as though the idea of adding it or subtracting it alternately flickered in their minds. This state of indecision was accompanied by obvious signs of distress.

The results obtained varied considerably, but the tests went far beyond the perceptual range and indeed represented an examination in the power of abstracting a general idea from a particular instance. The measure we intended to use, namely, correct performance as unity, and degrees of imperfection in performance as the fraction of which the numerator was the successes scored, and the denominator the total of possible successes, was not of much value for the reasons given above.

A more just measure is given by using categories such as bad, good, and excellent, for these contain some allowance for the lack of comprehension, and so forth.

Of the tests so performed eight are classed as bad. This group contains four young men (average age, 25). As above remarked, white children of eight years of age perform the test easily. Ten were classed as good, and four as excellent. That is to say, only four adult aborigines out of eighteen performed this test as well as white children.

Intelligence.

The tests so far recorded bring evidence that the physiological levels of the aborigine are much better or much like our own. Moreover, we have discovered so far no difference in the acuity of his various sense organs, with perhaps the exception of vision. If it is true the aborigine is the ultra-primitive variety of mankind, then we may assert at this point in our investigations the distinction does not lie in his basal physiological and psychological processes. The last test described above (the matching of colours) does seem to hint at a lower level of performance in conceptual processes. In the beginning we have discussed what was in our minds about trying to get some measure of one aspect of his mental processes, namely, intelligence, and naturally we turned to the intelligence tests. Though these tests have been applied to adults on a large scale, yet whatever reliability they possess is greater when applied to children of the appropriate ages.

It may be recalled that in Burt's book there has been recorded some remarks of Binet about objections to his methods. Some teachers who had demurred at his scheme were asked to demonstrate what methods they would use to assess intelligence. They proceeded to ask all kinds of questions such as common sense would suggest. Binet's comment was that they used a method the same in principle as his own except that he standardised the questions, defined the methods of putting them, valued them according to age, and tried them on a sufficient number to get rid of the error of random sampling.

Since our population was a random sample and contained many adults of various ages, and some quite illiterate, we tried the so-called common-sense method. Moreover, by interrogations referring to their immediate activities we thought that many objections might be met, such as lack of interest, or experience. Finally, it was possible to corroborate our conclusions by comparing them with those arrived at by the various members of the administrative staff. The able-bodied men about the place are for the most part engaged in some way in farm work. The younger members have formed a very enthusiastic football team.

The young women who are unmarried carry out various activities arising in the hostel. Cooking, dressmaking, house-keeping command their attention and industry. The boys and girls attend the school. The farm, some 4,000 acres, is under the management of a practical farmer who happens to be especially skilled, since in open competition the cleverness of his methods has brought him several silver cups. The present harvest (1928) has been a poor one. Nevertheless, the highest yield of wheat per acre in the district has been obtained from the mission farm. The farm manager is very well disposed towards the natives, and we witnessed many incidents which showed his consideration for them, and, on the other hand, their regard for him. We feel confident that his opinions on the capability of the aborigine as a farm labourer are worthy of the highest consideration. In general he said that the aborigines were poor labour in the sense of bringing little skill and understanding to the task. Their industry has little persistence, and a task set them must be watched until its completion. In the handling of animals, in the care of material, and the adjustment of the means to the end in the usual farm operations, they cannot be left to themselves. In all his experience the farm manager said he knew of only one native, and he was a half-caste, who might have been competent to farm on the share system with any prospect of success.

The schoolmaster was of the opinion that the aboriginal child exhibited a fair degree of competence in mastering and producing that sort of learning in which the exercise of the memory was the most important factor. However, subjects, and in particular arithmetic, where progress depended far more on the ability to solve problems, they were very slow and, in fact, never proceeded far.

The matron of the hostel, a most kindly lady, had never seen a native girl who was able to cut out a dress from a pattern, though many of them sewed quite well. Their standards in dress and colour, judged by the standards they tried to imitate, remained very rudimentary. In cooking, by constant practice, they achieved a fair measure of success, as in baking bread, for instance, but any kind of planning or provision beyond the immediate object seemed never to occur. The constant preoccupation of the matron was what the girls would do after the age of puberty. No amount of teaching ever made her feel sure that these girls would remain chaste for long. It is difficult to decide whether "taking to the bush with the men" is due to the strength of their feelings, or their feeble self-control, or their lack of comprehension of any other standard. The opinion seemed to be that their conduct was due to the first and the last of these suppositions.

Evidence from Games.—The football team drawn from the mission station is keen, skilful, and often successful. In addition to their skill, the other feature which has impressed impartial observers is the excellent team spirit. We were assured, and our own observation of one match substantiated this testimony, that the members of this team played so that their side might win, and each player would sacrifice an opportunity of individual distinction in the interests of the team. Attempts to tamper with their loyalty to the team have been made, we were told, but they have been invariably unsuccessful.

Along with these admirable qualities, there exists the quaint but interesting fact that the players don their football costumes at the beginning of the season and never take them off until the season is over.

Group Tests.—We shall now describe a few group tests. We think games provide one kind of test of what we are trying to get at, the ability of aborigines, because the aborigine is fond of games and plays them with keenness. They did form part of his own civilization, throwing the kookara, for instance. One simple game we played with them was passing the peg. Two rows, one of aborigines and one of white, were formed, and each row passed a peg from individual to individual. The game was won by the row which passed it the faster. This game is played very often at the hostel by natives in the station. The whites won the game for this reason. Though we had never played it before, it was immediately apparent that if we watched our immediate neighbour so that our eyes were on the peg, and if each did this we conformed to the fundamental principle of all games, *viz.:* "keep your eye on the ball." The aborigines had not discovered this, for they turned to pass the peg and thus kept losing sight of it.

Another group test used was to arrange three rows of candles, one behind the other, each row containing seven candles. The object was to light as many candles as possible with one match. Obviously the angle at which the match is held will be a factor determining the rate at which the wood is consumed. And again, if the back row is lighted first the succeeding rows can be lighted without the hand being scorched. Repeated attempts failed to bring home to the native contestants either of these points, and their performance in the best cases was less than half that usually achieved at childrens' parties. (The highest three scores of aboriginal girls averaged six. Fifteen is a common score at a party.)

We were present at a reading of the Scriptures and an examination of the young men and women in the instruction they had received from the pastor in the previous week. They might be said to read, but none managed it with any ease or feeling, and their rendering was monotonous and, we infer, without much understanding of the passages involved.

One other test we participated in along with the aborigines. The test might be ranked as a scientific one, except that certain elements should have been more rigidly guarded. The test consisted of the exhibition of thirty common articles, *e.g.,* bottle, cork, corkscrew, and so on. Each article was held up so that all could plainly see it for about five seconds, and then covered up. When the series had been exhibited in this way, we were all required to write down the names of as many articles as we could remember. The highest score was 26 obtained by a half-caste. Several girls scored 20 to 23. The scientific expedition averaged about 19, and one of their members, with 8, got the booby prize. This test, we consider, is largely one of reproduction, and ability only comes in when one arranges a classification of the articles in one's mind as one sees them held up. Practice would facilitate the introduction of the associative element. Our subsequent enquiries led us to infer that the aborigines relied entirely on memory, and the test is of interest in that it confirms the opinion that the power of memory amongst the aborigines would be of the same average order as amongst ourselves.

Our Own Interrogations.—We now present a few illustrative cases of our interrogations. A female aborigine, aged eighteen, had been educated at the mission station and had reached the third grade of the school. These grades correspond to the numbers in the State elementary schools. She had ceased to attend the school two years ago. She can describe the process of baking bread and can give a very good account of the procedure carried out when preparing yeast. When asked how she would prepare a rabbit for eating, she replied that she would fry it. She has some knowledge of geography and can say in general where Japan is, and how you would proceed if you wished to go to Melbourne or to the city of Adelaide. She does not know the simple arithmetical tables and cannot tell how many shillings go to the pound. In the candle test she averaged less than eight candles in three successive tests. In the memory test, reproducing the names of the articles shown, she scored 19, which was very good. The girl was among the more intelligent, Others who had been as long in the school were unable to recite the alphabet or to give the succession of numbers from twenty onwards. Any arithmetical problem, such as the value of twelve articles when one cost threepence, none of them succeeded in solving. The meaning of words such as religion, present, gift, moment, etc., they were unable to explain.

An aboriginal male aged 25 reached the fifth grade of the school and was considered a very good pupil. At the selection of the coloured wools he performed moderately, getting less than half the skeins of the corresponding colour. On the farm he has tried to learn to shear, but has not become even tolerably proficient. He has learnt no trade. His work is ploughing, but he does not know how many acres a day he can plough (some were able to tell us this). He does not know what becomes of the wheat when harvested. He does not know the meaning of the word bushel, and can give no idea of how much wheat there is in a bushel. He has no idea of the monetary value of wheat. He can recognise on the map such countries as England, but can suggest no reason why wheat should be sent to England. He can give no reason why some countries are hot and some cold, etc. This is a fairly typical investigation.

Such an aborigine, though employed daily on the farm, will assure one that he knows superphosphate, but has no idea what it is used for. We found that practically none of them had what might be called "money sense." Calculations of the order of one article costs threepence, how much would twelve cost? were too difficult for them. Arithmetic, even of the most elementary kind, does seem to present them with very great difficulty. A group of six girls, all of them either attending the school or just left the school, were examined on the multiplication tables. Only one attempted the twelve times table, and she made several mistakes in the attempt. To two young men who had attended the mission school and who were enthusiastic and skilled members of the football team, the problem was put: If one side scores seven goals and the other scores six goals six points, what would be the result? They were extremely puzzled and tried hard to find the answer. Each picked up a pencil and paper and tried to get an answer. It was clear they had the relevant information and even some idea of how an answer might be got, but they were unable to get the correct result. When the problem was explained, they seemed to appreciate the way in which it could be solved.

We record the attempt of a young man, 22 years of age, who had reached the fifth grade of the mission school, to find the number of pence in a pound. He knew the number of shillings in a pound and the pence in a shilling, information not often obtained in our interrogations. He worked in the following way—

$$\begin{array}{r} 20 \\ \times 12 \\ \hline 42 \\ 31 \\ \hline 352 \end{array}$$

We noticed among the young married women this same inability to think in numbers. A store is kept at the station, and it is customary for the families to make purchases there. These aboriginal women would purchase constantly at the store, but they never had any idea of the price of the articles they purchased. They brought whatever money they had, asked for what they wanted, and tendered all their money. They took whatever change might be given them. The store was looked after by the schoolmaster. He confirmed our own observations, and remarked that none of them had any idea of money.

It is perhaps a slight testimony to the usefulness of our interrogations that they brought out differences in the intelligence of individual aborigines. Investigators have remarked that previous attempts to value intelligence in different races have shown differences between races, but these differences have been less great than the differences between the individuals of the same race. One adult full-blooded aborigine whom we questioned seemed much more intelligent than the others. So much was this the case that we took special care to verify that he was a full-blood. And, indeed, it seemed that there was no reasonable doubt that he was a full-blooded native. This man is a farm worker. He told us a good deal about superphosphate and the role it played in farm work. He told us most of their wheat went to England, and England was a very small place with many people; therefore there would be difficulty in growing sufficient wheat there. Pointing to the map he showed us where England was, remarking on its distance from the torrid zone, indicated the position of the equator, and told us that the further you proceeded from the equator the colder it became. He can read, compose a letter, is a good shearer, and has a great deal of knowledge about such things as edible plants, and so forth. All his knowledge he is ready to impart. In sorting the skeins of wool he obtained the best score. His visual acuity was ordinary, being 26 feet by the test we used.

These examples are sufficient to show how we tried to get some measure of the aboriginal intelligence. It is, of course, no standardised procedure and will permit no very secure conclusions. Nevertheless, we venture to infer that if our random sample is at all representative aboriginal ability is of a poor kind, and certainly is far below the level necessary for any sort of successful adaptation to a white environment.

For various reasons, age, illiteracy, and so forth, the number we examined is very small. Of the fourteen examined on the plan already outlined, we conclude that one has fair ability, and that thirteen range from poor to very poor. The tests we applied are quite fairly within the scope of an average 8-year-old white child.

We would again say that we have been searching for some estimate of ability, and by ability we mean the power of perceiving the relations between things apprehended by the mind. We do not forget that successful adaptation to an old or to a new environment depends on other things beside ability—the power to resist the white man's diseases, the white man's vices, and the desire to succeed. It has been said (Rivers) that native races lose interest when their own culture is displaced, and they despair when faced by a new environment. We have no means of testing this hypothesis, but the demeanour of these natives does not suggest a hopeless pessimism. Their keenness on games, their readiness to sing, their friendliness and humour, their anxiety to participate and do well in these tests, rather suggest that their competitive instinct is by no means inactive.

We believe that this preliminary investigation is sufficient to warrant a more extensive investigation of aboriginal performance and ability by methods which have become frequent and familiar in our own schools.

Summary.

1. The results of certain physiological tests on the Australian aborigines are presented.
2. Tests of various kinds of sensory acuity are presented. There is some evidence for believing that their visual acuity is of a high order.
3. Some attempt has been made to assess their intelligence. There is the usual individual variation, but the average level is low.

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ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY: CENTRAL AUSTRALIA.

No. 7—PHYSIOLOGICAL AND PSYCHOLOGICAL OBSERVATIONS.

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[Read April 10, 1930.]

[This work was carried out at the Hermannsberg Mission Station in August, 1929. All adult natives tested were full blood.]

A.—An Investigation of the Visual Spatial Perception of the Australian Native.

Experiments which were carried out with this object fall into four groups:—

I. Estimation of the lengths of simple straight lines.
II. Reaction to the Müller-Lyer Illusion.
III. Estimation of horizontal and vertical lines.
IV. Interpretation of pictures showing an illusion based on strong lines of perspective.

1. Estimation of the Lengths of Simple Lines.

This was carried out by two independent sets of trials:—

1. A slide was prepared on the principle of the slide used by Professor Rivers in the Cambridge Anthropological Expedition to Torres Straits, Reports Vol. II., p. 117. The apparatus was made of strong white cardboard. A line, 75 mm. long and not quite 1 mm. wide, was drawn on the face of the slide, finishing 1 cm. from its proximal edge. This slide over-rode a similar line 170 mm. long, drawn so that it underlay exactly the first-mentioned line. Movement of the slide cut off any desired length of this second line. The test subject was instructed to move the slide until the two lines were of equal length. This estimated length was then read off on a scale on the back of the slide. The natives were very uncertain of the meaning of equal. A man would set the slide. A query then as to which line was big one, would lead to an instant indication of one or the other line. He would then make the alteration in the direction required by his answer. The performance might be gone through several times before final satisfaction was obtained. Only three men, Numbers 49, 53, and 56, went about the test confidently and straightforwardly. Comparative results starting from a closed or an open position of the slide respectively were, therefore, impossible. The results of the tests are given as the average estimates, with the mean variations.

2. The second series of tests consisted in obtaining judgments of the comparative lengths of lines prepared according to the standard Binet-Simon tests for the fourth- and thirteenth-year groups. The results are given in tabular form. If judged correctly, a dot marking is shown, if incorrectly, a mark 1+ or 2+ is made to indicate that the first or second line was stated erroneously to be the longer.

Estimation of Lengths of Simple Lines.

Serial Number.	Sex.	Age.	Years School.	SLIDE TEST. No. of Trials.	Average Result.	M.V.	BINET-SIMON LINES. 5 cm. 6 cm.	4 cm. 5 cm.	5 cm. 6 cm.	6 cm. 7 cm.	7 cm. 7 cm.	7 cm. 7 cm.	7 cm. 7 cm.
1	M.	55	0	Failed									
2	M.	40	0	2	77·00	3·00	.	.	1+	.	1+	1+	1+
3	M.	55	0	Failed									
5 ..	M.	55	0	6	75·50	6·20	.	.	.	.	1+	1+	1+
7	M.	40	0	Failed									
8	M.	45	0	Failed									
9	M.	45	0	Failed			.	.	.	.	2+	2+	2+
10	M.	45	0	4	69·75	5·25	.	.	.	.	.	1+	1+
11	M.	65	0	6	76·33	4·11	.	.	.	.	2+	.	1+
16	M.	60	0	Failed									
19	M.	21	0	6	70·11	0·15	.	.	.	.	.	.	.
20	M.	55	0	6	76·11	2·50	.	.	.	.	1+	1+	1+
21	M.	20	0	6	69·50	2·66	.	.	.	.	.	.	.
22	M.	24	0	6	70·50	2·33	.	.	.	.	1+	1+	1+
23	M.	30	0	6	71·83	2·83	.	.	.	.	.	.	.
25	M.	25	0	4	72·75	2·25	.	.	.	.	.	.	.
35	M.	40	6	6	71·16	2·90	.	.	.	.	.	.	.
36	M.	18	4	6	73·00	3·66	.	.	.	.	1+	1+	1+
37 ..	M.	18	4	5	74·60	0·56	.	.	.	.	2+	1+	1+
39	M.	50	?	3	72·66	1·91	.	.	.	.	.	.	.
42	M.	25	4	4	71·00	0·25	.	.	.	.	1+	1+	1+
43	M.	26	6	5	71·25	2·05	.	.	.	.	.	.	.
45	M.	24	0	2	70·00	.	.	.	.	.	1+	1+	1+
49	M.	25	6	3	71·00	0·66	.	.	.	.	.	.	.
50	M.	30	6	2	72·50	2·50	.	.	.	.	.	.	.
52	M.	45	6	4	73·75	1·25	.	.	.	.	.	.	.
53	M.	22	6	3	75·66	0·88	.	.	.	.	1+	.	.
54 ..	M.	25	0	3	73·00	2·00	.	.	.	.	.	1+	.
56	M.	20	6	3	75·33	0·44	.	.	.	.	2+	2+	2+
105	M.	15	4	4	71·25	2·75	.		.	.	.	.	.
102	M.	13	1	—			.	.	.	.	.	.	.
101	M.	11	3	—			.	.	.	.	1+	2+	2+
60 ..	F.	22	0	Failed			.	.	.	.	2+	2+	2+
66	F.	25	0	Failed			.	.	.	1+	1+	1+	1+
69	F.	44	0	Failed									
103	F.	18	5	—			.	.	.	.	.	.	.

Average estimation, 72·73%, which represents an average error of 3·03%.

The results prove that most of the subjects are capable of making a fairly accurate estimate of the length of a line. Further, they supply a control experiment to the use of the slide for the Müller-Lyer illusion.

A low mean variation in the slide test was expected to give a relative test of intelligence. It was, however, observed that some of the lowest mean variations appeared to be due to repetitions of a former judgment not dependent on free estimation, but rather on some locally recognised point on the apparatus.

2. Reaction to Müller-Lyer Illusion.

A slide apparatus was prepared in white cardboard similar in construction to that of Rivers, Ibid. Reports, Vol. II. p. 117, but with the revisions figured in Brit. Journn. Psych., Vol. I., p. 356. A control test was prepared by drawing three sets of the illusion on cardboard strips. The diagram of each was identical with the slide apparatus scheme, but the length of line, included between the obtuse angles of the oblique lines, was made 75 mm., 65 mm., and 60 mm., respectively, the line between the acute angles of the oblique lines being constant at 75 mm. Results are given in the following table. When the line between obtuse angles is stated to be greater, equal to, or less than the constant line, the signs +, =, or — are shown, respectively, in the table. An approximate reading for the illusion based on this control experiment is placed in the last column.

The subjects who failed in the previous experiment with the simple line apparatus were not tested with the slide apparatus for this illusion, but sometimes gave readings with the prepared sets.

Care was taken in carrying out the tests with the slide and with the set diagrams that the figure was viewed frontally and not at an angle. Further, the three set diagrams were submitted in regular order—firstly the one with the longest variable line, then the mean, and finally the figure with the shortest variable line. The middle member of the series was always presented in reversed relation to the other two, in order to avoid a habit of pointing to the right or left half of the figure.

Müller-Lyer Illusion.

					MULLER-LYER ILLUSION REACTION.						
					SLIDE TEST.			SET DIAGRAMS.			
Serial Number.	Sex.	Age.	Years. School.	Average Result Line Test.	No. of Trials.	Average Result.	M.V.	V. 75.	V. 65.	V. 60.	Approx. Reading.
2	M.	40	0	77·00	2	60·00	5·00	+	+	+	55
5	M.	55	0	75·50	4	40·00	5·00				
7	M.	40	0	—	—			+	+	+	55
10	M.	45	0	69·75	4	54·75	4·87	+	+	+	55
11	M.	65	0	76·33	4	56·25	2·75	+	+	+	55
19	M.	21	0	70·11	6	56·00	3·00	—	—	—	80
20	M.	55	0	76·11	6	60·66	2·83	+	+	+	55
21	M.	20	0	69·50	6	58·33	2·43	+	+	=	60
22	M.	24	0	70·50	6	54·66	3·33	+	+	+	55
23	M.	30	0	71·83	4	57·50	0·50	+	+	+	55
25	M.	25	0	72·75	6	60·66	2·56	+	+	=	60
35	M.	40	6	71·16	6	58·00	1·33	+	+	+	55
36	M.	18	4	73·00	2	58·00	0·00	+	+	+	55
37	M.	18	4	74·60	6	60·50	2·00	+	+	+	55
39	M.	50	?	72·66	3	57·00	2·00	—	—	—	80
42	M.	25	4	71·00	4	58·25	1·00	+	+	+	55
43	M.	20	6	71·25	4	62·50	2·00				
45	M.	24	0	70·00	1	55·00	·	+	—	—	70
49	M.	25	6	71·00	3	52·33	1·56	+	+	+	55
50	M.	30	6	72·50	2	61·00	1·00	+	=	=	62·5
52	M.	45	6	73·75	4	62·75	4·25	+	+	=	60
53	M.	22	6	75·66	4	62·50	2·25	+	+	—	62·5
54	M.	25	0	73·00	3	54·00	2·66	+	+	=	60
56 ...	M.	20	6	75·33	4	60·50	2·50	+	+	+	55
105	M.	15	4	71·25	4	60·50	5·00	+	+	+	55
102	M.	13	1	—	—			+	+	=	60
101	M.	11	3	—	—			+	+	+	55
60	F.	22	0	—	—			+	—	—	70
66	F.	25	0	—	—			+	+	—	62·5
103 ...	F.	18	5	—	—			+	—	—	70
	Average result					57·57			Average	....	60·1
	Average result, excluding No. 5					58·33					
	M.V. of average results					2·46					
	Average 11 males, no school					57·07	....	....	....	....	60·0
	Average 11 males, with school					59·71	....	....	....	....	57·0

The true average of the series is 58·33, as the result of No. 5 is anomalous, and he completely broke down in an attempt at the next slide test of horizontal and vertical lines. The older men were much more difficult to test than the younger men, and they quickly tired and lost interest. No. 5 was 55 years of age.

The results of Nos. 19 and 39 with the diagrams are quite inexplicable. They reacted well with the slide, and in each case the test with the diagram was repeated after the slide test and gave exactly the same judgments.

Rivers (Brit. Journ. of Psych., Vol. I., p. 357) gives the following average reactions to this illusion:—Todas, 59·8; Murray Islanders, 61·1; Uralis and Sholagas, 55·3; English, 57·9.

The results of the present series of tests, therefore, approximate most closely to those obtained by Rivers with the English.

The remarks concerning mean variation and intelligence, previously stated, apply also in this case. No final judgment of equality could be obtained in the tests with Nos. 36 and 45. Their statements of big one and little one were, however, narrowed down to a difference of less than a millimetre of movement of the slide, and this reading was accepted as an estimate of equality.

3. Reaction to the Illusion of Contiguous Horizontal and Vertical Lines.

This is another test in visual spatial perception which Rivers used in his investigation of the natives of Torres Straits. The method of Rivers (Reports, Vol. II., p. 108) was to draw a horizontal line 100 mm. in length and ask the native to draw, firstly a vertical line of equal length from the centre of the former line, secondly a similar vertical line from the extremity of the horizontal line, and thirdly a vertical line through the centre of the horizontal line, forming a cross with it. The average results obtained by Rivers for Murray Island men, for the three sets of lines, were 65·7 mm., 77·0 mm., and 90·1 mm., respectively. Children, white and black, exhibited a less degree of illusion; British students still less so, *viz.*, 89·0, 92·5, and 94·5. Todas (Brit. Journ. Psych., Vol. I., p. 339) gave reactions of 75·7, 87·6, and 95·4, respectively.

The method employed to test the Australian native was a further development of the slide method. A line 100 mm. long was drawn, and a long line drawn at right angles to this, making a "T" with a long tail. A blank slide was arranged to cover any desired length of this tail. The native made two series of estimations with this apparatus. Firstly, the slide was held so that the "T" faced him with the tail vertical to his front. Secondly, the "T" was placed with the tail parallel to his front and the cross piece to his right. The native was instructed to move the slide until the tail appeared equal to the cross piece. A series of readings was taken in each position, the result being read off by means of a scale on the back of the slide. The following is a table of the findings:—

	T Vertical.			T Horizontal.		
Serial No. of Aborigine.	No. of Trials.	Mean Result.	M.V.	No. of Trials.	Mean Result.	M.V.
2	4	79·75	8·12	4	81·00	5·50
5	Failed					
10	6	75·66	12·90	6	72·00	6·33
11	6	82·66	19·80	6	75·00	6·66
19	4	61·25	2·00	4	74·75	1·75
20	4	80·50	2·50	2	66·50	1·50
21	4	81·25	3·12	4	91·50	7·00
22	6	78·00	2·33	6	94·33	3·23
23	4	81·75	1·75	4	88·25	3·25
25	4	84·75	2·25	4	90·00	4·00

Serial No. of Aborigine.		T VERTICAL. No. of Trials.	Mean Result.	M.V.	T HORIZONTAL. No. of Trials.	Mean Result.	M.V.
35	....	4	71·25	3·87	4	82·25	1·25
37	....	6	78·66	2·56	6	74·66	1·76
39	....	Failed					
36	....	Failed					
45	....	Failed					
42	....	4	73·50	2·25	2	74·50	1·50
43	....	3	72·00	0·00	4	66·75	3·75
49	....	2	73·50	1·50	2	79·00	1·00
52	....	3	81·33	2·23	3	84·33	7·43
53	....	2	77·50	2·50	2	99·00	1·00
54	....	2	53·50	1·50	2	56·00	2·00
56	....	3	74·33	3·76	2	87·50	2·50
		Average	75·62	....	....	79·85	

There is little to be said of these results, except to note the large mean variations of the first three cases. This is probably a fatigue effect.

4. Recognition of Perspective in Pictures.

Mr. L. Howie, Director of the School of Design, kindly supplied the sketches for this test.

As a preliminary to the perspective pictures, four animal sketches were submitted for identification. The first was a copy of a native rock drawing in the possession of the school. It had the general shape and proportions of a kangaroo, but the open mouth showed a long row of teeth, and the hind feet were bent back and ended in four radiating toes. The second was a native drawing of an emu, distorted and conventional in design but recognisable. The third was an excellent sketch of a native companion, a bird of the crane family, but foreign to Central Australia. The fourth a realistic sketch of a dingo. The object of this preliminary test was to gauge the ability of the natives to identify a picture as a representation of a known object. I remember many years ago a lecture by a prominent artist in defence of the post-impressionist school of the time, in which he argued that a South African Bushman could interpret a crude native drawing as a representation of an animal, but failed to recognise that animal when portrayed in a photograph. The argument ran that the unbiassed visual perception of the Bushman recognised a realism in the crude native drawing which European education had destroyed in its protegees, until rediscovered by the post-impressionists.

Twenty-eight aborigines were tested with the above four pictures. The dingo was recognised by all. Picture No. I., in twenty-four cases, drew a simple comment of "Don't know," or "Can't know him." No. 23 stated, "Make him along Adelaide, can't know him." No. 2 guessed, "Think emu." Nos. 7 and 19 guessed "alligator." This picture, in almost every case, caused an outburst of merriment. Picture No. II. was called an emu seventeen times, a turkey once; other cases, "Don't know." No. III. was called an emu twelve times, a turkey once, an ostrich once, seven men stated they did not know, and seven men who had travelled into lake country recognised it. In one of the perspective pictures two kangaroos were drawn "normally" in black silhouette. These were recognised as kangaroos without exception. Sixteen of these twenty-eight natives had had no school instruction at all. These men undoubtedly were able to recognise known animals in what an ordinary European would call a good drawing. When an unknown animal was "well drawn," or a known animal represented in the conventional drawing of a kindred tribe, they guessed, or confessed ignorance of the object represented.

The pictures used to test the recognition of perspective were two black and white sketches. The first portrayed two kangaroos in a perspective scheme comprising a road, a fence, and a telegraph line with poles. The second showed two blackfellows armed with boomerangs in the verandah of a house in sharp perspective. In both cases the two figures were identical in outline and size, but the setting of the figures was such that the illusion was presented strongly that the back figure was at least twice the size of the front figure.

These pictures were presented one at a time to the native who was being examined. He was asked to say what he saw. A more or less complete enumeration of the items of the picture followed. In only two cases was there any interpretation of the picture as a whole. Nos. 7 and 16 called the blackfellow picture "kurdaitja," *i.e.*, an avenging party. The examinee was then asked if the two figures were one little one, one big one, or all the same size. In each case where there was a judgment of a large and a small figure, a finger was pressed on the figure judged and the remark made, "That big one," "that little one," or words with that significance.

The results are summarised in the two following tables. The first concerns the natives who have had no schooling, the second those who have had school training. The method of recording results in the table is to place a "+" mark under "Front" or "Back" to indicate that the front or back figure was judged the larger, a "=" mark under "Both =" to record a statement of equality.

Pictures.—Natives without Schooling.

Serial No. of Aborigine.	Sex.	Age.	KANGAROOS. Back +	Both =	Front +	BLACKFELLOWS. Back +	Both =	Front +
21	M.	20		=			=	
19	M.	21	+				=	
22	M.	24			+			+
45	M.	24			+		=	
54	M.	25	+				=	
25	M.	25		=				+
23	M.	30		=			=	
2	M.	40			+			+
7	M.	40	+					+
8	M.	45	+					+
9	M.	45			+			+
1	M.	50	+					+
3	M.	55	+					+
5	M.	55			+			+
20	M.	55	+					+
16	M.	60			+	+		

It will be seen that a judgment indicating a perception of the illusion usually is countered by an opposite decision in the second picture, signifying the even chances of a pure guess. But No. 16 discovered the illusion, apparently, as he stated: "Young man," pointing to the front figure; "old man," pointing to the back figure. Nos. 19 and 54 may have seen the illusion in the kangaroo picture, as their judgments are qualified by a statement of equality regarding the figures of the second picture. Not more than three, therefore, of the thirty-two judgments recorded indicate an interpretation of the perspective of the drawings.

Pictures.—Natives with School Experience.

Serial No. of Aborigine.	Sex.	Age.	KANGAROOS. Back +	KANGAROOS. Both =	KANGAROOS. Front +	BLACKFELLOWS. Back +	BLACKFELLOWS. Both =	BLACKFELLOWS. Front +
101	M.	11	+			+		
102	M.	13		=			=	
105	M.	15	+			+		
36	M.	18	+			+		
37	M.	18	+			+		
43	M.	20		=			=	
56	M.	20		=		+		
53	M.	22	+			+		
42	M.	25			+			+
49	M.	25	+			+		
50	M.	30	+			+		
35	M.	40	+			+		
52	M.	45	+			+		
39	M.	50		=			?	

This table shows very different results, surprisingly so, as in the course of the examination the good and indifferent results seemed hopelessly confused. The school history was obtained later, and provided the key to the situation.

No. 102 had had only eighteen months schooling and was still unable to read.

No. 39 was said to have had some schooling, but the amount was unknown. His judgment on the blackfellows was, "That big one, that one little one; yes, same size, one little one, one big one."

Apart from these two natives, the results of the twenty-four judgments of the other twelve subjects show only five in which the perspective was not visualized.

The interpretation of perspective is not a matter of intelligence but of experience. My daughter, four years of age, ignorant of letters but well acquainted with pictures, stated that the front figure in each of the pictures was the baby one, when asked if the figures were the same size or not.

B.—DISCRIMINATION OF NUMBERS BY THE AUSTRALIAN ABORIGINE.

The natives at the Mission were almost entirely of the Aranda nation. There are native names for numbers in the Aranda language up to four, *viz.:* Ninta, one; tara, two; taramininta, three (two and one); taramatara, four (two and two). Beyond this there are native words meaning some, a few many, and very many, but no higher numerals are given special words. The proposed investigation had the object of discovering whether this vagueness of terminology covered the extent of the natives' ability to distinguish numbers.

A suggestion had been received that Professor Porteus was using cards with spots in an investigation of this nature in North Western Australia, so the same idea was employed in the hope of obtaining comparable results.

White cards were prepared, nine centimetres square, with black spots about four millimetres in diameter, ranging from one to forty in number.

The intended nature of the test was to find out how far the natives could arrange the cards in serial order from one to forty. When the test was applied it was found that the number of cards was too great. Cards one to twenty-one were used in consequence. These cards were spread out before the native being examined. The proposal to arrange the cards in sequence from one to twenty-one was explained in Pidgin English and such few native words that were at command, combined with a demonstration. The cards were then mixed up and the native told to make the attempt.

The results were as follows, in the order in which the natives came up for examination. Sometimes the native was given a start by placing cards, 1, or 1 and 2, to help him begin. Any cards so placed are enclosed in brackets in the records:—

No. 2. Parkbaga.—Male, circ. 40 years, no school. Cards arranged thus:—(1, 2), 8, 16, 3, 4, 10, 5, 14, 11, 13, 15, 7, 9, 12, 17, 6, finished.

No. 3. Mangaraka.—Male, circ. 55 years, no school. Started with 2, arranged others thus:—4, 10, 1, 2, 3, 6, 11, 13, 12, 8, 15, 7, 5, finished.

No. 1. Aldinga.—Male, circ. 50 years, no school:—1, 2, 3, 4, 5, 11, 12, 8, 7, 17, 10, 13, 9, finished. This man counted eleven spots on the sixth card but placed it next to 5, in spite of a challenge.

No. 5. Rodney.—Male, circ. 55 years, no school:—10, (1), 2, 12, 21, 6, 17, 13, 7, 9, 11, 3, 8, 4, 16, 15, 5.

No. 105. Henoch.—Male, 15 years, 4½ years school. This boy counted the spots carefully and arranged them correctly in 7½ minutes.

No. 7. Engerilyeka.—Male, circ. 40 years, no school, but in gaol as a young man:—5, (1), 2, 3, 4, 7, 9, 8, 6, 15, 17, 10, 21, 20, 18, 14, 13, 11, 12, 16, 19.

No. 9. Mulkunda.—Male, circ. 45 years, no school:—(1), 2, 3, 4, 11 (withdrawn on challenge), 5, 11, 12, 10, 7, 6, 13, 9, 20, 17, 14, 8, 16, 15, 19, 21, 18.

No. 8. Minuka.—Male, circ. 45 years, no school. No amount of explanation could make this man understand what was required of him. He was shown cards 5 and 10 and asked on which one big mob marks sit down, on which one little mob sit down. Mr. Heinrich, of the Mission staff, who speaks the language fluently, tried to help the man to make a decision between the two cards. The only responses obtained were, "Can't know him," "Don't know."

The state of affairs at this stage was most unsatisfactory. Mr. Heinrich then appeared with two cards, representing realistically a flight of three and a flight of five ducks, respectively. These were used as the basis of the explanation of big mob and little mob. The spot cards were then presented in pairs for a similar decision. Care was taken that the positions in which the cards were presented were altered frequently, but irregularly, so that the judgment should not be merely a habit of pointing to the left or right card. The examination of the natives on these lines gave the following results. In recording the experiments, the numbers of the pairs of cards are given in ordinary figures if judged correctly, but are in italic figures if wrongly judged. If the cards were wrongly stated to be equal the sign = is added; if the smaller figure was mistaken for the larger the sign + is added. Further, if the spots were counted, the letter "c" is added; if the spots were not counted, no letter is added. If the spots were incorrectly counted, the incorrect count follows the letter "c."

No. 11. Maleki.—Male, circ. 65 years, no school:—Birds; 3, 19; 5, *7* first +, then corrected; 9, 14; 20, 21; 13, 17; *13, 14*+; 12, 15; 10, 11; 23, 27; *22, 24*+; 29, 28; 36, 30; *31, 32*+.

No. 12. Murunda.—Male, circ. 45 years, no school:—Birds; spots failed.

No. 13. Tapanya.—Male, circ. 35 years, no school:—Birds not understood.

No. 16. Wabiti.—Male, circ. 60 years, no school:—Birds correct after much explanation. Spots failed.

No. 10. Naitata.—Male, circ. 45 years, no school:—Birds; 4, 6; 11, 12; *23, 20*+; 13, 14; 17, 21; 29, 31=, then corrected; 15, 16; 32, 38+, then corrected; *36, 39*=.

A younger and brighter set of men were now available for testing, so cards 1 to 10 were given to place in order of sequence.

No. 19. Tondalbinga.—Male, circ. 21 years, no school:—Birds; Cards: 1, 2, 3, 5, 4, finished. 5, 6 c; 7, 8 c; 12, 13 c; 11, 17; 17, 18 c; *25, 26=*; 31, 33; 22, 38; *31, 38+*.

No. 22. Ally.—Male, circ. 24 years, no school:—Cards: 1, 2, 3, 4, (5) helped, 6, 7, 8, 9, 10. Counted 9 as 10, *14, 15+* c *14, 13;* 11, 12; 17, 20 c; 25, 26 c 24, 26; *31, 33+* c *32, 24*; 22, 39 c 22, 40.

As a considerable amount of counting was going on, it was then decided to record ability to count to 20, followed by the eighth year Binet-Simon test of ability to count backwards from 20 to 1 in about 30 seconds.

No. 21. Korongili.—Male, circ. 20 years, no school:—Counts 20, not back. Cards: 1-10 correctly, without help. *14, 15+* c. *15, 14*; 11, 12 c.; 17, 20 c.; 25, 26 c; 31, 33 c; 31, 32.

No. 25. Tundabinya.—Male, circ. 25 years, no school:—Cannot count 20. Birds; Cards failed; *7, 9=*; 5, 6; 7, 8; 22, 39; *33, 39=*; 31, 39; 31, 33; *25, 26=*; *17, 20=*; *11, 12=*; *13, 14+*.

No. 23. Kurumalyi.—Male, circ. 30 years, no school:—Birds; 4, 5 c; *7, 8+*; *13, 14+*; 7, 8; *13, 14=*; *17, 20=*; *31, 33=*; *24, 25=*; 26, 38.

No. 35. Ezekiel.—Male, circ. 40 years; school, 6 years:—Counted 20, and back. Cards: 1-8, correct; 1-10, failed. 11, 12; *13, 14+*; 17, 20; 22, 25; 32, 39; 31, 33.

No. 37. Kangei.—Male, circ. 18 years; school, 4 years, off and on. Mr. Heinrich states very dense. Counts 20 and back:—Cards: 1, 2, 3, 4, 5, 6, 7, 8, *10, 9*. 11, 12 c; 13, 14; 22, 25; 31, 32.

No. 39. Namitjera.—Male, circ. 50 years; some school, unknown quantity:—Cannot count; cannot place cards. 6, 9; 9, 10; 11, 12; *17, 18+*; 32, 39; *13, 14=*; 22, 25; *31, 32=*.

No. 20. Tjilba.—Male, circ. 55 years, no school:—Counts 20, not back. Cards: 1, 2, 3, 4, 5, 7, 8, 10, 6, 9. 9, 10; 11, 12; *17, 18+*; 32, 39; *13, 14+*; 22, 25; *31, 32=*.

No. 45. Dr. George.—Male, circ. 24 years, no school:—Counts 20, not back. Cards: 1, 2, 3, 4, 5, 7, 6, 10, 9, 8. 9, 10; 11, 12; 17, 18; 32, 39; 13, 14; 21, 23; *31, 33+*.

No. 43. Gustav.—Male, circ. 20 years; school, 6 years, not continuous:—Counts 20 and back. Cards: 1-10, correct—counted, bothered with 9 and 10. *11, 12=*; *17, 20=*; *32, 39=*.

No. 42. George.—Male, circ. 25 years; school, 4 years, not continuous:—Counts 20, and back; one slip, 11, 9, corrected spontaneously. Cards: 1-10, correctly and quickly. 11, 12; 17, 18; 32, 39; 31, 33.

No. 52. Tom.—Male, circ. 45 years; school, 6 years:—Counts 20, not back. Cards: 1, 2, 3, 4, 6, 7, 5, 9, 8, 10. 9, 10; *13, 14+*; 22, 26; 11, 12; 17, 18; 32, 39; *31, 33+*.

No. 50. Erukinja.—Male, circ. 30 years; school, 6 years:—Counts 20, not back. Cards: 1, 2, 3—then watched my face, waiting for an indication for next choice. 9, 10; 13, 14; 22, 26; 11, 12; 17, 18; 32, 39; *31, 33+*.

No. 54. Uki.—Male, circ. 25 years, no school:—Counts 20, not back. Cards: 1-10, correctly and quickly. 13, 14; 22, 27; 11, 12; 17, 18; 32, 39; 31, 33.

No. 53. Lucas.—Male, 22 years; school, 6 years:—Counts 20, and back. Cards: 1-10, correctly and quickly. 11, 14; 22, 25 c; 11, 12; 17, 20; 32, 39; 31, 33.

No. 56. Powell—Male, circ. 20 years; school, 6 years—broken, running away:—Counts 20, and back; one mistake, reversing 14, 15, and needed encouragement. Cards: 1-10, correctly and quickly. 13, 14; 22, 25; 11, 12; 17, 20; 32, 39; 31, 33, after indecision.

No. 49. Albert.—Male, circ. 25 years; school, 6 years, not continuous:—Counts easily to 20, and back. Cards: 1-10, correctly and quickly. 13, 14; 22, 25; 11, 12; 17, 20; 32, 39; 31, 33.

No. 101. Percy.—Male, circ. 11 years; school, 3½ years:—Counts 20, not back. Cards: 1-10, correctly.

No. 102. Nikia.—Male, circ. 13 years; school, 1½ years:—Counts 20, not back. Cards: 1, 2, 5, 10, 9, 4, 8, 3, 7, 6.

No. 66. Yaberkulla.—Female, circ. 25 years, no school:—Counts 1-16, then 18, 19, 31. Unable to place cards. 5, 6; *9, 10+*; *7, 8+*.

No. 69. Minekata.—Female, circ. 44 years, no school:—"Can't know him."

No. 103. Veronica.—Female, 18 years; school, 5 years:—Counts 20, and back. Cards: 1-10, correctly and quickly.

No. 104. (¾) Eugenie.—Female, 14 years; school, 4½ years. Too shy to count. Cards: 1-10, correctly.

As counting spots on the cards is essentially the same as counting coins, some of the natives performed the sixth year Binet-Simon test of counting thirteen pennies.

The valuation of the judging of pairs of cards cannot depend primarily on a right answer. A blind guess has an equal chance of success or failure. A failure is, however, of importance, as it indicates an error in judgment or a blind guess, which is equally damning. The importance of this is shown in:—No. 37: no mistakes in pairing up to 31, 32, yet misplaces 9 and 10 in series; No. 53: no mistakes in pairing, yet had to count 22, 25 to be sure of his ground; and, finally, No. 56: no mistakes in pairing, yet showed indecision over 31, 33, indicating that his successful judgment was more or less of a guess.

The experiments do, however, disclose some degree of order of merit in estimating numbers. The index is supplied by the ratio of the difference between the two numbers to the lower number itself, *i.e.*, a failure in 5, 6 indicates a failure at the ratio 1:5; a failure in 17, 20, a ratio 3:17 or 1:5·7; a failure at 32, 39, a ratio 7:32 or 1:4·6. Of these three examples, 1:5·7 is a better result or rather a less error than 1:4·6, and so on. A summary has been drawn up on this basis of estimating merit.

The result expressing the highest error is taken in each test, and the index figure in the table is the value of "x" in the ratio 1:x for this error.

Discrimination of Numbers.

Serial No. of Aborigine.	Sex.	Age.	Years of School.	Index of Paired Card Judgment.	Cards Arranged in Sequence.	Counting, 1 to 20.	Counting Back, 20 to 1.
42	M.	25	4	16+	1—10	Yes	Yes
49	M.	25	6	16+	1—10	Yes	Yes
53	M.	22	6	16+	1—10	Yes	Yes
56	M.	20	6	16+	1—10	Yes	Yes
54	M.	25	Nil	16+	1—10	Yes	No
37	M.	18	4	16+	1—8	Yes	Yes
50	M.	30	6	15·5	1—3	Yes	No
45	M.	24	Nil	15·5	1—5	Yes	No
21	M.	20	Nil	14	1—10	Yes	No

Serial No. of Aborigine.		Sex.	Age.	Years of School.	Index of Paired Card Judgment.	Cards Arranged in Sequence.	Counting, 1 to 20.	Counting Back, 20 to 1.
22	....	M.	24	Nil	14	1—10	—	—
35	....	M.	40	6	13	1—8	Yes	Yes
52	....	M.	45	6	13	1—4	Yes	No
20	....	M.	55	Nil	13	1—5	Yes	No
39	....	M.	50	?	13	Nil	No	No
11	....	M.	65	Nil	11	—	—	—
66	....	F.	26	Nil	7	Nil	16	No
10	....	M.	45	Nil	6·7	—	—	—
23	....	M.	30	Nil	5·7	—	—	—
43	....	M.	20	6	4·6	1—10	Yes	Yes
19	....	M.	21	Nil	4·4	1—3	—	—
25	....	M.	25	Nil	3·5	Nil	No	No
16	....	M.	60	Nil	1·5+	—	—	—
12	....	M.	45	Nil	1·5+	—	—	—
8	....	M.	45	Nil	0	Nil	—	—
13	....	M.	35	Nil	0	Nil	—	—
69	....	F.	44	Nil	0	Nil	No	No
1	....	M.	50	Nil	—	1—5		
9	....	M.	45	Nil	—	1—5		
7	....	M.	40	Nil	—	1—4		
3	....	M.	55	Nil	—	1—3		
5	....	M.	55	Nil	—	1—2		
2	....	M.	40	Nil	—	Nil		

The last six results are not comparable with the previous twenty-six, and are arranged merely in order of merit amongst themselves. The results of the school children are omitted from the list. The experiment raises the very interesting question as to how much educated people rely on counting in their estimate of numbers. The educated mind is steeped in counting from an early age. A mass of visible units is unconsciously broken up into groups to facilitate the judgment, and rapid counting normally accompanies a movement of the eyes over a series. It is significant that the spots of playing cards are limited by a four spot grouping and then transfer to a picture series; also that large numerals are written with a grouping of figures into threes. I am convinced that five units constitute the limit of immediate recognition, and that estimates of numbers beyond this involve rapid counting, grouping, or guessing.

The natives in our series showed that they were not familiar with numbers. At least thirteen could count to twenty, and of these seven could count backwards from twenty to one. Yet their counting was laborious, and those that counted backwards seemed surprised with their prowess. I think that rapid counting and grouping can be eliminated as a method of estimating numbers on their part. In no case were all the judgments dependent on counting. Some judgments were rapid, while all counted comparisons were slow and the counting audible and visible.

My opinion is that all judgments showing an index above six in the list are shrewd or lucky guesses, and that the results of the experiment in comparing pairs of cards show that the natives possess a decided ability to estimate comparative numbers by guessing.

The method of arranging a sequence of numbers would appear from the results in general to pick out in relief those individuals who have a working acquaintance with figures. The idea of a sequence, in the absence of a knowledge of figures, is too abstract to be grasped by the unenlightened.

C.—PHYSIOLOGICAL OBSERVATIONS.

1. Visual Acuity.

Two methods were used to test visual acuity.

1. Snellen's Type.—A Snellen "illiterate type" E, 18 millimetres square, was the standard adopted. This letter subtends an angle of five minutes at a distance of twelve metres or 39·37 feet. The letter was centrally drawn on a small circle of white cardboard, which was mounted on a large sheet of white cardboard in such a way that it could be freely rotated, without wavering or eccentric movement from the back of the cardboard sheet. The basis of the test was to find the maximum distance at which the orientation of the E could be distinguished. The individual examined faced the test board and held a square cardboard with a similar but large E in front of him and turned this to correspond in position with the E on the test board. The position adopted was recognised by the examiner by means of a large arrow drawn on the reverse side of the cardboard square. A few tests were carried out at close range to school the native in the technique.

The first tests, which were made with adult natives, were proceeded with by sending the native to a distance and then having him approach until he could recognise the position of the E correctly. This distance was then noted, and the test repeated several times with the E rotated to different positions. This method needed the presence of an assistant to note the distances. No assistance was available on other days, so the course was marked by signs at ten foot intervals. The test subject was started at a medium distance, and given several trials. He was then advanced or retired ten feet, and the trials repeated until a distance was attained at which the subject made two errors of 180 degrees or one error of 90 degrees in at least five tests.

2. A Modification of Guillery's Spots.—Two sheets were prepared each showing the outline of a man in profile—one black on a white ground, the other white on a black ground. Three rectangular windows were made in each figure in the position of the head, chest, and thigh, respectively. Slides were arranged behind these windows, so that in any of the three a spot 3·6 mm. square could be exhibited—a black spot in the white background, and vice-versa. The test subject was sent to a distance and approached until the spot was visible. He had to check his statement by pointing to his own head, neck or chest, and correctly indicating the position of the spot shown on the card. The distance at which the spot was picked up correctly was noted, an incorrect indication eliminated.

Several trials were made with each subject with each card. The visual acuity tests were carried out towards the end of the stay at Hermannsberg, and adult subjects were not available to any extent, so most of the work was done with school children and young girls. A very noticeable feature of the examination was the great influence of concentration. Most of the boys were keen. The most interested ones peered between the brim of their hats and the edge of the square card held just under the eyes. Most of the girls were shy and lackadaisical and gave poor results. One girl peered intently like the boys and gave a better result than most of them, being outdistanced by only one lad.

The Guillery spots gave much lower readings than the E test. These spots subtend an angle of one minute at twelve metres, and this angle is supposed to be the same as that for the differentiation of the E. The boy who gave a remarkable reading with the E test was frankly indifferent with the spot test and gave a mediocre reading. Further work is required to confirm results obtained, as they give evidence of an acuity up to 370/40. On the other hand, whites of the party, and of the district, gave an average reading with the E test of 130/40, which reduces the comparative acuity of the best native reading to about 300%

above normal. Great care had to be taken that comrades did not signal to the test subjects. This was frequently attempted at first, but was checked by careful watching. The recorded results excluded any where signalling took place. At times during the examination the sun shone on the boards. Shading the board reduced the visibility, and was discontinued.

Visual Acuity—Adults. Snellen Test.

WHITES.		BLACKS.	
C.	110 feet	No. 45	110 feet
M.	120 „	No. 51	135 „
T.	120 „	No. 2	130 „
B.	130 „	No. 47	155 „
H.	170 „	No. 57	160 „

Visual Acuity—Children and Adolescents.

SNELLEN TEST.		GUILLERY SPOTS. White Spot on Black Ground.	GUILLERY SPOTS. Black Spot on White Ground.
Boys—Arthur (¾)	370 feet	120 feet	80 feet
Percy	270 „		
Eugen	220 „	100 „	60 „
Harold	240 „	130 „	110 „
Otto	210 „	130 „	110 „
Konrad	210 „	130 „	120 „
Nikia	190 „	140 „	140 „
Rudolf	96 „		
Edwin		180 „	180 „
Henry		170 „	150 „
Walter (¾)		160 „	150 „
Obed (¾)		90 „	70 „
Girls—Eva	330 „	120 „	110 „
Claudia	160 „	90 „	90 „
Edda	160 „		
Irene	170 „	90 „	90 „
Veronica	120 „		

2. Visual Acuity for Primary Colours.

The slides for the Guillery spots were also furnished with colour squares 3·6 mm. in size, which could be displayed in any of the three windows. The apparatus was unhandy, and time was not available to complete a series of tests. The following results are interesting, however, and it is hoped to work out the subject more fully.

	White Background.					Black Background				
	Black.	Red.	Yellow.	Green.	Blue.	White.	Red.	Yellow.	Green.	Blue.
Whites—J.		12			6	40	52	22	44	11
M.		12			6	43	38	48	20	18
F.						40	28	40	29	14
¾-Caste—Adolf ...	65	48	15	38	11	80	48	24	48	26
Obed ...	48	36	14	40	10	70	65	48	65	31
Blacks—Eugen	66	34	25	42	65	90	37	70	38	21

The figures in the table represent distances in feet at which the colours were recognised correctly, not the distances at which the spots were visible, *e.g.*, on the black background, M., at 38 feet, saw the green spot as white; at 90 feet, Eugen saw the yellow spot as white; at 90 feet, Obed saw the white spot as yellow, and at 65 feet the yellow spot as white.

3. Observations with Masson's Discs.

Discs were prepared, which were marked with Indian ink on a white background, to give grey bands on rotation representing a blackness of 1/200, 1/250, 1/300, and 1/350, respectively. Trials with these were unsatisfactory, as it was difficult to obtain a definite answer from the natives, especially a negative. An impression was gained that they did see 1/300, and some perhaps 1/350, but the replies were unconvincing.

4. Colour Sense.

1. *Colour Nomenclature.*—This was investigated by asking the natives to name the colours of standard coloured papers and Holmgren's wools. Mr. B. Maegraith carried out the major portion of this work. The following vocabulary was obtained. The word "indora" means "the very thing"; a reduplication of a word has the significance of a qualification or weakening.

White—Tjilkara indora.
Black—Urpula indora.
Red—Tataka.
Vermillion—Tataka indora.
Magenta—Tataka tataka.
Pink—Tataka tjilkara tjilkara.
V, deep red, deep brown—Urpula urpula.
Cadmium orange—Tataka.
Mikado orange—Nduana nduana.
Yellow, ochre, pale yellow—Nduana, nduana indora. One boy gave ultmara ultmara.
Dirty yellow, capucine yellow—Nduana nduana.
Green, sage green—Turka turka.
Blue green, duck egg, pale green, pale blue—Ilbungera.
Light wisteria—Ilbungera indora.
Blue, indigo, violet, deep blue—(variously) urakuata ngera.
Urpula, "no name," "blue"
Purple—"No name."
Puce—Ultmara ultmara.

"Ultmara ultmara" is uncertain obviously, it also means "a dust cloud." It is doubtful if there is a word for blue; "urakuata ngera" means "like fire smoke"; It appeared on the second day of questioning a group of girls who had replied "no name" or urpula. The word was unknown to the Mission staff, who have a good command of the language.

2. *Colour Blindness.*—Many natives, of both sexes, were tested with Ishihara's colour plates, but no cases of colour blindness were detected.

3. *Colour Contrast.*—A hole was cut in the centre of a sheet of bright blue paper. This was laid on a grey background and covered with tissue paper. The yellow tinge of the grey circle appeared clearly to us, but not one of the natives noticed it. When interrogated, they did not look closely, they would glance and reply "blue," the colour of the ground, or "don't know."

4. *Colour Preference.*—This test was carried out with females. Strings of bright "butter beads" were laid out on a form. The individuals were brought up singly and asked which they liked best. A small handful of these beads was given them. Beads selected were then removed from the display, and they were asked again which they liked best; fewer of the beads of this choice were given, and so on. The beads were white, black, royal blue, turquoise blue, green, yellow, and red. The results were plotted as a graph for each colour, the number of times the colour in question represented the first, second, third, fourth, fifth, sixth, or seventh choice. The centre of gravity of the graph was made the indicator of relative preference. The following order of preference was obtained:—

Juveniles (17).—Green, yellow, black, royal blue, red, turquoise blue, white.

Adults (7).—Red, turquoise blue, black, yellow, royal blue, white, green.

Considerable difficulty was encountered in examining the elderly women. In two cases the results were deleted because they simply picked the nearest colour each time. As there were 17 juveniles and only 7 adults, the order of preference for the total 24 cases was the same as that for the juveniles. The high order of black was a surprise. It is, of course, in good taste.

5. Hearing.

No test of auditory acuity was carried out. Professor Kerr Grant kindly supplied a Galton's whistle for the use of the expedition. The whistle was blown by means of the pressure pad of a sphygmomanometer. The whistle was not graduated in wave lengths. There was difficulty in making the natives differentiate between the hiss and the clear whistle note. The test for the upper auditory limit was carried out repeatedly in the presence of natives and members of the expedition. The upper range appeared to be identical in both blacks and whites.

6. Tactile Sensation.

A number of Von Frey's hairs were prepared by mounting one end of a strand of horsehair or silkworm gut with glue between two narrow strips of cardboard. Professor Kerr Grant kindly measured the diameter of the hairs for me. The pressure weight of each hair was measured by pressing the hair vertically on the pan of pharmaceutical scales. This last measurement is somewhat of a conjuring feat, but repeated estimates were made to ensure as great a degree of accuracy as possible. The hairs were graduated by dividing the pressure weight by the area of cross section in square millimetres.

The values for the hairs worked out as follows:—

Nature of Hair.	Pressure Wt. in gm.	Diameter in Inches.	Diameter in mm.	Area in sq. mm.	Pressure Divided by Area.
I. Horsehair	0·455	0·009	0·2285	0·041	11·1
II. "	0·650	0·009	0·2285	0·041	15·8
III. "	1·040	0·009	0·2285	0·041	25·3
"	1·625	0·011	0·2793	0·061	26·7
"	1·495	0·010	0·2539	0·050	29·9
IV. Silkworm	6·50	0·018	0·457	0·164	39·6
Horsehair	4·55	0·012	0·3047	0·073	62·7
Silkworm	11·70	0·017	0·4316	0·146	80·1

Hairs one, two, three, and six in the above series, marked I., II., III., and IV., respectively, were used in the tests. The natives were told to shut their eyes, and were watched to see that they did so, and as an additional precaution the part stimulated was screened. They were told to say "Yes" each time they felt a touch. From time to time no touch was made at the normal stimulation interval. The softest hair giving a response was recorded. This was the most satisfactory test carried out with the natives in regard to definiteness of response.

The following is the tabulated list of results obtained:—

Tactile Sensibility.

	Palmar Tip Right Index Finger.	Back of Hand.	Mid Fore Arm Ant. Surface.	Nape of Neck.	Lower Leg Mid Ext. Surface.	Middle of Sole of Foot.
Adult Males—Parkbaga	II.	II.	I.	II.	I.	IV.
Korongili	I.	I.	II.	I.	I.	IV.
Paddy	I.	II.	I.	I.	I.	IV.
Manguraka	III.	I.	II.	I.	I.	IV.
Manasseh	II.	I.	I.	I.	I.	—
Uki	I.	I.	I.	I.	I.	—

Tactile Sensibility (Continued).

	Palmar Tip Right Index Finger.	Back of Hand.	Mid Fore Arm Ant. Surface.	Nape of Neck.	Lower Leg Mid Ext. Surface.	Middle of Sole of Foot.
Boys—Harold	II.	I.	I.	I.	I.	III.
Henry	I.	I.	I.	I.	I.	I.
Enos	I.	II.	I.	II.	I.	IV.
Rudolf	I.	III.	I.	II.	II.	II.
Percy	II.	III.	II.	III.	II.	IV.
Obed (¾)	I.	II.	III.	II.	III.	IV.
Adolf (¾)	III.	I.	II.	I.	I.	IV.
Girls—Veronica	II.	III.	I.	II.	II.	III.
Claudia	II.	I.	II.	II.	II.	III.
Edda	II.	I.	I.	I.	I.	III.
Median Result	II.	I.	I.	I.	I.	IV.

These results are surprising, as the skin of the natives appears harsh and parchment-like and would be expected to be relatively insensitive. The only relative figures I have to hand are some figures of Von Frey, quoted by Head Studies in Neurology, Vol. I., p. 321:—Finger, 3 gm./sq. mm.; back of hand, 12 gm./sq. mm.; forearm, 8 gm./sq. mm., or less. These results must concern non-manual workers, as I have tried my hairs on labourers and find that hair II. is an average finding for the tip of the index finger. The mean results for forearm and leg in my series might be lower if a more sensitive hair had been available for the tests, as the "I" results represent a substantial majority in these two sites of stimulation.

7. Pain Sensation.

The Australian aborigine is so hardy in withstanding physical injury, that some estimation of pain sensitivity is interesting. An algesimeter was prepared from a spring balance graduated in half ounces up to five pounds. This was tested against standard weights and found accurate. A drawing pin was pushed through a piece of cardboard to steady it, and placed point up on the pan of the scales. The scales were adjusted to zero. The test subject was instructed to place the tip of the right index finger on the point of the pin, and then press down until hurt too much.

The following table gives the best effort of each individual in ounces of pressure:—

WHITES.		NATIVES. Adult Men.		Boys.		Girls.	
T.	8	Manasseh	12	Henoch	12	Eva	20
H.	12	Paddy	16	Enos	16	Elfrida	20
F.	12	Dr. George	16	Otto	40	Veronica ..	24
Ha.	16	Engerilyeka	28	Reuben	40	Elsie	28
M.	48	Uki	28	Adolf (¾)	40	Claudia	32
		Korongili	36	Rudolf	56		

Penetration of the skin occurred at a pressure of about 16 ounces. A rueful examination of the finger was the general rule, as though the experience was more painful than was liked.

8. Reaction Time.

An attempt was made to estimate reaction times to light and sound. The native has a reputation for lagging in following the later of two consecutive orders, *i.e.*, carrying on with the original order when new orders are given. A third test, therefore, was made after the simple reaction to light and sound; the native had to respond to a sound stimulus, but not to light. Several light stimuli were made before the sound signal was given. Professor Hicks kindly loaned apparatus for the experiments. The apparatus consisted of a clockwork drum with smoked paper. A small electric globe and a switch in one unit, and an electric buzzer and switch in another unit, were connected in parallel. These units together were connected in series with a couple of dry cells, a spring switch, and a marker recording on the drum. The subject examined pressed down the spring switch. When the light or buzzer switch was closed the circuit was then complete and the marker point on the drum depressed. In response to the signal, the native released the spring switch, the circuit was opened, and the marker point rose again. When the drum was in motion, the interval between stimulus and response was shown by the interval between the downward and upward movement of the marker line. The time relation was read by timing a complete revolution of the drum, 42 seconds, and dividing this by the circumference of the drum, 500 mm. Each millimetre on the drum record, therefore, indicated a time interval of 0·084 seconds. Unfortunately the drum revolutions were not constant, and these figures are subject to a 10% error.

The natives were schooled and practised in the reactions before the actual experimental record was made.

The following results were obtained. Figures represent time in seconds:—

Koringili.—Male, 20 years of age. No school:—1. Light Stimulus: 0·336, 0·412, 0·403, 0·386, 0·294, 0·302, 0·318. 2. Sound Stimulus: 0·285, 0·285, 0·285, 0·285. 3. Ignore Light, Respond Sound: 0·420. Difference, 2 and 3: 0·135.

Manasseh.—Male, 20 years of age. Six years school:—1. Light Stimulus: 0·268, 0·168, 0·236, 0·202, 0·236, 0·168, 0·236. 2. Sound Stimulus: 0·218, 0·176, 0·151, 0·160, 0·160, 0·168, 0·160. 3. Ignore Light, React Sound: 0·320. Difference, 2 and 3: 0·169 to 0·102.

Engerilyeka.—Male, 40 years of age. No school:—1. Light Stimulus: 0·252, 0·227, 0·202, 0·168. 2. Sound Stimulus: 0·244, 0·236. 3. Ignore Light, React Sound: 0·470. Difference, 2 and 3: 0·234 to 0·226.

Paddy.—Male, 50 years of age. No school:—1. Light Stimulus: 0·386, 0·260, 0·260, 0·236. 2. Sound Stimulus: 0·320, 0·160, 0·151, 0·151. 3. Ignore Light React Sound: 0·495. Difference, 2 and 3: 0·344 to 0·175.

An attempt was made with a boy but his results are an interesting commentary on divided attention. The environment had too many distractions.

Eugen.—Male, 13 years. Four years school:—1. Light Stimulus: 0·925, 0·540, 0·540, 0·398, 0·368, 0·510, 0·316, 0·286, 1·01, 2·02, 0·453, 0·453, 0·687.

Schafer (Schafer's Text Book of Physiology, Vol. II., p. 610) quotes the following average reaction times from Richet:—Sudden Sound, 0·150 sec; Electric Flash, 0·195 sec. James (Text Book of Psychology, 1904, p. 124) quotes reaction times for Sound, 0·136-0·167; for Light, 0·150-0·224 sec. For complicated reactions, white signal or no signal, the time was lengthened by 0·03-0·05 sec.

In our experiments the reaction times were usually longer than those given by these authorities, and were very variable. The lag of the complicated reaction measured against the shortest reaction time is four to seven times as long as the figures quoted by James. The variability of the responses, however, may account for a large part of the apparently excessive time for a complicated reaction.

D.—OBSERVATIONS ON INTELLIGENCE.

The problem of estimating the intelligence of the Australian aborigine in terms of the intelligence standards accepted by European peoples bristles with difficulties. The natives have so few social characteristics in common with our civilization.

The semi-civilized native, represented by the majority of the natives at the Mission, has some points of contact with our systems of thought, but a frank application of standard intelligence tests cannot give results which can be compared fairly with those obtained from Europeans. These natives still live a camp life; they frequently discard their clothes and live a bush life; they are ignorant of money, which only enters occasionally into their systems of barter with the Europeans. Many have attended the Mission school, but the teaching is hampered by the camp life, the nomadic disappearances, and by the absence of books, toys, problem games, papers, shops, and civilized conversation at home, which play a large part in the education of the European child. On the other hand, the teaching is hampered by the numerous duties which the Mission teacher has to combine with that of schoolmaster. Observations on intelligence are, therefore, beset with incalculable factors, but this does not seem an efficient excuse to do nothing. The present paper is presented with this apologia.

All adult natives examined were full bloods.

1. Binet-Simon Test.

Time and circumstance allowed of only one complete examination.

No. 101 (General Series), No. 13 (School Series).—Percy, male, aged 11 years; $3\frac{1}{2}$ years at school. This boy ran naked in the bush until he was seven years of age. Since that time he has lived at the Mission. He is a full-blood aborigine.

Burt's arrangement of the Binet-Simon scale was used. Mr. Heinrich acted as interpreter, as Percy was more familiar with the Aranda language than English.

He accomplished tests to number 25—middle of sixth year—satisfactorily. In the colour test, "blue" was called "Urbula" (black), but this is normal with these natives.

No. 25 concerns coins.—This was a failure.

No. 27 concerns definitions.—This he could not comprehend properly. He did, however, state a horse had four legs, and that a table is wood, which are definitions better than use, so he was conceded this test, which demands use only.

No. 28. Repeating five figures.—Failed.

No. 33. Concerns coins.—Failed.

No. 36 was the last of the series of successes.

No. 42. Months of year.—Succeeded.

No. 47. Sentence building.—Succeeded.

No. 48. Copying two diagrams.—One and three-quarters right. Succeeded.

No. 53. Sentence building.—Succeeded.

Percy's score, therefore, reads: 36—3+4=37=7 years, 4 months.

Percy could only repeat four syllables in English, but accomplished twenty-one in Aranda.

When testing for discrimination of numbers and visual spatial perception, three of the Binet-Simon tests were included:—

Firstly. No. 38. Eighth year.—Counting backwards from twenty (*vide* Discrimination of Numbers):

Nine adult males who had had schooling.—Seven succeeded, two failed.

Four adult males, without schooling, who could count to twenty, all failed.

One adult female, with schooling, succeeded.

Two schoolboys failed.

Secondly. No. 56. Twelfth year.—Inferring situation or emotion in a picture (*vide* Visual Spatial Perception):

Two out of thirty succeeded.

Thirdly. No. 57. Thirteenth year.—Resisting suggestion of lines (*vide* Visual Spatial Perception):

Twenty-nine adult males tested.—Correct, thirteen: School, six; no school, six; doubtful, one. Left line longer (counted a success by Yerks), nine: School, three; no school, six. Failed, three: School, one; no school, two. Unable to comprehend test, two.

Three schoolboys tested.—Correct, two: Fifteen and thirteen years of age. Failed, one, eleven years of age.

Four adult females tested.—Correct, one, schooling. Failed, two, no schooling. Unable to comprehend test, one.

2. Performance Tests.

1. *Puzzle A* consisted of nine simple geometrical figures cut out of a sheet of thick cardboard (*vide* fig. 1). A roughly executed landscape in thick brush

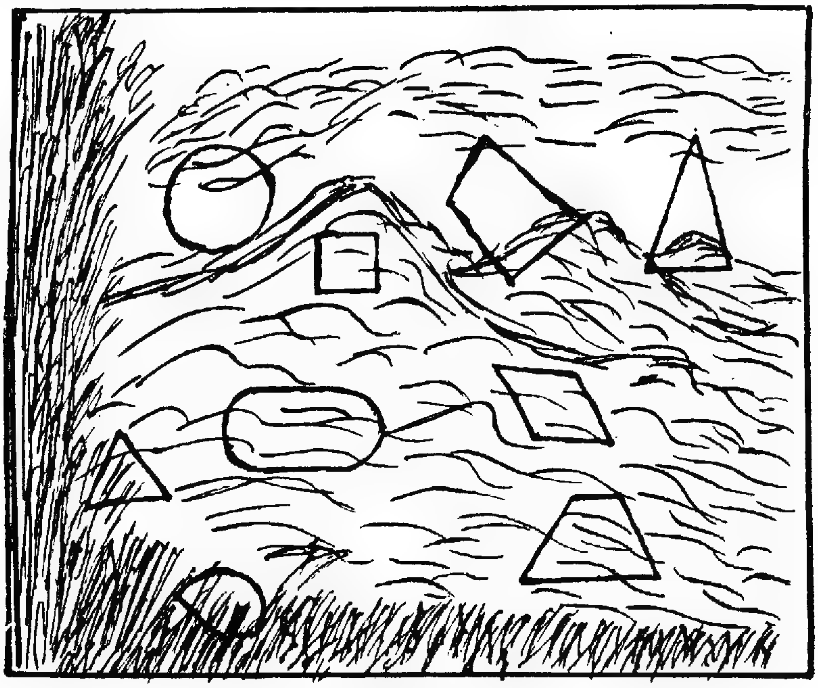

Fig. 1. Actual size, 18 in. by 12 in.

lines gave orientation lines for the circle, square, oblong, and equilateral triangle. Other figures would fit in one direction only, and the lines were of less importance. Only one man, No. 49, of thirty-eight individuals tested, troubled to match lines in placing the pieces.

The test was shown to the examinee with all the pieces in place. The pieces were then pushed out of their holes before him, the board laid down in front of him, the pieces placed right side up, and the test subject told to make each one sit down in its proper camp. Individuals who did not complete the test resigned after vainly trying to force wrong pieces into the wrong holes by strong pressure. Similarly, the ones that took a long time to complete the test usually wasted time by trying to force misfits to conform to the hole selected.

The average civilized child of four years of age should complete this test.

This was the first occasion in which any of the natives had met with a problem of this nature.

The following is a table of results:—

Puzzle A.

Serial Number.	Sex.	Age.	Years School.	Number of Pieces Correctly Placed.	Time Required.	Remarks.
76	F.	50	0	1	—	
10	M.	45	0	3	—	
2	M.	40	0	5	—	
3	M.	55	0	5	—	
5	M.	55	0	5	—	
69	F.	44	0	6	—	
1	M.	50	0	9	5·0 min.	
16	M.	60	0	,,	5·0 ,,	
7	M.	40	0	,,	3·5 ,,	
53	M.	22	6	,,	3·5 ,,	
49	M.	25	6	,,	3·5 ,,	Matching lines
66	F.	25	0	,,	3·25 ,,	
50	M.	30	6	,,	3·0 ,,	Matched square
102	M.	13	1	,,	3·0 ,,	
8	M.	45	0	,,	2·5 ,,	
39	M.	50	?	,,	2·5 ,,	
9	M.	45	0	,,	2·0 ,,	
23	M.	30	0	,,	2·0 ,,	Careful
54	M.	25	0	,,	2·0 ,,	
21	M.	20	0	,,	1·75 ,,	
60	F.	22	0	,,	1·75 ,,	
104 (¾)	F.	14	4	,,	1·75 ,,	Giggling
11	M.	65	0	,,	1·5 ,,	
25	M.	25	0	,,	1·5 ,,	
20	M.	55	0	,,	1·5 ,,	
43	M.	20	6	,,	1·5 ,,	
42	M.	25	4	,,	1·5 ,,	
22	M.	24	0	,,	1·3 ,,	
35	M.	40	6	,,	1·3 ,,	
45	M.	24	0	,,	1·3 ,,	
101	M.	11	3	,,	1·25 ,,	
19	M.	21	0	,,	1·0 ,,	
36	M.	18	4	,,	1·0 ,,	
56	M.	20	6	,,	1·0 ,,	
105	M.	15	4	,,	1·0 ,,	
106	F.	19	5	,,	1·0 ,,	
107 (¾)	M.	8·5	2	,,	0·75 ,,	
37	M.	18	4	,,	0·66 ,,	

2. *Puzzle B.*—This was a Dearborn Form Board, kindly lent by the Director of Education through the good offices of Dr. Constance Davey. It was made of half-inch wood, with the pieces fitting into quarter-inch depressions. The board and pieces were stained uniformly black. The scheme of the puzzle is drawn diagrammatically in fig. 2. It will be seen that there are two sets of four geometrical figures. For one set the corresponding pieces are two halves representing a longitudinal division of the figure. For the second set there are three pieces, representing a transverse division with a longitudinal subdivision of one half. The big difficulty in the puzzle arises if the subdivisions last mentioned are

arranged longitudinally; they fit satisfactorily, yet the puzzle is insoluble until this arrangement is broken up. If the subject has the good fortune to place the non-subdivided half in the form first, the solution is much easier. With four chances of making this primary mistake practically all experienced it, yet with the diamond and hexagon it seemed more difficult to resolve than with the other figures.

This puzzle, unlike puzzle A, had as a complication the possibility of pieces being wrong side up.

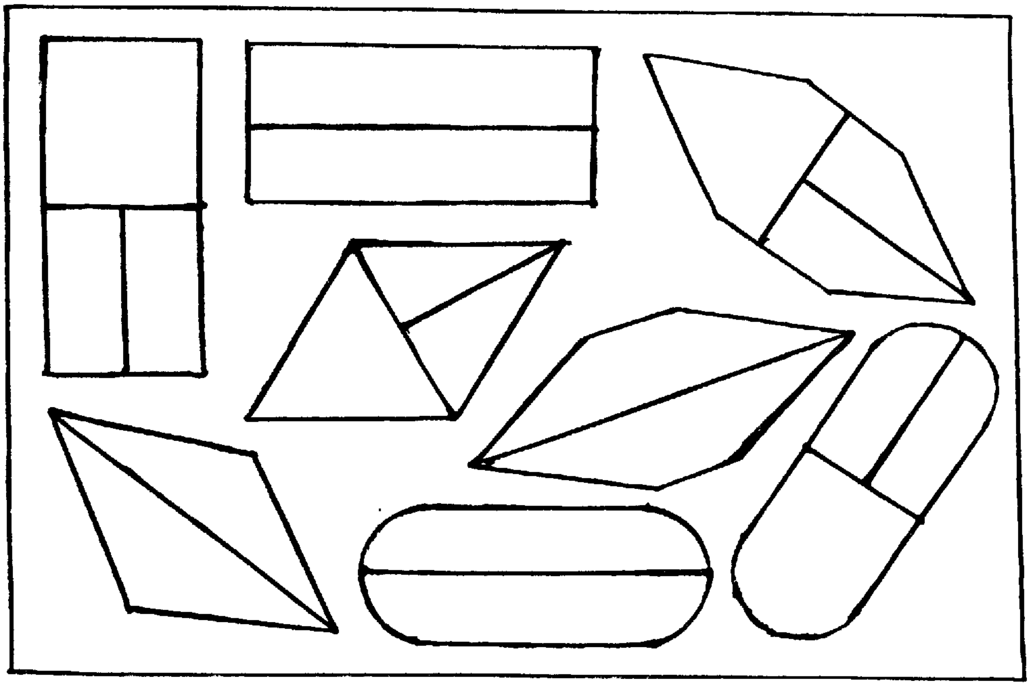

Fig. 2. Actual size, 18 in. by 12 in.

The board completed was shown to the native. The pieces were tipped out in front of him, and he was told to put them back into their proper camps.

The following is a list of results:—

Puzzle B.

Serial Number.	Sex.	Age.	Years School.	Relative Success with Puzzle.	Time.	Remarks.
8	M.	45	0	Failed		
23	M.	30	0	Two incomplete		Diamond and Hexagon Subdivisions unsolved.
60 .	F.	22	0	" "		" "
66	F.	25	0	" "		" "
104 (?) ...	F.	14	4	" "		" "
25	M.	25	0	One incomplete		Hexagon Subdivision unsolved.
50	M.	30	6	Complete	21·0 min.	Solved Diamond Subdivision Block: worried by final piece wrong side up.
52 ..	M.	45	6	"	15·0 "	
102	M.	13	1	"	15·0 "	
20 .	M.	55	0	"	13·0 "	
22 ...	M.	24	0	"	11·5 "	

Puzzle B (Continued).

Serial Number.		Sex.	Age.	Years School.	Relative Success with Puzzle.	Time.		Remarks.
42	....	M.	25	4	,,	10·5	,,	Puzzled by Diamond and Hexagon.
43	....	M.	20	6	,,	6·0	,,	
45	....	M.	24	0	,,	6·0	,,	
49	....	M.	25	6	,,	6·0	,,	
107 (¾)	....	M.	8·5	2	,,	6·0	,,	
101.	....	M.	11	3	,,	5·0	,,	
53	....	M.	22	6	,,	4·5	,,	
56	....	M.	20	6	,,	4·5	,,	
106	....	F.	19	5	,,	4·5	,,	
35	....	M.	40	6	,,	4·3	,,	
21	....	M.	20	0	,,	3·0	,,	
37	....	M.	18	6	,,	3·0	,,	
54	....	M.	25	0	,,	3·0	,,	

3. *Estimation of Length of a Line* with a slide apparatus *(vide* Visual Spatial Perception). Twenty-nine male adult natives were tested with this apparatus:—

Six failed completely—Nos. 1, 3, 7, 8, 9, and 16.

Two gave very big mean variations—Nos. 5 and 10.

The remaining twenty-one performed the test satisfactorily.

Three adult females—Nos. 60, 66, and 69—failed in the test.

4. *Spotted Card Tests (vide* Discrimination of Numbers).—Twenty-six adult natives were tested by showing pairs of cards with different numbers of spots. They had to state which was the greater card with the number of spots:—

Three could not be made to understand what was required of them.

Two could only understand in so far as birds were drawn instead of simple spots.

Four more were poor at guessing.

The remainder, seventeen in number, were remarkably good at guessing.

Only those who could count well were able to arrange cards in a sequence.

5. *Porteus Maze Tests.*—The results here were marred by a mistake in copying the fourteenth year maze. The mistake was overlooked owing to a last minute hurry before departure. This error spoilt the first major slip-away trap of the test, but left the second intact. Also, the maze tests were carried out in part only, as a separate series of tests was found to be unfeasible, and this problem was slipped in at the end of a long series of other examinations. The fifth year maze was used as an explanatory basis for the test. The native was told it was a cattle yard, and, tracing the course with a pencil, it was shown that the bullock must not go down any of the races where the end was closed. He was then given a pencil and told to go ahead with the sixth-year maze. The track was marked in pencil and a separate sheet used for each person. The records were preserved.

The following is a table of results. If the maze was correct, *i.e.,* if the line drawn did not in any case go beyond the margins of any outlet in a wrong direction, a sign "R" is recorded . If the line transgressed beyond the limits of any outlet in a wrong direction the error is recorded by the sign "E," followed by a figure stating the number of times an error was made in executing the maze. The Roman numerals denote the various mazes in their year values; the garbled fourteenth year maze is denoted by the sign G 14:—

PORTEUS MAZE.

Name.		Sex.	Age.	Years School.	Maze Results. VI.	VII.	VIII.	IX.	X.	XI.	XII.	G 14
43 Gustav	....	M.	20	6	R	—	—	R	R		R	R
35 Ezekiel	..	M.	40	6	R	—	—	—	R	R	E·1	R
37 Kangei	....	M.	18	4	R	—	—	R	—	R	—	R

PORTEUS MAZE (Continued).

Name.	Sex.	Age.	Years School.	Maze Results. VI.	VII.	VIII.	IX.	X.	XI.	XII.	G 14
19 Tondalbin ..	M.	21	0	R	—	R	R	—	R	—	R
54 Uki	M.	25	0	R	—	R	—	R	R	—	R
49 Albert	M.	25	6	R	—	R	—	R	R	—	R
101 Percy	M.	11	3	R	—	R	—	R	R	—	R
66 Yaberkulla ..	F.	25	0	R	—	R	—	R	R	—	R
103 Veronica	F.	18	5	E·1	—	R	—	R	R	—	R
56 Powell	M.	20	6	R	—	R	—	R	E·1	—	R
42 George	M.	25	4	R	—	R	—	E·1	R	—	R
53 Lucas	M.	22	6	R	—	R	—	R	R	—	E·1
104 Eugenie (¾)	F.	14	4	R	—	R	—	R	R	—	E·2
45 Dr. George ..	M.	24	0	R	—	R	—	E·1	R	—	E·1
Konrad	M.	12	3	R	—	R	—	—	E·1	—	E·1
102 Nikia ...	M.	13	1	R	—	R	—	R	R	—	E·4
25 Tundabinya	M.	25	0	R	-	R	—	E·4	R	—	R
23 Kurumalyi ..	M.	30	0	R	—	R	R	R	E·2	—	—
22 Ally	M.	24	0	R	—	R	R	E·1	E·1	—	E·2
50 Erukinya	M.	30	6	R	—	E·2	E·2	E·1	—	—	—
7 Engerilyeka	M.	40	0	E·3	E·2	E·3	E·4	E·6	E·1	—	E·3
Elfrida ...	F.	19	?	R	R	E·2					
27 Natjulpuka ..	M.	60	0	—	—	E·5	—	E·6	E·10	—	E·11
39 Namitjera ..	M.	50	?	E·1	—	Abandoned					

3. General Observations.

1. *Games.*—The only game known to be played by male children and adults is a German game called Milton. This is an elaborate form of noughts and crosses. Three 'concentric" rectangles are drawn on the ground. The rectangles are joined together by diagonal lines at the corners, and by perpendicular lines at the centres of the sides. Sticks or stones are used as markers, the intersections of the lines and the three rectangles are the points of attack. The object is to place three markers on three consecutive points in a line. Children were observed playing this game and showed themselves proficient. Girls do not play this game.

The girls are good at cat's cradles. A large number of these were collected by Mr. Hale and Mr. Tindale for the Adelaide Museum. Boys do not play cat's cradles.

2. *Memory.*—

i. Remote memory of the natives is very good. Older members of the tribe can give detailed descriptions of long distant incidents. There is an eight group marriage system in the tribe, and everyone is tribally related to everyone. Even the small children appear to know the precise tribal relationship between all the individuals in the community.

ii. Immediate memory was actually tested only in the case of the boy Percy —auditory, twenty-one syllables; visual, one and three-quarters of two diagram tests. Dr. Harold Davies found that the natives were very quick in picking up and reproducing singing notes.

iii. Rote memory.—Pastor Albrecht expressed the opinion that the Christian natives were fairly good with their catechism as long as the normal order was preserved; if, however, the order of questioning was changed about, they became confused.

3. *Conservation.*—The natives have no idea of conserving food or clothing in ordinary life. Starving natives will eat as much food as they can hold, if it be given them, but will not think to preserve the surplus. If a man be given some

good clothes, he will exchange them readily for the ruined garments of a friend. In normal life they have no need to conserve food; while clothing is worn, if at all, in imitation of the white man. They do conserve their native tobacco, which at times has to be collected at a distance. They are extraordinarily careful in the use and preservation of any plug tobacco which they may receive from white people.

4. *Mental Defective.*—One full blood youth was mentally defective. No relatives were afflicted similarly. He was microcephalic. He exhibited idiolalia. He was able to point out eyes, mouth, etc., in the picture of a dingo. He was good tempered, and not vicious in habit except for open masturbation. He accompanied his relatives in their wanderings.

E.—SCHOLASTIC TESTS.

Two afternoons were employed in class examination of the school children. All the children are taught in one room by Mr. Heinrich, who combines the occupation of schoolmaster with multifarious other duties at the Mission. School hours and lessons are scheduled on normal lines, but are subject to contingencies. School books are partly in English, partly in the Aranda language. All books are kept in the schoolroom.

Outside school hours the children have duties about the Mission, or with relatives in the camp nearby. They retire to dormitories, one for boys, and one for girls, about 8 p.m.

The senior scholars varied from eight to fifteen years of age, and had had two and a half to four and a half years' schooling. They were examined in writing, spelling, arithmetic, and drawing.

Junior pupils were mostly about six to eight years of age; some were older, being new from the bush. All had had about four months schooling, and were unable to write. They were examined in drawing only, but they exhibited their prowess by chanting letters of the alphabet as they were written on the blackboard.

During the examination, copying was prevented as far as possible by alternating seniors and juniors, and by supervision.

Most of the children were full blood aborigines. Some were the offspring of one full blood parent, and one half white parent. These latter children are indicated by the mark "$\frac{3}{4}$" in the tables of results.

Senior Scholars.

Nature of Tests.

The material for the tests and their interpretation was drawn from Burt's Mental and Scholastic Tests (London County Council, 1921).

Writing and Spelling.—Blank unruled sheets of paper were issued, and on this each pupil wrote his or her name. The following words were then read out slowly and repeatedly by Mr. Heinrich, and the children wrote down the words—a, it, cat, run, bad, but, table, even, fill, money, sugar, number, rough, raise, scrape, surface, pleasant, saucer, decide, business, carriage. These words were taken from Burt's Graded Vocabulary Test (p. 354), and represent the first three of each set of ten words that he gives for the age groups 5, 6, 7, 8, 9, 10, and 11. Owing to language being essentially foreign, pat and bat were accepted for bad, race for raise, and suffers for surface. Writing was judged from these answers in accordance with Burt's specimens, p. 371, *et seq.* Spelling merit was recorded by the number of words correctly spelt. This figure was multiplied by 10/3, and awarded an age ratio by reference to Burt's Norms for Boys (p. 402), plotted as graphs. Where the score was a figure below the lowest norm of six years, an arbitrary age was assigned by reference to an ideal extension of the graph.

Arithmetic.—This examination was Burt's test of Four Fundamental Rules, pp. 366 to 369. This represents a series of problems in addition, subtraction, multiplication, and division. The score is read by the number of correct figures given by five minutes' work on each set of problems. Typewritten copies of Burt's tests had been prepared. Firstly, each pupil was given the sheet of the sums in addition, face down. Each child then wrote his or her name on the reversed sheet. The nature of the problem was explained. At a signal, all the children turned over their sheets and set to work. After five minutes, at an order, all the sheets were turned over again and collected. A similar procedure was carried out for the sheets of sums on subtraction, multiplication, and division, respectively. The score for each sheet was read in accordance with Burt's instructions, pp. 301-302, and an age ratio given to the score by reference to graphs prepared from Burt's Norms for Boys, pp. 405-406. Graphs were prolonged ideally to junior ages below the lowest given norms of six years for addition, subtraction, and multiplication, seven years for division.

Drawing.—1. The children performed the Porteus Maze Test for Age IV. They all succeeded. The efforts varied in excellence of performance and were graded into three classes: Class I., lines between angles straight, well centred, and parallel to the sides of the figure; Class II., lines less straight, etc; Class III., lines meandering. This classification, of course, only refers to variations in neuromuscular control, and care of execution. This grading brought out an interesting sex differentiation:—Class I.: Boys, 5. Class II.: Boys, 12; Girls, 7. Class III.: Boy, 1; Girls, 5.

2. Sheets of plain paper were distributed and the children told to draw pictures of a man, an emu, and a dog. The assessment of the merit of these drawings and their co-relation to an age ratio is no easy matter. An attempt has been made to do so, after a careful noting of the points of each picture, and a study of Burt's comments and examples, pp. 317-326, 383-394.

The general features of the children's drawings can be analysed as follows:—
Total number, 32—Boys, 17; girls, 15.

Drawings of Men:

Man, Type A. 1—Profile facing left, walking. Head upright oval, anterior line shows angular prominence of nose, then depression of lips, then angle of chin, and then is carried back and down to join the anterior line of the chest. Posterior line of head curves in to indicate neck and is continued into the posterior body line. Anterior and posterior body lines convex, and continued below into anterior and posterior lines of left leg, which converge to the ankle without indicating the bulge of the calf. The lines then turn to the left to form a roughly triangular foot without indication of toes. The lines of the right leg, similar in character to those of the left leg, join the posterior line of the left leg, sometimes slightly overlapping this line. Drawn by: Boys, nil; girls, 3.

Man, Type A. 2—Similar to A. 1, except that posterior body line is curved to show hollow of back and prominence of buttock. Drawn by: Boys, 3; girls, nil.

Man, Type A. 3—Similar to A. 2, except that posterior line shows strong angle to represent prominence of the left shoulder. Drawn by: Boys, 6; girl, 1.

Man, Type A. 4—Similar to A. 1, but anterior line of head shows no features. Drawn by: Boy, 1; girls, nil.

Man, Type A. 5—Similar to A. 3, only left leg is posterior and right leg lines join anterior line of left leg. Drawn by: Boy, 1; girls, nil.

Total numbers: Boys, 11; girls, 4.

Man, Type B.—Head and body as in Type A., but body continued below into two legs. Anterior body line runs on down front of one leg, round foot up to the crutch, then down front of the second leg and returns to continue in the posterior line of the body. Drawn by: Boys, 2; girl, 1. One of these boys shows the body line typical of A. 3.

Man, Type C.—Head circular. Body and limbs linear. Legs bent to indicate: running left, girls, 2; running right, girl, 1; legs scribbled, girls, 2. Total girls, 5.

Man, Type D. 1—Head oval, body oval, triangular skirt, legs with feet turned to the left. Drawn by: Boy, 1.

Man, Type D. 2—Head oval, with loops added to left side to represent nose and lips. Legs with feet turned to left. Drawn by: Girl, 1.

Man, Type D. 3—Head circular, body triangular, legs with feet turned out. Drawn by: Boy, 1.

In addition, one boy and one girl drew the head and bust only of the man, the fragment being of the A. type.

One boy and three girls did not attempt the drawing of a man.

Eyes, Types A. and B.—Represented by dot under an arc: Boys, 4; girls, 1. By dot only: Boys, 7; girls, 0. Unrepresented: Boys, 2; girls, 4.

Eyes, Type D.—Unrepresented: Boys, 2; girl, 1.

Eyes, Type C.—No features, twice; two eyes only, twice; two eyes, vertical line for nose, cross line for mouth, once.

Ears.—These were drawn by five boys and one girl.

Hair of Head.—This was shaded in by six boys and one girl. Three boys drew a moustache, one boy a beard and side whiskers.

Arms.—In pictures of Types A. and B. these were always shown stretched out to the left. The arms took origin from the back line of the body in nine pictures by boys and two by girls; from the middle of the shoulder area of the body in four pictures by boys, and were omitted by one girl. The body was represented as transparent to the right arm by two boys and two girls. The arms originated in the anterior chest line in D. 1 and D. 2, and from the neck in D. 3, and from the head or body line in type C. The arms were somewhat shaped by ten boys and no girls. The elbow was indicated by eight boys and one girl. Three boys drew the hands with five fingers, three with four fingers, and four as enlarged ends of the arms. Only one girl of the A. and B. groups indicated a hand, and that with three fingers. Two C. type pictures gave cross lines, and one circles, to represent hands.

Knees.—Six boys and one girl gave some indication of knees. The girl, type A. 3, produced a very confused picture by extending the lines of the right leg up to the level of the hips.

Hats.—These were occasionally represented. The simplest form was a transverse line across the top of the head. Three boys and five girls did this. Two boys added to this shading to indicate the crown of the hat. Three boys and two girls drew a crown to the hat outside the line of the head.

Clothes.—The great majority of the pictures gave no markings on the body or limbs to suggest clothing, except that six boys and one girl shaped the heel of the foot squarely, suggesting the heel of a boot, and one other girl added spurs to this heel. Yet there was no representation of natural features of a naked body or scarring, except that one girl added a rectangular pendent in the crutch of a type B. picture. Four boys did make an effort to represent clothes. No. 14 drew a double line across the neck, and a similar line across the hips, and added two vertical lines down the chest and a curved line across the shoulder. No. 9 drew a single line across the neck. No. 10 did this and added some vertical lines.

No. 15 drew a line across the neck, and shaded the chest vertically and the hips horizontally. D. 1 is probably a representation of a skirt.

Weapons.—One boy and one girl drew double lines from the hands to the ground for a stick or a gun. One boy drew a crude gun extending horizontally from the arms. One boy showed a shield in the left hand, and a boomerang in the upraised right hand. One girl drew a crude shield for a type C. man.

Action.—This is well represented by four boys and one girl, fairly by five boys and three girls.

Proportions are given in the tables of results. The length of the head from vertex to chin is taken as unity, and length of body, legs, and arms expressed in terms of this unit under the symbols B/H, L/H, and A/H, respectively.

Drawings of an Emu:

These were carried out in a much more spirited manner on the whole. The bird was invariably represented facing left, and in profile. The action of running was realized excellently by two boys (Nos. 1 and 3); well by six boys and one girl (No. 23); fairly by one boy; slightly by two boys and one girl. Action was nil in drawings by six boys and thirteen girls. General outline was excellent in the picture by one boy (No. 3). His was the only case where the curve of the crest met the beak at a sharp angle. His was also the only case where a three dimensional character was given by contour lines of feathering. Otherwise, outline drawings were as follows:—Good, six boys, one girl; fair, seven boys, three girls; poor, one boy, three girls; crude, two boys, eight girls. Shading lines were common in this picture only, eleven boys and three girls attempting some representation of feathering. The thighs were shaped by eleven boys and two girls. The hock joint was represented by fourteen boys and two girls. The legs were drawn as simple straight lines by no boys, but by nine girls. The feet were represented in a natural fashion by three boys; in a semi-natural fashion by three boys; in a conventional manner as a trident by nine boys and eleven girls; feet were omitted by one boy and four girls.

Drawings of a Dog:

This animal was pictured invariably in profile facing left. Action was portrayed excellently by five boys (Nos. 1, 3, 11, 14, and 15); well by one girl (No. 28); fairly by six boys and four girls; poorly by three boys and one girl; action nil, three boys and six girls. Three girls did not attempt the drawing. The general outline was excellent in the pictures by the five boys and one girl mentioned above; good, one boy; fair, six boys, four girls; crude, five boys and seven girls. The drawing by boy No. 11 was remarkable, being futurist in character but realizing intense action. The ears were drawn as follows:—Two ears erect, three boys, eight girls; one ear erect, two boys, one girl; one ear erect, one drooping, one girl; one ear drooping, eleven boys; two ears drooping, one boy; no ears, two girls. Tails were almost always long and curving up or coiled up. One boy drew a stumpy tail. Three girls drew long down-turned tails.

Composition.—Five boys and nine girls made no attempt to combine the figures. Eight boys and two girls made some attempt to portray a chase. A more realistic result was obtained by four boys (Nos. 3, 11, 14, 15).

As the full blood aboriginal children and the three-quarter caste children live under identical circumstances and receive the same education, it is interesting to note if the results show any variation where there has been an infusion of white blood. The figures in the preceding table have, therefore, been split up into age groups, and further divided according to sex and blood, and average figures calculated. Nos. 16 and 23 have been eliminated in these averages as their period of school has been relatively small.

Serial Number.	Sex.	Age.	Years School.	Writing.	Spelling.	Scholastic Mental Ages. Arithmetic. Addn.	Subt.	Mult.	Div.	Av.	Drawing P. IV.	Pictures.	Type Man.	Remarks on Pictures of Proportions B/H	L/H	A/H	General.
9	M.	15	4·5	8	7·8	7·0	6·3	8·1	6·6	7·1	II.	9	A.2	4·0	2·2	2·0	
16	M.	14	2·5	7	6·0	5·3	6·0	6·1	7·0	6·1	II.	8	B.	2·6	1·5	2·5	Crude
1 (¾) ...	M.	14	4·5	9	8·9	7·0	7·3	8·4	6·8	7·4	I.	11	A.3	3·0	3·0	3·0	Realistic
3 (¾) ...	M.	13	4·5	9	8·9	7·0	7·0	7·6	7·3	7·2	I.	12	A.3	2·0	2·3	2·5	Realistic; Emu 3 dimens.
17 (¾)	M.	13	3·5	7	7·5	5·6	5·9	7·2	6·7	6·4	II.	8	A.3	2·0	3·0	2·0	
6	M.	13	4·5	7	6·7	6·0	6·8	7·7	7·1	6·9	II.	7	A.5	2·5	2·1	1·0	Crude
14	M.	13	3·5	8	6·0	4·8	5·8	6·7	6·6	6·0	I.	10	A.3	2·5	2·8	2·0	Realistic
7 (¾)	M.	12	4·5	6·5	6·3	5·5	5·7	6·2	—	5·8	I.	8					Man not drawn
12 (¾)	M.	12	3·5	8	8·9	7·7	6·7	6·3	7·2	7·0	II.	8	A.3	2·5	2·0	2·5	Shield, boomerang
10	M.	12	3·5	7	6·0	4·5	5·9	5·7	6·5	5·6	II.	9	B.	2·0	2·0	1·5	
11	M.	12	3·5	6·5	8·9	5·9	6·0	6·3	6·5	6·2	II.	9	A.4	1·5	2·0	1·3	Gun extended; huge bullet in flight
15	M.	12	3·0	8	5·3	5·0	5·5	6·3	—	5·6	I.	9	A.2	4·0	2·0	3·0	
8	M.	11	3·0	8	5·7	4·8	5·6	5·6	—	5·3	II.	7	D.3				Crude
13 . .	M.	11	3·5	8	6·0	4·8	—	—	—	4·8	II.	8	D.1				Crude
4	M.	10	3·5	6·5	5·7	6·5	6·7	6·7	7·0	6·7	II.	8	A.3	2·0	1·6	1·1	Crude; Emu toes natural
5	M.	9	2·5	7	6·0	4·3	—	—	—	4·3	III.	6					Head and bust only
2 (¾) .	M.	8·5	2·5	7	6·0	4·8	5·6	—	—	5·2	II.	7	A.2	3·0	1·6	1·2	
21 (¾)	F.	14	4·5	8	7·1	5·0	5·5	6·1	6·6	5·8	III.	6	B.	2·6	2·4	1·5	Crude
20	F.	13	4·5	8	6·7	4·8	6·0	5·8	6·5	5·8	III.	6	A.1	2·2	2·0	—	
28	F.	13	4·0	8	5·7	5·3	5·6	5·9	—	5·6	II.	9	A.3	2·0	1·3	1·3	? gun, spurs; confused legs
29	F.	13	3·5	9	6·0	4·3	5·6	5·8	—	5·2	II.	7	A.1	1·2	1·2	1·2	
23	F.	13	2·5	6·5	6·0	4·8	5·6	5·6	—	5·3	II.	7					Man not drawn
22 ...	F.	12	3·5	7	6·7	—	—	5·9	—	5·9	II.	6	D.2	1·2	1·2	0·7	Crude
30	F.	12	3·0	8	6·0	5·3	5·7	6·4	6·5	6·1	II.	7					Head only
27 (¾)	F.	11	3·0	8	6·7	4·8	5·4	5·8	6·5	5·6	—	6					Man not drawn
26	F.	9	2·5	6	7·1	4·5	5·6	6·3	—	5·6	—	6	A.1	1·2	1·2	1·2	
32	F.	9	2·5	7	6·0	4·5	5·5	5·5	—	5·2	III.	5	C.				Crude
18	F.	8·5	2·5	7	6·0	—	—	—	—	—	III.	6	C.				Crude
31	F.	8	2·5	6	6·0	4·8	5·7	—	6·5	5·7	II.	6	C.				Crude
25 ...	F.	8	2·0	7	6·3	4·8	5·6	5·6	—	5·3	II.	6	C.				Crude
19 (¾) .	F.	8·5	2·5	6	6·0	4·3	—	—	—	4·3	III.	5					Man not drawn
24 (¾)	F.	8	2·0	7	6·3	4·5	5·6	5·8	6·5	5·6	—	5	C.				Crude

Scholastic Tests.—Averages of Groups.

Blood.	Sex.	Number Individuals in Group.	Years of Age Groups.	Average Age of Group.	Average Years of School.	Average Scholastic Mental Years. Writing.	Spelling.	Arithmetic Average.	Drawing.
Full	M.	3	13—15	13·6	4·2	7·6	6·8	6·7	8·6
¾	M.	3	„	13·3	4·2	8·3	8·4	7·0	10·3
Full	M.	5	11—12	11·6	3·3	7·5	6·4	5·5	8·4
¾	M.	2	„	12·0	4·0	6·7	7·6	6·4	8·0
Full	M.	2	8·5—10	9·5	3·0	6·7	5·8	5·5	7·0
¾	M.	1	8·5	8·5	2·5	7·0	6·0	5·2	7·0
Full	F.	3	13—14	13·0	4·0	8·3	6·1	5·5	7·3
¾	F.	1	„	14	4·5	8	7·1	5·8	6·0
Full	F.	2	11—12	12·0	3·2	7·5	6·3	6·0	6·5
¾	F.	1	„	11·0	3·0	8·0	6·7	5·6	6·0
Full	F.	5	8—10	8·5	2·4	6·6	6·3	5·4	5·8
¾	F.	2	„	8·2	2·2	6·5	6·1	4·9	5·0

The most definite result of this grouping is to show a superiority of scholastic attainment by the senior boys with white blood over that of their full-blooded companions. It is tempting to draw a conclusion that the full-blooded children are retarded in mental growth with increasing age to a greater degree than children with some degree of European ancestry. The numbers are too few to warrant this deduction, however.

Junior Scholars.

Porteus Maze III. and IV. year tests were judged with regard to quality of performance. Classes IV. and V. were added to the three classes already used in the case of the senior scholars. Class IV. represented efforts where the test line touched, or nearly touched the maze lines. Class V. to cases who failed in the test by overstepping the prescribed boundaries. The following is a summary of results:—

Number Examined.		Porteus III.		Porteus IV.		Mental Age of Pictures.	
12 Boys, 6—8 years	....	Class III.	3	Class III.	3	6 years	4
	....	„ IV.	8	„ IV.	6	5 „	3
	....	„ V.	1	„ V.	3	4 „	5
8 Girls, 6—8 years	....	„ III.	2	„ III.	1	6 „	0
	....	„ IV.	6	„ IV.	4	5 „	4
	....	„ V.	0	„ V.	3	4 „	4
Boy, 13 years	....	„ III.		„ IV.		6 „	
„ „ „	....	„ II.		„ II.		6 „	
„ 9 „	....	—		„ III.		5 „	
„ „ „	....	„ III.		„ III.		5 „	
Girl, 9 years	....	„ III.		„ IV.		5 „	

3. Graded Reading Test.

Several natives were asked to carry out Burt's Reading Accuracy Test. Ibid., pp. 339-341. The following results were obtained:—

Serial No. of Native.		Sex.	Age.	Number of Words Read.	Scholastic Mental Age.
101	....	M.	11	44	8·4 years
105	....	M.	15	29	6·9 „
103	....	F.	18	35	7·5 „
43	....	M.	20	31	7·1 „
56	....	M.	20	35	7·5 „
53	....	M.	22	64	10·4 „
42	....	M.	25	34	7·4 „
49	....	M.	25	71	11·1 „

No. 101 is the same youth as No. 13, and No. 105 the same youth as No. 9, in the School Group Series of senior scholars.

AN ANALYSIS OF THE VEGETATION OF KANGAROO ISLAND AND THE ADJACENT PENINSULAS.

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[Read June 12, 1930.]

Contents.

I. INTRODUCTION.

The relationship between the floras and the ecology of Kangaroo Island and the adjacent peninsulas of Fleurieu, Eyre, and Yorke presents one of the most interesting problems which South Australia offers, and the present paper is a study, in particular, of the affinities of the Island flora, of the main trends of plant migration between the Island and the three peninsulas, of endemism in the four geographical groups and, finally, a study of the plant communities and their relation to one another and to the succession shown in the forests of the Mount Lofty Ranges on the mainland.

The problem of the affinities of the flora of Kangaroo Island was one which interested the late Professor Ralph Tate, who collected on the Island, on Eyre Peninsula, and on Southern Yorke Peninsula, and the results of his labours are embodied in his paper on "The Botany of Kangaroo Island." Tate, in this paper, gives a historical sketch of the Island, and an account of its geology, as he understood it, and also a short history of botanical exploration on the Island.

Briefly summarised the results of botanical exploration up to Tate's time were as follows:—

Robert Brown	1802	29	species
Baudin's Expedition	1803	4	,,
Collections for Baron von Müller	1849-51	44	,,
F. G. Waterhouse	1861	83	,,
R. S. Rogers	1882	4	,,
R. Tate	1883	75	,,

This made a total of 350 species found on the Island. Later collections, particularly those of Dr. R. S. Rogers, Dr. J. B. Cleland, and Mr. J. M. Black, have resulted in the publication of the record of 653 native species (6). This list embodies all collections made on the Island, including Tate's and the earlier records, and, in addition, localities supplied by Professor T. G. B. Osborn and the author from the western end of the Island.

Tate recorded 11 endemic species on the Island, but 5 of these have since been found to have a wider distribution and are found on the mainland also, and new endemic species and varieties have been added.

The publication of J. M. Black's "Flora of South Australia" has placed floristic botany on a sound basis, and has made possible the accurate cataloguing of South Australian plants. Also, the more thorough botanical exploration of the adjoining peninsulas has entirely altered the figures arrived at by Tate.

II. SOURCES.

In the present paper the floristic and ecological relations of the Gulf Region are brought under review. The elucidation of these questions required the careful compilation of lists of the local florulas and comparison of the individual species with regard to their distribution on the Island, on the three peninsulas, on the mainland generally, in the Eastern States and Tasmania and in Western Australia. The sources from which the data were obtained are listed below:—

Bailey, F. M.—"The Queensland Flora" (3).

Bentham, G.—"Flora Australiensis" (4).

Black, J. M.—"Flora of South Australia" (2).

Cleland, J. B., and Black, J. M.—"The Flora of the Encounter Bay District" (7).

Cleland, J. B., and Black, J. M.—"An Enumeration of the Vascular Plants of Kangaroo Island" (6).

Field Naturalists' Club of Victoria—"Census of Victorian Plants."

Maiden, J. H.—"Census of New South Wales Plants" (19).

Morrison, A.—"List of Extra-tropical Western Australian Plants" (29).

Tate, R.—"The Botany of Kangaroo Island" (25).

Tate, R.—"The Botany of Southern Yorke Peninsula" (26).

Tate, R.—Manuscript notes containing extensive records of localities of plants of the South Australian flora, in the possession of the Botany Department of the University.

Rodway, L.—"The Tasmanian Flora" (24).

And, finally, the author's collections of plants on Kangaroo Island, on the Fleurieu Peninsula and in the Port Lincoln District.

III. TOPOGRAPHICAL AND GEOLOGICAL.

Fenner (9) gives an account of the region under consideration. The unit in question is a portion of what is usually referred to as the "Great Rift Valley of South Australia" (12).

Geologically, the region consists mainly of Palaeozoic rocks (Cambrian and Pre-Cambrian), overlain in most cases by a thin sheet of Tertiary sands, gravels or limestones, as in the Central Plateau of Kangaroo Island, in Yorke Peninsula, and in Southern Eyre Peninsula; but in the Fleurieu Peninsula the ancient rocks are more exposed.

Concerning the Gulf Region of South Australia, Fenner notes that: "In the western half . . . we have a broad platform of Palaeozoic rocks . . . In

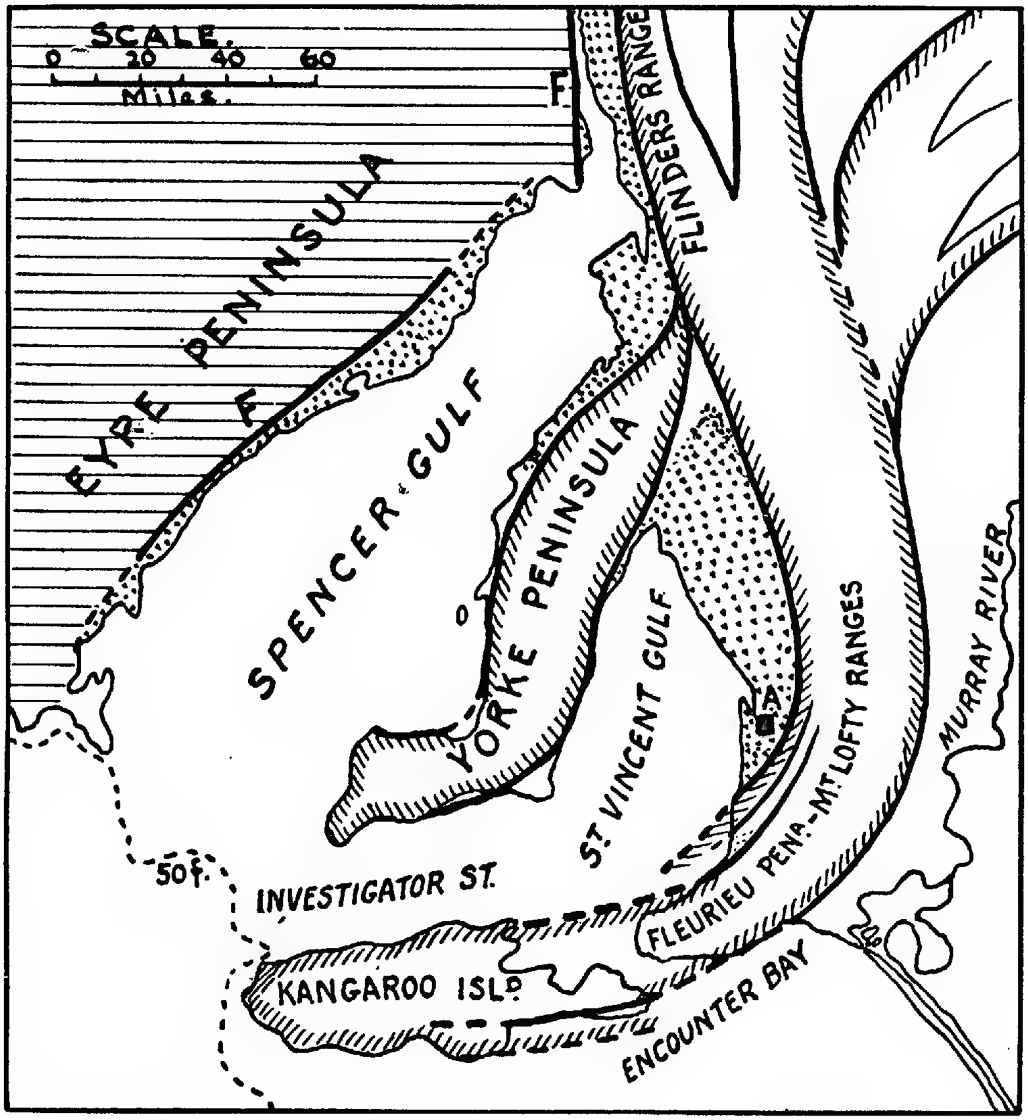


Fig. 1.

Plan showing the main geographical and structural features of the Gulf Region. (After C. Fenner.)

the central zone the sunken areas of Spencer Gulf and Gulf St. Vincent with associated alluvial plains. In the east a huge double arc of highlands of Palaeozoic rocks containing within its curve the secondary and lower highland of Yorke Peninsula. . . . This great highland belt of Cambrian and Pre-Cambrian rocks has long been recognised as a very definite horst of about Pleistocene age (the Kosciusko uplift)." These points are seen clearly in the map in fig. 1, which is reproduced from Fenner's paper.

The main physiographic features of the units comprising the Gulf Region can be summarised as follows:—

EYRE PENINSULA is chiefly less than 500 feet in elevation, though occasionally rising to 1,000 feet; streams are rare. Geologically, it consists of Palaeozoic rocks overlain by Tertiary deposits, and is relatively stable.

YORKE PENINSULA also consists of Palaeozoic rocks of the same type as those on Eyre Peninsula, covered by a thin sheet of Tertiary gravels and limestone. The average elevation is about 400 feet. Plutonic rocks outcrop at the southern end of the peninsula. Fenner *(loc. cit.)* discusses the probable relations of this horst to that of the Mount Lofty arc.

FLEURIEU PENINSULA is of highly varied relief, the highest point reaching 2,334 feet. The older rocks are frequently exposed. Its northern continuation is with the Mount Lofty Range, and its southern extension with Kangaroo Island (see map in fig. 1). In its southern portions an important factor modifying the vegetation is the broad stretch of glacial deposits stretching from Encounter Bay to Gulf St. Vincent and including the Mount Compass area, and also the belt of uplifted glacial sands between Encounter Bay and Normanville.

KANGAROO ISLAND is the second in size of all the islands belonging to the Australian system (excluding New Guinea). Its length along the longer diameter is about 90 miles, its width in the main portion of the Island 25 miles, and in the Dudley Peninsula about 10 miles. The area is approximately 1,500 square miles. It also consists mainly of Palaeozoic rocks, as was first recognised by Peron (22), covered more or less by Tertiary deposits. The average height of the mass is about 400 feet, rising to about 1,000 feet in Mount McDonnell. The western end of the Island is somewhat higher, being about 600 feet high on the average.

Fenner (9) summarises the Gulf Region as follows: "We have as the north-western edge boundary the Lincoln Fault; the semi-circular eastern boundary is the horst of the Mount Lofty Ranges and Kangaroo Island, broken to the south-west by the tectonic movements associated with the foundering of the Jeffrey Deep. Within the semi-circle we have a series of depressed blocks, more or less concentric, with one segment uplifted relatively to its neighbours, giving the Yorke Peninsula Horst."

Previous to the uplift and subsequent tectonic movements, Kangaroo Island, Eyre Peninsula, Yorke Peninsula and Fleurieu Peninsula were covered by a Tertiary sea of Miocene and early Pliocene age when the present thin sheet of sands, gravels, and limestones was deposited. At the present day, the 50-fathom line runs from the western end of Kangaroo Island to the southern end of Eyre Peninsula, and within this area are the "sunklands" covered by the shallow seas forming the gulfs. Spencer Gulf averages less than 20 fathoms throughout, and Gulf St. Vincent averages about 16 fathoms.

IV. CLIMATIC.

The region dealt with in this paper does not comprise the whole of the peninsulas but only the southern portion of each of them. The areas explored botanically are limited by the 20-inch annual isohyet, since it is only in districts with a greater annual precipitation than this that the characteristic sclerophyll vegetation of the stringybark type is developed. In Yorke Peninsula, and in Eyre Peninsula, the 20-inch isohyet cuts off only the extreme southern portion; on Fleurieu Peninsula practically the whole of this southern extension of the main Mount Lofty Block has a rainfall greater than 20 inches per annum.

The vegetation of the northern portion of the Fleurieu Peninsula has been studied by Adamson and Osborn (1) in their classic paper on the *Eucalyptus* forests of the Mount Lofty Ranges. This paper laid the foundations for ecological work in the southern portions of South Australia. The present paper takes into account the part of the peninsula between Mount Compass and Normanville in the north, and Cape Jervis and Encounter Bay in the south. The greater portion of this area receives more than 25 inches of rain per annum. Kangaroo Island has few meteorological stations. Approximately, however, the western end and the southern half of the Island receives more than 25 inches per annum, the rest between 20 and 25 inches, and a small portion of the north coast, including the Dudley Peninsula and the area around Kingscote, less than 20 inches of rain per annum. In the vegetation map of southern South Australia, on p. 112

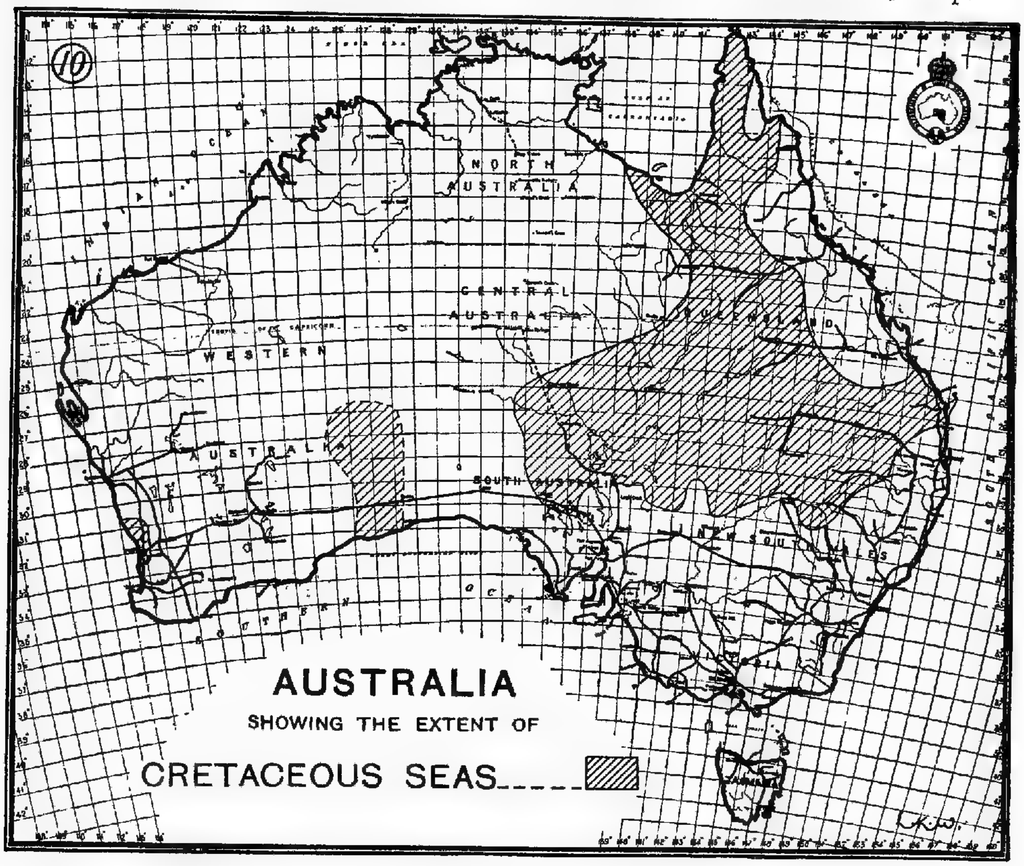


Fig. 2.
(After L. Keith Ward.)

(fig. 3), the annual isohyets in the area under consideration are shown. The isohyets in this map are compiled from the latest data of the Commonwealth Meteorological Bureau.

As regards the reliability of the rainfall, all the country considered here lies within the 15% isopleth (13).

V. ANALYSIS OF THE FLORA OF THE REGION.

(A). Early Migrations of the Southern Flora.

Hooker, in his "Introductory Essay to the Flora of Tasmania" (15), discussing the origin of the Australian flora, states that "the massing of the most peculiar features of the Australian flora in the West, unmixed with Polynesian, Antarctic and New Zealand genera, is an argument for regarding Western Australia as the centrum of Australian vegetation, whence a migration proceeded eastward."

It is definitely established that the flowering plants arose in Upper Cretaceous times, though a few genera extend back to the Lower Cretaceous. Fig. 2, reproduced from Keith Ward's paper (27), shows the extent of Cretaceous seas in Australia. Even if the south-west corner of the continent were the centrum in which the characteristic Australian vegetation arose and from which it spread over the continent, the narrow neck around the present Gulf Region tended to bring about isolation of the western and the eastern continental masses. The eastern continental mass included Tasmania, which has only recently been separated from the mainland, for Bass Strait is still subsiding.

The effect of this isolation of the eastern and western portions of the continent through Cretaceous times resulted in the production of many endemic species in each of the two areas, so that two centres originated from which migration proceeded. The western area retained its pure Australian types, whilst the east has had an admixture of Australian, Malayan, and Antarctic types.

With regard to the Australian genus *Eucalyptus,* the result of this isolation has been made clear by Herbert in his work on the major factors in the present-day distribution of that genus (14). His table showing the comparative endemism of Eucalypt species in South Western Australia, in Victoria and Southern New South Wales, and in Tasmania is as follows:—

	Endemics.	Total Species.	Per Cent. Endemism.
South Western Australia	25	42	59·7
Victoria and Southern New South Wales	27	85	31·7
Tasmania	13	26	50·0

The high percentage of endemics in Tasmania is due to its further isolation. Grouping Tasmania with the other Eastern States, we have 35% endemism in the east and 59·7% endemism in the west, showing clearly that these two areas are centres of species production.

From its position, the Gulf Region of South Australia might be expected to have a flora intermediate between that of the eastern and that of the western portions. In 1859 Hooker (15) remarked "On the Floras of the Countries around Spencer Gulf." He says: "South Australia has been but imperfectly explored, and is apparently poor in species. . . From the examination of a number of South Australian species . . . I am inclined to suspect that it contains so few peculiar genera, and so large a number of species which are either identical with, or strictly intermediate in character between eastern and western ones, that they will favour the idea of the flora being to a very great extent derivative."

Examination of the flora of South Australia has borne out Hooker's surmise; but the history of this portion of the South Australian flora has not been one of long continued isolation nor of continued intermixture of migrating forms, as has been the case of the eastern and western portions of the continent. In the early Middle Tertiary (Miocene and Early Pliocene), the country east of Eyre Peninsula to the River Murray in the north, and down to about Portland in the south, was covered by a shallow sea which destroyed the then existing vegetation. This submersal was followed by an uplift in the Pleistocene (the Kosciusko uplift) which raised the highlands round the Gulf Region; and this uplift was followed by the tectonic movements which resulted in the formation of the horsts and sunklands forming the "Rift Valley."

Following this uplift, colonisation of the virgin area naturally followed—from the east to a large extent, and from the west through Eyre Peninsula.

Kangaroo Island was formerly connected with the mainland by the shallow sunklands at present forming the Gulfs and Investigator Strait, and an analysis of its flora shows that this southern land appears to have been the chief passage for the migration of southern forms of plant life, and also, to a limited extent, a centrum from which migration of species took place. Following the separation of the Island from the mainland, a considerable number of endemic species have arisen, and also on the extreme southern extremity of Eyre Peninsula—the Port Lincoln district—a number of truly endemic species are found. These endemic species are not relic species, but new species and varieties which have arisen since isolation took place. These endemics, as will be seen, are limited in the Island to its western end, and the conclusion one reaches is that this and the Port Lincoln district are the areas of longest isolation and are small "breeding grounds" of species.

(B). Restricted Species.

In the appendix to this paper is given a complete list of plants found on Kangaroo Island and on the adjacent peninsulas. The list is as complete as is possible at the present time, and it is hoped will also serve as local florulas for the districts in question, apart from its value in the present study. All the localities have been carefully checked.

The list does not include introduced alien plants nor native plants belonging to littoral and maritime communities. It is composed, therefore, solely of plants which belong to the various sclerophyll formations. In the next to last column are given the plants which are also found in the Eastern States of Victoria, New South Wales, and Queensland, and in the last column the species found in Western Australia.

From this list the statistics shown in Tables I. and II. are derived.

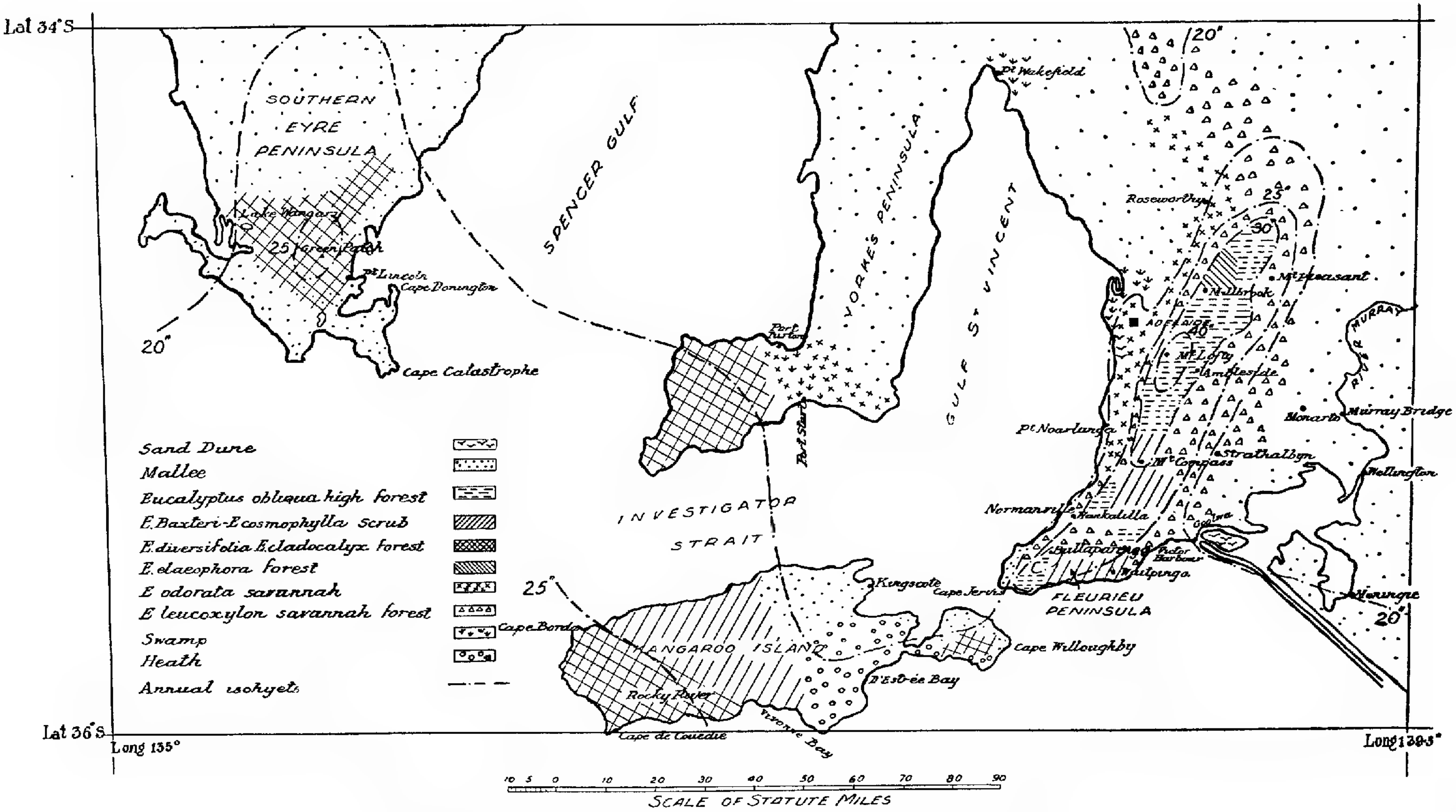
Table I.

Total number of species in Gulf Region	657
Number of species found also in Eastern Australia	551
Number of species found also in Western Australia	300
Western Australian species found also in Eastern Australia	279
Species found in Eastern Australia but not in Western Australia	272
Species found in Western Australia but not in Eastern Australia	21
Endemic species	82

From this table several facts are made clear. The spread of the western species towards the east is shown clearly. Of the 551 species which the Gulf Region has in common with the Eastern States, 279 are of western origin. Hooker's surmise (15) that the flora of "The countries around Spencer Gulf" was composed almost equally of species from the east and from the west, is seen in the fact that of the total species of the region, 272 species are of eastern origin, whilst 300 are of western origin; 4 species are found in Tasmania but not in the eastern mainland States, and the remainder are endemic to the region.

The Gulf Region marks approximately the limit of the eastern species, for these 272 species are not found to any extent to the west of the region under consideration, whilst only 21 species of western origin are not found to the east of the region under consideration.

These figures indicate the early spread of the western species and the later migration from the east. The spread of species at the present time from east to west, or *vice versa*, is limited by the arid and semi-arid belt running northward from the Australian Bight.



VEGETATION MAP OF SOUTHERN SOUTH AUSTRALIA

Fig. 3.

The influence of the Gulfs as barriers to migration of species is brought out if the composition of the floras of Fleurieu Peninsula and of Southern Eyre Peninsula are compared (see Table II.) :—

TABLE II.

Showing composition of the floras of the sclerophyll vegetation of Fleurieu Peninsula and of Southern Eyre Peninsula.

1. FLEURIEU PENINSULA.

Total number of species	323
Species of western origin	150
Species of eastern origin	144
Restricted species	29

2. SOUTHERN EYRE PENINSULA.

Total number of species	283
Species of western origin	185
Species of eastern origin	73
Restricted species	25

On Fleurieu Peninsula 44% of the species are of eastern origin; on Southern Eyre Peninsula only 26% are of eastern origin, while the western species here greatly predominate and comprise 65% of the total number of species.

Western species which occur in the Gulf Region but which do not extend to the Eastern States are:—*Schoenus sculptus, Gahnia deusta, Hakea multilineata, Grevillea pauciflora, G. aspera, Olax Benthamiana, Didymotheca thesioides, Lepidium pseudo-ruderale, Pultenaea vestita, Templetonia retusa, Dodonaea hexandra, Hisbiscus Wrayi, Lasiopetalum discolor, Melaleuca fasciculiflora, Loudonia aurea, Hydrocotyle diantha, Leucopogon hirsutis, Goodenia primulacea, Scaevola crassifolia, Isotoma scapigera,* and *Erechthites picroides.*

In addition to these species, there are four species not found in the eastern mainland States but which are common to the Gulf Region and to Tasmania. These are:—*Schoenus fluitans, Actrotriche patula, Galium ciliare,* and *Ixiolaena supina.*

In Table III. the numbers of species making up the florulas of the different units of the Gulf Region are given:—

TABLE III.

Total number of species	657		
Number of species found on the Island	613	93·3%	of total spp.
Number of species in west end of Island ..	388	59·5%	,, ,,
Number of species on Fleurieu Peninsula ..	321	50%	,, ,,
Number on Fleurieu Peninsula, excluding glacial	276	42·0%	,, ,,
Number of species on Southern Eyre Peninsula	283	43·1%	,, ,,
Number of species on Southern Yorke Peninsula	217	33·2%	,, ,,
Number of species in western and central portions of Kangaroo Island	474	72·1%	,, ,,
Number of species restricted to the Gulf Region of South Australia	82	12·5%	,, ,,

The noteworthy facts arising from this table are: Firstly, that of the total number of species 93·3% are found on Kangaroo Island, and, secondly, that 72·1% of the total number are found in the central and western portions of the Island. Of the plants found on the Island, 77·3% are found in this combined area. These two regions are grouped together, not only because they are adjoining, but also because they have similar rainfalls and both belong to the same formation, namely, variants of the stringybark formation. This fact, and the facts brought out below which show that the endemic plants of the Island are centred in this western portion, afford strong evidence that the Island formed the chief channel for plant migration in earlier times, and also point to the fact that the western end was probably a local centrum from which colonisation of the adjacent peninsulas of Fleurieu and Yorke occurred after the Pleistocene uplift, and after the separation of Eyre Peninsula.

(c). Endemic Species.

From Table III. it is clear that 82 species, or 12·5% of the total plants are endemic to the Gulf Region, and the distribution of these species in the different units of this region is given in Table IV.:—

Table IV.

	Kangaroo West.	Island. East.	Eyre Peninsula.	Fleurieu Peninsula.	Yorke Peninsula.
Schoenus Tepperi	x		x	x	x
S. discifer		x			
Heleocharis halmaturina	x				
Cladium capillaceum	x				
G. hystrix	x				
Xanthorrhoea Tateana	x			x	
X. semiplana			x	x	x
Caladenia ovata	x				
C. bicalliata		x			
Petrophila multisecta	x				
Adenanthos sericea var. brevifolia	x	x			
Hakea cycloptera			x		
Grevillea quinquenervis	x				
G. Rogersii	x				
Trichinum Beckerianum	x				
Cheiranthera volubilis	x				
Acacia dodonaeifolia	x		x		
Pultenaea teretifolia			x	x	
P. teretifolia var. brachyphylla	x				
P. involucrata	x			x	
P. rigida	x		x		
P. acerosa var. acicularis	x				
P. caniculata var. latifolia			x	x	
P. trifida	x	x		x	
P. viscidula	x				
P. heterophylla			x		x
P. cymbifolia	x				
P. trinervis			x	x	
P. trichophylla			x		
Boronia Edwardsii	x				
B. palustris	x				
Correa decumbens	x				
Tetratheca halmaturina	x				
Micranthemum demissum var. microphyllum	x				
Beyeria subtecta	x				
D. humilis	x		x		x
Pomaderris halmaturina	x				
P. flabellare			x		
Trymalium Wayi		x		x	
Spyridium thymifolium	x		x	x	
S. vexilliferum var. latifolium	x			x	
S. phylicoides	x		x	x	
S. halmaturinum	x				
S. halmaturinum var. scabridum	x				
S. halmaturinum var. integrifolium	x				
S. leucopogon			x		
Cryptandra hispidula	x			x	
C. Waterhousei	x	x			

TABLE IV. (Continued).

	Kangaroo West.	Island. East.	Eyre Peninsula.	Fleurieu Peninsula.	Yorke Peninsula.
Commersonia Tatei			x		
Hibbertia sericea var. major	x		x	x	
H. stricta var. oblongata	x				
H. virgata var. crassifolia	x			x	
Pimelia macrostegia	x				
Eucalyptus cneorifolia		x		x	
E. cladocalyx	x	x	x		
E. cosmophylla	x			x	
E. conglobata			x		
E. fasciculosa	x	x	x	x	
Thryptomene ericaea	x	x			
Lhotzkya glaberrima	x	x		x	
L. glaberrima var. magnisepala	x				
L. Smeatoniana	x				
Darwinia homoranthoides			x		
Homoranthus Wilhelmi			x		
Halorrhagis acutangula	x		x		
Hydrocotyle crassiuscula	x	x			
H. comocarpa	x				
Styphelia exarrhena	x		x	x	
Leucopogon concurvis	x			x	
Actrotriche fasciculiflora	x			x	
Veronica parkalliana			x		
Logania insularis	x				
Solanum hystrix			x		
Eremophila Behriana		x	x		
Goodenia amplexans var. crassifolia	x				
Scaevola humilis	x			x	
S. linearis	x		x		x
Stylidium Tepperianum	x				
Brachycome cuneifolium	x		x		
B. neglecta			x		
Achnophora Tatei	x				

On analysing these distribution figures one obtains the following data:—

TABLE V.

Total number of species endemic to the whole region	82
Number of these species found in west end of Kangaroo Island	64
Restricted to west end of Island	30
Restricted to east end of Island	2
Common to western and eastern ends, but restricted to the Island	6
Number of species endemic to Island	38
Restricted to Port Lincoln district	10
Restricted to Southern Fleurieu Peninsula	0
Restricted to Southern Yorke Peninsula	0
Common to Port Lincoln and west of Island	4
Common to Port Lincoln and east of Island	1
Common to Fleurieu and west of Island	10
Common to Fleurieu and east of Island	2
Common to Fleurieu and whole of Island	2
Common to Port Lincoln, Island and Fleurieu	2
Common to Fleurieu, west of Island and Fleurieu	5
Common to Port Lincoln, Island, Yorke and Fleurieu	4
Common to Port Lincoln and Fleurieu	3
Common to Port Lincoln, Fleurieu and Yorke Peninsulas	1
Total	82 species

From this analysis several important facts appear. First, that of the 82 plants endemic to the region as a whole, 64 species or 75% of the total number are found in the western end of Kangaroo Island. For the purpose of the present discussion, "west end" includes the "West" and "Central" divisions set out in the list of plants in the appendix, since they are variants of the same sclerophyll formation and have the same rainfall as has been pointed out before. Secondly, 38 or 47% of the total number of endemics are found only on Kangaroo Island; and of these 30 or 37% of the total endemics are restricted to the western end of the Island. Thirdly, the only other unit of the region in which endemic species are found is the Port Lincoln district, that is, the southern end of Eyre Peninsula, which has 10 species or 12% of the total endemics. No endemic species are found on Fleurieu Peninsula nor on Yorke Peninsula. Fourthly, that 69% of the total endemic species are found on the Island and on Southern Eyre Peninsula.

These facts signify clearly that the union of the Island with Fleurieu Peninsula and with Yorke Peninsula has been relatively recent when compared with the union of the Island with Eyre Peninsula. The number of Island species common with Eyre Peninsula shows, of course, that union between the two groups at one time occurred. The fact that pure endemic species are localized at the western end of the Island and at the southern end of Eyre Peninsula points to the same conclusion, namely, that continued isolation has resulted in species formation. That this isolation has been comparatively recent, geologically speaking, is reflected in the considerable number of varieties of mainland species which are confined to the Island.

Of the pure endemic species and varieties of the Island, 65% are species having affinities with Western Australian species, while the remaining 35% are of eastern origin. Of the 10 species endemic to Southern Eyre Peninsula, 80% are of western origin. It is, therefore, probable that Kangaroo Island and the southern portions of the sunklands of the Gulf Region formed the main channel for the spread of western species; and it is clear that the western end of the Island shows considerable affinities with the flora of Southern Eyre Peninsula. With the separation of the Island from this peninsula, migration of the eastern species continued from the main land mass, resulting in the large number of species on the Island which are common with the Eastern States of Australia. The production of endemic species, chiefly western in character, that is, of purely Australian types, occurs only at the points of greatest isolation.

Examining the endemic species of the whole region under consideration, one finds that the greater number of these species are restricted to three or four typically Australian families. These are as follows:—

Proteaceae	5	species
Rhamnaceae	12	,,
Myrtaceae	11	,,
Genus *Pultenaea* .. .. (Leguminoseae)	12	,,

That is to say, 35 species or 41% of the total endemics are confined to these three families and the one genus of the Leguminoseae. Considering the Island endemics alone the numbers are:—

Proteaceae	3	species
Rhamnaceae	5	,,
Myrtaceae	3	,,
Genus *Pultenaea*	3	,,

That is, 37% of the Island endemics are restricted to these families.

The large number of species belonging to the genus *Pultenaea* which are found on the Island is noteworthy, as Tate (25) remarks: "One marked difference is the absence in Kangaroo Island of Pultenaeas (except in three species occurring rarely), so abundant, specifically and individually on the Mount Lofty Range." In Tate's time, however, the western end of the Island had been but imperfectly explored, and the Island at present shows a wealth of species of this genus when compared with the ranges of the mainland.

The more notable plants which are common on the mainland but which are not found on the Island are *Themeda ciliata, Glossodia major, Persoonia juniperina, Ranunculus lappaceus,* and species of *Loranthus.*

VI. ANALYSIS OF THE VEGETATION OF THE REGION.

(A). Life-forms of the Vegetational Units of the Region.

Before proceeding to the more detailed study of the ecology of the various units making up the region, a table is presented showing the biological spectra of the vegetation in the different areas. The usual symbols established by Raunkiaer are used and the proportion of each of the life-forms expressed as percentages. For purposes of reference, the life-forms corresponding to the symbols are reproduced below:—

Phanaerophytes: Plants with dormant buds exposed freely to the air.
- MM. Mesophanaerophytes, trees; 8-30 metres.
- M. Microphanaerophytes, small trees and shrubs; 2-8 metres.
- N. Nanophanaerophytes, shrubs; 2 metres and less.

Chamaephytes Ch. Buds perennating on surface of ground or just above it (25 cms.).

Hemicryptophytes H. Dormant buds in upper soil.

Geophytes G. Dormant parts well buried.

Therophytes Th. Ephemeral plants—annual plants with short life cycle.

Epiphytes E. There are no true members of this class in South Australia, but the parasitic genera *Loranthus* and *Cassytha* are included in this class.

A number of biological spectra are now available for the southern portions of South Australia—those of the stringybark and savannah forests by Adamson and Osborn (1), and of the mallee by Wood (28)—so that it is possible to compare different regions and to assign the vegetation of any particular area to its formation by comparing its spectrum with those already obtained. Comparisons of the spectra of the vegetation of the units comprising the Gulf Region are compared with that of other portions of South Australia in the following table:—

Table VI.

	No. of Species.	MM.	M.	N.	Ch.	H.	Th.	G.	HH.	E.
Mount Lofty Ranges	362	2	8	25	12	24	10	17	1	1·5
Fleurieu Peninsula	276	2	8	24	10	21	10	21	3	1·5
Stringybark Associations—										
Mount Lofty	244	1	9	**34**	13	23	4	13	1	1·5
West Kangaroo Island	388	2	7	**33**	11	18	11	13	3	0·5
South Eyre Peninsula	283	1	10	**33**	12	14	15	11	1·5	1·0
South Yorke Peninsula	217	—	10	**34**	13	13	17	10	—	2·0
Scrub on Sands—										
Central Plateau (K.I.)	232	—	7	**50**	11	11	6	14	0·5	1
Fleurieu Plateau	113	—	6	**49**	14	16	1	10	—	2
Mount Compass	112	—	9	**50**	10	16	3	7	—	2
Mallees—										
Total Mallee	590	—	13	**30**	19	11	**21**	3·5	—	0·5
Yorke Peninsula	302	—	13	**32**	15	9	**22**	6·5	—	1·5
Eyre Peninsula	406	—	11	**31**	18	8	**21**	6·0	—	2·0
Dudley Peninsula	306	—	8	**29**	11	**17**	**20**	11·0	1	0·7
Heath Land –										
Kangaroo Island	94	—	6	26	20	18	13	14	—	3·0

It is at once apparent from these figures that the Fleurieu spectrum can be grouped with the Mount Lofty Range spectrum as given by Adamson and Osborn (1).

The vegetation of the west end of Kangaroo Island, of Southern Eyre Peninsula, and of Southern Yorke Peninsula have close affinities with stringybark forests of the Mount Lofty Ranges.

The scrub lands of the Central Plateau of Kangaroo Island and of the Plateau of the Fleurieu Peninsula, covered with glacial sands, are grouped with that of the Mount Compass area, whose spectrum is calculated from the list of plants given by Adamson and Osborn in the paper already referred to.

The vegetation of the Dudley Peninsula is grouped with the mallee lands of Eyre and Yorke Peninsulas.

The heath lands of the D'Estree Bay region form a community of its own, apparently comparable with the heath lands of the South-East of South Australia, the ecology of which has not yet been studied.

The spectra of the different areas thus give a preliminary grouping and a clue to the formation to which the vegetation of each unit belongs, and it remains to analyse in more detail the composition of these associations.

(B). The Fleurieu Peninsula.

The southern portion of the Fleurieu Peninsula considered in this paper is bounded, approximately, on the north by the Inman Valley, running from Victor Harbour to Normanville. This valley is filled with glacial sands of Permo-Carboniferous age. South of this line rise the hills, locally known as "The Tiers," which form the backbone of the southern portion of the Peninsula; these hills have an east-west trend. Proceeding southwards, one meets first low rolling hills of quartzite and hornstone (21); these foothills are about 500 feet high on the average. The hills forming the main block of the peninsula rise steeply from the foothills. These hills form an uplifted peneplain of rolling hills and broad valleys, recalling vividly those of the Mount Compass area. The elevation lies between 1,000 and 2,000 feet. Here the older rocks are covered with unconsolidated glacial sands of Permo-Carboniferous age; the average depth of the sands is about 20 feet. They carry a dwarf *Eucalyptus Baxteri-E. obliqua* scrub. The sands frequently become lateritic, and fine ironstone nodules are fairly common. Where this is abundant *Eucalyptus cosmophylla* and *Casuarina striata* become locally dominant.

The glacial sands cover the greater portion of the plateau, but are seen only locally in the country west of a line drawn from Second Valley to the Blowhole Creek; patches occur between Campbell's Creek and Blowhole Creek, and also the flat lowland around Cape Jervis is covered with glacial deposits. This westerly portion of the peninsula has a higher rainfall than the more easterly portions, and it seems that the glacial sands originally covered the whole of the plateau, but in this region have been weathered away.

Practically the whole of the peninsula receives over 25 inches of rain per annum, the Second Valley Forest Reserve receiving the highest recorded, *viz.*, 31·8 inches. There are, however, no rainfall stations through the plateau area proper which is at present uninhabited. Towards Encounter Bay the rainfall diminishes to 22·5 inches at Victor Harbour.

The nature of the vegetation of the area can best be made clear by comparing the biological spectrum of this region with that of the Mount Lofty Ranges given by Adamson and Osborn (see p. 117). It will be seen that the spectra for the two regions agree substantially in every category; and, indeed, the same associations occur with the same florulas as those given by Adamson and Osborn.

The climax stringybark high forest of *Eucalyptus Baxteri* and *E. obliqua*, however is soon reached. A transect from Cape Jervis to Delamere brings out clearly the nature of these formations. Near the point of Cape Jervis, on a soil containing a good deal of travertine limestone, mallee with *E. leptophylla* as the dominant species occurs, but this is soon replaced on the flats covered with glacial deposits by savannah forest dominated by *E. leucoxylon*. From the flats the hills rise steeply. The lower foothills are covered by *E. leucoxylon* open savannah forest, but rising up the steep Cape Hill to the plateau this is replaced by the sclerophyll *E. obliqua-E. Baxteri* forests. Rainfall is here the factor determining the forest type. The rainfall rises over a short distance of seven miles from 16·3 inches per annum at Cape Jervis, to 30·8 inches per annum at Bullarparinga. A distinct facies is given here to the climax high forest of *E. obliqua* by the numerous grass-trees *(Xanthorrhoea Tateana)*, which are not found in the main block of the Mount Lofty Ranges. The trunks of these grass-trees are frequently 12 feet high, and appear to be localized to this corner of the Fleurieu Peninsula and to Kangaroo Island.

Proceeding southwards from Normanville (annual average rainfall 20·8 inches) a somewhat similar sequence of vegetational units is met with. At Normanville a thin tongue of glacial sands lies between the dune area of the coast and calcareous and arenaceous beds of Pre-Cambrian age, which were originally covered with savannah forest of *Eucalyptus odorata* ("peppermint gum"), of which patches still remain. On the glacial sands themselves a remarkable community occurs, dominated by trees of *Banksia marginata*. These trees are on the average 20 to 30 feet high, and specimens with trunks two feet in thickness are common. One example measured 2 feet 8 inches at breast height. *Olearia ramulosa* and *Calythrix tetragona* are the commonest undershrubs, whilst large areas of the sands are covered with mats of *Kunzea pomifera*, and the fern *Cheilanthes tenuifolia*. The association is noteworthy on account of the tree form of *Banksia marginata;* in the Mount Lofty Ranges this species occurs as a small shrub up to about 10 feet in height, and on the sands of the Mount Compass area and on the Fleurieu Plateau it occurs as a small shrub about one foot high.

Other plants in this association are *Bursaria spinosa, Hibbertia stricta, Lycium australe, Leptospermum myrsinoides, Grevillea lavendulacea, Casuarina stricta, Muehlenbeckia adpressa, Mesembryanthemum aequilaterale, Clematis microphylla, Cassytha glabella, Psoralea patens, Fusanus acuminatus, Xanthorrhoea semiplana, Exocarpus cupressiformis, Lepidosperma semiteres, Callitris robusta, Pimelea glauca,* and *Leucopogon parviflorus*. These plants are chiefly those of the savannah forests mixed with those of the coastal dune areas.

Rising to the foothills from this association, *Banksia marginata* is replaced by a savannah in which *Casuarina stricta* is the dominant tree, with *Acacia pycnantha, Olearia ramulosa, Hibbertia stricta,* and *Xanthorrhoea semiplana* as the most important undershrubs, and *Stipa variabilis* as the commonest native grass. This association soon gives place to degenerate savannah forest of *Eucalyptus odorata* and *E. leucoxylon*. On the higher foothills to the south pure savannah forest of *E. leucoxylon* is developed. In the Hay Flat Valley, south from Normanville, *E. leucoxylon* forest is also developed on glacial sands, but is here more xerophytic in nature, and the undershrubs are more akin to those of the stringybark forests; *Actrotriche serrulata, Astroloma conostephioides, Hibbertia sericea,* and *Xanthorrhoea semiplana*, for example, become prominent. The community developed is similar to that described by Adamson and Osborn for blue gum forests on ironstone soils (1), although here there is practically no ironstone present in the sands.

Rising steeply to the main plateau, one passes rapidly through typical stringybark forests until the roof is reached, when the facies of the vegetation changes abruptly and the typical scrub of the dwarf *Eucalyptus Baxteri-obliqua-cosmophylla* type is reached. The vegetation here is quite characteristic and similar in all respects to that described from the Mount Compass area by Adamson and

Osborn (1). More abundant than in the latter region, however, are the Rhamnaceous shrubs *Spyridium parvifolium, S. thymifolium,* and *Cryptandra hispidula,* which contribute largely to the characteristic facies shown here. At the bottom of the broad valleys extensive swamps occur. The soil is peaty and of acid reaction (pH. from 4·6 to 5·0), and the most important constituents of the swamps are *Viminaria denudata, Acacia rhetinoides, Leptospermum scoparium,* and *Melaleuca squamea.* Fringing the swamp proper are dense masses of *Sprengelia incarnata, Gahnia psittacorum, Schoenus brevifolius,* and *Xyris operculata.* These swamps, in their essentials, are similar to those already described for the Mount Compass area (1).

As in the Mount Compass district ironstone nodules are frequently developed, and this change in soil type causes a partial replacement of *E. Baxteri* by *E. cosmophylla* as the dominant eucalypt shrub. *Casuarina striata* also becomes prominent, though otherwise the typical vegetation persists. Adamson and Osborn correctly consider both scrub on glacial sands and scrub on ironstone soils as edaphic sub-climaxes of the high forests of *E. Baxteri* and *E. obliqua.* The writer, however, tends to group the two formations together, and regards them as a sub-climax on relatively unconsolidated sands—whether of glacial or sedimentary origin—which are more or less lateritic.

The similarity between the scrubs of the Mount Compass and of the Fleurieu Plateau and that of Kangaroo Island strikes one at once. The Central Plateau of Kangaroo Island is composed of Palaeozoic rocks covered with Tertiary sands, in which a good deal of ironstone is developed. Here *E. cosmophylla* is more prevalent than *E. Baxteri* on account of the greater iron content.

Comparison of the spectra of the vegetation from the three sand areas is instructive:—

	MM.	M.	N.	Ch.	H.	Th.	G.	HH.	E.
Central Plateau, K.I.	—	7	50	11	11	6	14	0·5	1
Fleurieu Plateau	—	6	49	14	16	1	10	—	2
Mount Compass	—	9	50	10	16	3	7	—	2

The three spectra agree in all essentials. The outstanding feature is the great abundance of woody shrubs—the nanophanaerophytes—which form 50% of the vegetation in each case. The therophyte element has almost disappeared. The Central Plateau of the Island is, however, richer in geophytes than either of the other regions.

At Waitpinga Creek, on the eastern end of the peninsula, the glacial sands merge into stabilized dunes. The vegetation of this area has been described by Cleland (8). Here *Eucalyptus diversifolia* occurs, mixed with *E. fasciculosa* and *E. leucoxylon* in a small circumscribed community. The significance of this community will be discussed when dealing with the vegetation of Kangaroo Island.

(c). Kangaroo Island.

The general physiography of Kangaroo Island was first described by Peron (22), zoologist to Baudin's expedition, who says: "The country is composed of hills more or less elevated, but of which the summits are nearly everywhere regular and uniform." Geologically, the Island consists of Pre-Cambrian rocks, overlain in the Central Plateau by Tertiary sands. The Palaeozoic rocks outcrop in the western end of the Island, and ring the Island on the northern and southern sides and continue into the Dudley Peninsula.

Maps showing the distribution of rainfall on the Island vary. The map of Australia published by the Commonwealth Meteorological Bureau in 1925, shows the 20-inch isohyet cutting off the northern portion of the Island around Kingscote and the north end of Dudley Peninsula, while a map for the period April to November shows the 20-inch isohyet for this period in approximately the same place.

The 25-inch isohyet, in the former map, cuts off only the western portion of the Island. Griffith Taylor shows a different 20-inch isohyet from either of the above maps. Fenner (10) shows the 25-inch isohyet running east and west through the Island, the southern portion receiving more than 25 inches per annum. The chief difficulty lies in the fact that there are no meteorological stations on the Central Plateau region of the Island. From the map for the April-October period, it appears that Fenner's map is correct. This position agrees with the vegetational map, for the characteristic vegetation on sands is developed on this plateau. Everywhere on the mainland this is developed in areas with rainfall from about 23 or more inches per annum.

In Tate's time the western end of the Island was unexplored, and Tate (25) recognised four "prominent groups" of vegetation. These were as follows:—

1. Scrubby Heath Lands.—By this is meant the scrub of *Eucalyptus Baxteri* and *E. cosmophylla*, developed on the more or less lateritic sands, and is similar to that already described for the Fleurieu Plateau.
2. Sylvan Vegetation.—"Confined to the borders of the watercourses, and the chief forest tree is *E. cladocalyx*, with which is associated, not infrequently, *E. leucoxylon*, and, occasionally, *E. viminalis* and *E. rostrata*."
3. The Savannah Vegetation.—"More or less grassed hill slopes . . . dotted with clumps of *E. cneorifolia* intermingled with *E. incrassata*."
4. The Vegetation of the Littoral Tracts.—These are the mud flats of the coasts and lagoons and the sand dune areas.

From the more modern point of view the Island can be divided into four vegetational groups, ignoring the littoral vegetation. These are as under:—

i. Mallee Scrub.

This is developed on the Dudley Peninsula and in the area around Kingscote, and is limited, approximately, by the 20-inch isohyet. This scrub corresponds to Tate's "savannah vegetation." The nature of this formation has been briefly mentioned by Wood (28). Its connection with the mallee of Eyre Peninsula and of Yorke Peninsula is made clear by comparing the biological spectra of the regions.

	MM.	M.	N.	Ch.	H.	Th.	G.	HH.	E.
Total Mallee	—	13	30	19	11	21	3·5	—	0·5
Yorke Peninsula	—	13	32	15	9	22	6·5	—	1·5
Eyre Peninsula	—	11	31	18	8	21	6·0	—	2·0
Dudley Peninsula	—	8	29	11	17	20	11·0	—	0·7

The mallee of the Island dominated by *Eucalyptus cneorifolia* and *E. incrassata* shows a higher percentage of hemicryptophytes and geophytes than either of the other two regions, and is a transition region with affinities nearer to formations of the stringybark type than any other mallee community that has so far been examined in South Australia.

ii. Eucalyptus Baxteri-E. cosmophylla Association on Lateritic Sands.

This association is similar to that on the Fleurieu Plateau and to the Mount Compass region. As shown by Adamson and Osborn (1), it is an edaphic subclimax of the *E. obliqua* forests of South Australia on sands where the rainfall is about 25 inches per annum or more. A complete list of the plants found in this association is given in the appendix. The facies of the vegetation is similar to that developed on the Fleurieu Plateau, slightly changed by the prevalence of such plants as *Petrophila multisecta, Adenanthos sericea, Boronia Edwardsii, B. filiformis, Hibbertia Billardieri*, and others. Its spectrum has been compared with that of the vegetation of the Fleurieu Peninsula and with the Mount Compass region on another page.

iii. Heath Lands.

Heath is developed in the country between American River and D'Estree Bay on Tertiary sands which are underlain by clay. The vegetation is largely that of the *E. Baxteri-E. cosmophylla* sub-climax, but the Eucalypt species are more suppressed and their place taken by Myrtaceous plants, by Cyperaceae, and by Epacridaceae. Its nearest affinity is with the vegetation of the plateau, and it appears similar to the heath lands of the South-East of South Australia. Until the relations of the communities in the latter area are worked out, it appears unwise to discuss the community further at this stage.

iv. Eucalyptus diversifolia-E. cladocalyx Sub-climax Association.

This association is one which plays a large part in the ecology of Kangaroo Island and of Southern Eyre Peninsula, and in part of Southern Yorke Peninsula.

Eucalyptus cladocalyx, as noted by Tate in his "sylvan vegetation," is found along watercourses in the wetter parts of Dudley Peninsula. In such situations as these it is often the more or less dominant tree, sometimes forming a savannah type of forest with *Acacia armata, Dodonaea viscosa, Bursaria spinosa,* and *Olearia teretifolia* as the chief undershrubs. In the western end of the Island, however, it is much more common. Fringing the borders of swamps it forms a more or less open forest, but on slightly higher ground it has the typical undergrowth of the stringybark forests of the Mount Lofty Ranges and that of the Central Plateau of the Island. Occasionally, in very wet situations, an almost impenetrable forest is formed, dominated by *E. cladocalyx* and by shrubs of *Beyeria Leschenaultii, Lasiopetalum discolor, L. Schulzenii, Correa rubra, Bauera rubioides, Adriana Klotzschii,* and *Cassytha* spp.

The latter shrubs, on the Plateau and in the forest proper of the Island, are less than a metre high, but here grow to a height of several metres and form dense thickets tangled together by the *Cassytha* vines.

Over the greater portion of the west end of the Island, however, *E. cladocalyx* is found on the hills and on the stabilized sand ridges in association with *E. diversifolia,* with undershrubs typical of the stringybark formation. The most important of these are *Adenanthos sericea, A. terminalis, Grevillea halmaturina, Isopogon ceratophyllus, Petrophila multisecta, Hakea ulicina, Choretrum spicatum, C. glomeratum, Leptomeria aphylla, Exocarpus cupressiformis, Xanthorrhoea Tateana, Astroloma humifusum, A. conostephioides, Actrotriche fasciculiflora, Lasiopetalum discolor, Boronia Edwardsii, B. filifolia, Hibbertia stricta, H. stricta* var. *glabriuscula, H. Billardieri, Pultenaea daphnoides, P. viscidula, P. floribunda, Billardiera scandens, Bauera rubioides, Acacia armata, Ixodia achilleoides,* and others. A complete list will be found in the appendix.

On Southern Eyre Peninsula similar communities of *Eucalyptus cladocalyx* and *E. diversifolia* occur, and on the extreme southern portion of Yorke Peninsula a community dominated by *E. diversifolia* occurs. On the Island and in Southern Eyre Peninsula *E. cladocalyx* and *E. diversifolia* bear much the same relation to one another as do *E. obliqua* and *E. Baxteri* on the mainland, that is, *E. Baxteri* occurs on shallower and sandier soils than does *E. obliqua,* and *E. diversifolia* on sandier soils than does *E. cladocalyx.* I have, therefore, grouped *E. cladocalyx* and *E. diversifolia* together as the dominant tree species in what is a sub-climax of the stringybark formation.

The resemblance of the *E. cladocalyx-E. diversifolia* forests of the Island to the *E. obliqua-E. Baxteri* forests of the mainland is apparent if the species comprising the undergrowth are considered, but becomes quite clear if the spectra for the western end of the Island are compared with the spectrum of the vegetation of the stringybark forests of the Mount Lofty Ranges, and with that of Southern Eyre Peninsula and with Southern Yorke Peninsula.

	MM.	M.	N.	Ch.	H.	Th.	G.	HH.	E.
Mount Lofty	1	9	34	13	23	4	13	1	1·5
West Island	2	7	33	11	18	11	13	3	0·5
South Eyre Peninsula	1	10	33	12	14	15	11	1·5	1·0
South Yorke Peninsula	—	10	34	13	13	17	10	—	2·0

The spectrum for the west end of the Island agrees with that of the typical stringybark forest in all categories, except that the percentage of therophytes, or annual plants, is increased at the expense of the hemicryptophytes. This increase in the therophytic element is due partly to the more sandy nature of the soil, and partly to the partial savannah nature of the pure *E. cladocalyx* forest.

On Southern Eyre Peninsula and on Southern Yorke Peninsula the therophyte element increases progressively and the geophyte element decreases. These changes are characteristic of increasing aridity, and this is borne out by comparing the rainfall data for the two regions.

The *E. diversifolia-E. cladocalyx* association reaches its climatic limit near Port Lincoln on Eyre Peninsula. The association here reaches its greatest development along the road between Port Lincoln and Lake Wangary. The rainfall increases from 20 inches per annum at Port Lincoln to about 26 inches at Green Patch, and then falls again to about 20 inches per annum at Lake Wangary. In this portion of the Peninsula the change from this community to mallee communities of *E. odorata* is gradual. *E. cladocalyx,* in the Port Lincoln district, has a poor and straggling habit, and *E. diversifolia* dominates the association.

The extreme end of Yorke Peninsula is cut off by the 20-inch annual isohyet, and in this region *E. cladocalyx* is not present, but an association dominated by *E. diversifolia* alone exists. Tate (26) commented on the existence of this vegetation, and referring to the vegetation on either side of the Great Salt Marsh of Southern Yorke Peninsula he says: "The botanical differences are so marked as to be matter of common observation, and yet the climatic and hydrographic conditions are absolutely the same on either side of the Great Salt Marsh. On the north side the country is savannah-timbered with *Casuarina stricta, Melaleuca parviflora,* with small trees of *Eucalyptus odorata,* whilst the chief undershrubs are *Bursaria spinosa* and *Myoporum insulare.* . . . Most of the south side is covered with a dense mallee scrub, the chief constituents of which are *E. santalifolia* (= *E. diversifolia* Bonpl.) and *E. dumosa.* The facies of the florula recalls that of Kangaroo Island and the Port Lincoln district, yet it is wanting in several of their salient forms such as Grevillea, Cryptandra and Xanthorrhoea and various genera of Myrtaceae."

The spectrum of the region reveals that on Southern Yorke Peninsula we have a community which is intermediate between that of the typical stringybark climax and the mallee of Northern Yorke Peninsula.

	MM.	M.	N.	Ch.	H.	Th.	G.	HH.	E.
Stringybark (Mt. Lofty)	1	9	34	13	23	4	13	1	1·5
West End of K.I.	2	7	33	11	18	11	13	3	0·5
South Yorke Peninsula	—	10	33	13	13	17	10	—	2·0
North Yorke Peninsula	—	13	32	15	9	22	6·5	—	1·5

It is clear that here the *E. diversifolia* community is at its climatic limit, and tends to pass over to the savannah phase which invariably intervenes between the communities of the stringybark formation and the mallee. This nearing of the limit is reflected in the increase of the therophytic element in the flora and the decrease in the geophytic element.

It is clear that in the *E. diversifolia-E. cladocalyx* association we have a vegetational unit in these regions analogous to the association of *E. obliqua-E. Baxteri* on the mainland.

The recognition of this association as a sub-climax of the *E. obliqua-E. Baxteri* association is complicated by the fact that the dominant tree *(E. diversifolia)* has a mallee habit, that is to say, it has not a single trunk but several branches arise from the crown of the root.

Investigation of the affinities of this species showed, however, that *E. diversifolia* is very nearly allied to *E. obliqua, E. Baxteri,* and *E. macrorrhynca,* which are typical stringybarks. The species was made by Bonpland (5) from trees grown in the South of France from "seeds brought by Baudin's expedition to New Holland." Bentham, in the "Flora Australiensis," remarks "that this species is now reduced by Dr. von Müller to a form of *E. obliqua.*"

Maiden (17), in his "Critical Review of the Genus Eucalyptus," remarks: "More field work requires to be done in South Australia to define the relations between *E. diversifolia* and the other species concerned." And in his "Contribution to the Botany of South Australia" (18) he says: "I have referred it *(E. diversifolia)* to *E. capitellata* Sm. (= *E. Baxteri* (Benth.) Maiden and Blakely), and to this opinion I adhere until a view of better specimens than I have seen in various herbaria shows this opinion to be an erroneous one." Specific rank is given to the species by Black in his "Flora of South Australia," and, indeed, the habit is distinctive enough to warrant such rank. Its obvious relations to *E. obliqua* and *E. Baxteri* are, however, shown by the above opinions of Bentham, von Müller, and Maiden. The habitat of the species is never that of a typical mallee. In addition to the districts already mentioned, it is found at Guichen Bay in the South-East, at Portland in western Victoria, on stabilized dunes, and at Yetemerup and King George Sound in Western Australia. All these regions have a rainfall of from 25 to 30 inches per annum. It is also reported from the "Murray Scrub," but no locality is given and Maiden regards it as doubtful.

Its affinities, its attendant vegetation, and the spectrum of the vegetation associated with it, all point to its relation to the stringybark formation.

The cause of the replacement of *E. obliqua* and *E. Baxteri* by *E. diversifolia* calls for comment. The soil upon which the association dominated by this tree is found is more sandy than that upon which the characteristic *E. obliqua* associations are developed. Its general habitat, apart from the Island and Port Lincoln, is upon stable inland dunes. But on the Island and at Port Lincoln, although sand ridges are found, the Palaeozoic rocks are but thinly covered in many places. A potent factor is probably that in these two areas *E. obliqua* and *E. Baxteri* have reached here the western limit of their range. These species do not occur on Eyre Peninsula, and only in stunted form on the ironstone plateau of Kangaroo Island. In this respect the community appears to be somewhat analogous to the forests of *E. elaeophora* described by Adamson and Osborn (1) from the northern portions of the Mount Lofty Ranges. On account of the sandy nature of the soil upon which it is developed, the *E. diversifolia* association is regarded as a sub-climax of the stringybark formation rather than as a co-climax, as far as South Australia is concerned.

As in the stringybark forests of the Mount Lofty Ranges, *E. viminalis* is present in the deeper gullies associated with *Banksia marginata, Acacia rhetinoides,* and *Pultenaea daphnoides.* In wetter situations such as these, *E. obliqua* and *E. Baxteri,* are also occasionally found in tree form, as for example on the wet, sandy ground between Rocky River and Cape Borda. In this respect the resemblance is close to the forests developed on the sandy soils of the Mount Compass district and of the Fleurieu Plateau, where trees of *E. Baxteri* are found together with the undershrubs of the tableland.

In addition to its occurrence on the western end of Kangaroo Island and on Southern Eyre Peninsula, *E. diversifolia* occurs as a constituent of the scrub of the Dudley Peninsula and the area around Kingscote. Here the trees have a more rugged bark than the relatively clean-stemmed trees of the west end of the Island. The tree with the more rugged bark appears to be a form more tolerant of dry conditions than the clean-stemmed form. On the mainland, near Waitpinga and Newland Head, as already noted (8), a small patch of this form of *E. diversifolia* occurs. Generally speaking, the communities dominated by *E. diversifolia* appear to be the most arid of all the communities forming the stringybark formation.

(D). Southern Eyre Peninsula.

The chief interest in this peninsula centred around the occurrence of the *E. diversifolia-E. cladocalyx* association in this district. Geologically, the country consists of Palaeozoic rocks. A low range of hills follows the gulf; beyond this it falls to a somewhat swampy area, and beyond this again is a level plain stretching to Lake Wangary and to the Marble Ranges in the west. The rock exposures, according to Mawson (20), are Pre-Cambrian and similar to those of Southern Yorke Peninsula. The rocks are schistose, chiefly gneissic, and along the Port Lincoln-Lake Wangary road, where the *E. diversifolia-E. cladocalyx* association is chiefly developed, is a highly metamorphosed belt.

Towards the south of this area the rocks appear to be covered with deeper sands, and in this region also Recent limestones cover the older rocks. In this southern region, particularly in the small peninsula formed by Western Cove, Cape Donington, and Cape Catastrophe, typical mallee scrub is developed with *E. oleosa, E. gracilis, E. incrassata,* and *E. conglobata* as the dominant eucalypt species. A list of the Port Lincoln plants is given in the appendix.

(E). Southern Yorke Peninsula.

This region has only once been visited by the author, when complete collections of the flora were not made. The formation has been analysed from Tate's comprehensive list of species. As has been observed above, Tate remarked upon the differences in the flora of the extreme southern end of the peninsula, which is separated from the northern part by the Great Salt Marsh which runs across the peninsula, approximately from Port Turton to Port Sturt. Tate says "the differences are so marked as to be a matter of common observation, and yet the climatic and hydrographic conditions are the same."

Actually the conditions are not the same, for the 20-inch annual isohyet runs, approximately, along the Great Salt Marsh, and this isohyet, as has been noticed previously, is the limit of the communities of the stringybark formation. Tate's list of species, supplemented by later collections, is given in the appendix.

According to Howchin (16) the region consists of Archaean rocks overlain by glacial clay, on top of which are Pleistocene sands.

The *E. diversifolia* association on the tip of Southern Yorke Peninsula appears as a relic of the times when the peninsula was united to Kangaroo Island and when higher rainfall conditions probably prevailed.

VII. SUCCESSION IN THE SOUTHERN AUSTRALIAN SCLEROPHYLL FORESTS.

It is now possible to obtain a clear picture of the sclerophyll communities in Southern Australia dominated by trees of various species of *Eucalyptus*. The savannah forests of *E. leucoxylon* and of *E. odorata* developed in South Australia are here disregarded, for although on ironstone soils associations dominated by these trees approach the sclerophyll type of the stringybark forests, normally their facies and constitution are different. The major factor determining the distribution of the different associations is rainfall, while edaphic factors and species reaching the limit of their range play a secondary important part.

The chief formations and associations of the sclerophyll forests of Southern Australia are summarised below:—

A. Mallee.

Developed on sandy alkaline soils, usually with travertine limestone, between the 20-inch and 8-inch annual isohyets (Wood, 28).

B. The Stringybark Formation.

1. *Eucalyptus obliqua-E. Baxteri association.*
   Developed on siliceous soils derived from Pre-Cambrian rocks. Soils slightly acidic. Occurs up to 2,000 feet elevation between the 25- and 30-inch annual isohyets. In South Australia this is the Climatic Climax Association (Adamson and Osborn, 1).
2. *Eucalyptus elaeophora consociation.*
   Developed on highly metamorphosed hard schists and gneisses of Pre-Cambrian age in the Mount Lofty Ranges. Rainfall, 30 to 35 inches per annum. *E. obliqua* is here near its western limit.
3. *Eucalyptus Baxteri-E. cosmophylla sub-climax.*
   Dwarf scrub on sandy and sandy-lateritic tablelands. Sands of glacial or sedimentary origin. Rainfall, 23 to 30 inches.
4. *Eucalyptus diversifolia-E. cladocalyx sub-climax.*
   Developed on sandy soils of Recent origin or derived from Pre-Cambrian schists. Rainfall, 20 to 30 inches per annum. *E. obliqua* at western limit of its range.
5. *Eucalyptus obliqua-E. amygdalina-E. macrorrhynca consociation.*
   In the Healesville district of Victoria this association is developed as described by Petrie, Jarrett, and Patton (23). This consociation is not the climax association in this wet district, but appears as a developmental phase which culminates in the restricted climax forest of *E. regnans.* Geologically, the soils are derived from rocks of Silurian age; to the north of Healesville the Silurian forms a junction with dacite, a hard laval rock, rich in silica, and, therefore, slightly acid. Rainfall, 35 to 45 inches per annum. The authors also describe forests of *E. viminalis,* of whose status they are not sure. They occupy the same relation to the stringybark forests here as they do in South Australia, and Adamson and Osborn have shown that forests of this tree are allied, not to the sclerophyll forests but to the savannah forests of *E. leucoxylon.*
6. *Eucalyptus regnans.*
   Forests of this tree form the climatic climax of the "Stringybark Formation" in Southern Australia under high rainfall conditions. Elevation, about 2,500 feet. Rainfall, 45 to 50 inches per annum.

VIII. VEGETATION MAP OF SOUTHERN SOUTH AUSTRALIA.

On page 112 is reproduced a vegetation map of the southern portion of South Australia, the flora of which has been dealt with in this paper. In the area shown in the map, between latitudes 34° and 36° south, and between the parallels of 135° and 139·5° east longitude, is developed the characteristic forest and scrub vegetation. Part of the mallee only is shown in this map; the total extent of this formation has been shown in a map in an earlier paper on "Floristics and Ecology of the Mallee" (28).

In his vegetation map of South Australia, Prescott (30) included the area of the Mount Lofty Ranges as "temperate savannah and forest"; the limits of the different associations making up this area are detailed in the present map, and, in addition, the sclerophyll forests of Kangaroo Island, Eyre Peninsula, and Yorke Peninsula.

The relation of the different forest types to the annual rainfall can be seen from the map in which isohyets are also drawn.

IX. SUMMARY.

In this paper an analysis is made of the flora and of the vegetation of Kangaroo Island, and of the peninsulas of Fleurieu, Eyre, and Yorke.

The flora of this Gulf Region is composed almost equally of migrant species from the western and eastern centres of distribution in Australia, together with 82 endemic species, out of a total of 657 species. The migration from the west was earlier than the migration from the east; and the Southland, represented at present by Kangaroo Island and the sunklands of the gulfs, formed the chief means of passage through which the species of westerly origin passed. The migration of species from the eastern centre occurred chiefly after the separation of Eyre Peninsula, and the gulfs have proved a barrier to westerly migration of these species.

As the result of continued separation, species production occurred at the points of greatest isolation, namely, in the west end of Kangaroo Island and the southern portion of Eyre Peninsula. In these two regions 69% of the total endemic species are found, the greater number of which are confined to four families.

In the second part of the paper the ecology of the Gulf Region is dealt with. Excluding the savannah forests of *Eucalyptus odorata* and *E. leucoxylon*, all the forest and scrub types developed within the 20-inch annual isohyet are of the sclerophyll type and are variants of the "Stringybark Formation" of the Mount Lofty Ranges, with *E. obliqua* as the climatic climax forest tree. A new edaphic sub-climax of this formation is recognised—the *E. diversifolia-E. cladocalyx* sub-climax—present in the west end of Kangaroo Island, in the Port Lincoln district, and in the southern extremity of Yorke Peninsula. Other sub-climaxes and associations are recognised, and their relations to the succession shown in the sclerophyll forests of Southern Australia are discussed.

A vegetation map of the forests of Southern Australia is included in the paper.

ACKNOWLEDGMENTS.

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X. APPENDIX. LIST OF SPECIES FOUND IN THE GULF REGION.

In this appendix is given a complete list of species inhabiting the region discussed in this paper, together with their distribution in the different units making up the region. The explanation of the symbols at the head of the different columns is as follows:—

W.—West end of Kangaroo Island.
C.—Central Plateau of Kangaroo Island.
D'E.—Sandy heath land from American River to D'Estree and Vivonne Bays.
D.—Dudley Peninsula.
Fl.—Savannah and stringybark forests of the Fleurieu Peninsula.
Fl. G.—Glaciated area of the Fleurieu Peninsula.
Pt. L.—Port Lincoln district of Southern Eyre Peninsula.
Y.P.—Southern Yorke Peninsula.
Eastern Australia.—States of Victoria, New South Wales, and Queensland.
Western Australia.—The extra-tropical portions of Western Australia.

No authorities for the specific names are given in the list, but the nomenclature throughout is that of Black's "Flora of South Australia."

	Growth. Form.	W.	C.	D'E	D	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
Lindsaya linearis	H.	x				x	x	x		x	x
Adiantum aethiopicum	H.	x				x		x		x	x
Cheilanthes tenuifolium	H.	x		x	x	x		x	x	x	x
Pteridium aquilinum	G.	x			x	x	x	x		x	x
Blechnum discolor	H.	x				x	x			x	
B. capense	H.	x				x	x			x	
Gymnogramme leptophylla	H.	x				x	x			x	x
Gleichenia circinata	H.	x				x				x	
Schizea fistulosa	H.	x				x	x			x	x
Ophioglossum coriaceum	G.	x				x	x			x	x
Pleurosorus rutifolius	H.					x				x	x
Asplenium flabellifolium	H.					x				x	x
Lycopodium laterale	H.	x					x			x	
Phylloglossum Drummondii	G.	x				x	x			x	
Selaginella Preissiana	H.		x				x			x	x
Isoetes Drummondii	G.	x				x				x	x
Todea barbara	Ch.	x				x				x	
Callitris cupressiformis	M.	x								x	
C. robusta	M.				x					x	x
Typha angustifolia	HH.	x				x				x	x
Triglochin striata	HH.				x	x		x		x	x
T. centrocarpa	Th.	x			x			x	x	x	x
T. procera	HH.	x				x		x		x	x
Ottelia ovalifolia	HH.	x				x				x	x
Imperata cylindrica	H.							x		x	x
Neurachne alopecuroides	H.		x				x	x		x	x
Microlaena stipoides	H.	x				x		x		x	x
Stipa elegantissima	H.				x	x			x	x	x
S. teretifolia	H.				x	x				x	
S. eremophila	H.				x					x	x
S. pubescens	H.				x	x				x	x
S. semibarbata	H.	x		x		x		x		x	x
S. McAlpini	H.	x				x				x	x
S. variabilis	H.		x				x	x	x	x	x
Themeda ciliata	H.					x		x		x	x
Echinopogon ovatus	H.				x					x	x
Sporobolus virginicus	H.	x		x	x					x	x
Calamagrostis filiformis	Th.	x			x					x	
C. filiformis var. Billardieri	Th.	x								x	
C. quadriseta	H.	x								x	x
C. minor	H.	x								x	
Danthonia penicillata	H.					x		x	x	x	x
Dichelachne crinita	H.				x		x		x	x	x
D. sciurea	H.	x				x				x	x
Amphibromus nervosus	H.	x			x	x				x	x
Distichlis spicata	H.			x	x			x	x	x	
Poa caespitosa	H.	x	x		x	x		x	x	x	x
P. lepida	H.				x				x	x	
Glyceria stricta	H.				x	x				x	x
Agropyrum scabrum	H.				x		x	x	x	x	x
Cyperus vaginatus	H.		x			x		x	x	x	x
Schoenus apogon	H.	x			x	x		x	x	x	
S. deformis	H.							x			
S. Tepperi	H.		x	x							
S. fluitans	HH.	x									
S. sculptus	H.	x						x			x
Heleocharis sphacelata	H.	x	x	x	x	x				x	
H. acuta	H.	x			x					x	x
H. multicaulis	H.	x			x					x	
H. halmaturina	H.	x									
Scirpus fluitans	HH.	x			x			x		x	x
S. setaceus	H.				x	x				x	x
S. cernuus	H.	x		x	x	x		x	x	x	x
S. antarcticus	H.	x			x					x	x
S. inundatus	HH.	x			x	x				x	
S. nodosus	G.	x		x	x	x		x	x	x	x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
Chorizandra enodis	H.		x	x	x	x		x		x	x
Cladium junceum	G.	x		x		x		x	x	x	x
C. Gunnii	H.	x								x	
C. arcuatum	H.	x						x		x	
C. cappilaceum	H.	x									
C. filum	H.	x		x		x		x	x	x	
C. tetragonium	H.	x								x	
C. acutum	H.	x						x		x	
Gahnia trifida	Ch.	x								x	x
G. deusta	H.	x		x		x		x	x		x
G. psittacorum	Ch.	x				x				x	
G. hystrix	H.	x									
Caustis pentandra	Ch.	x		x	x					x	x
Lepidosperma exaltatum	Ch.	x				x				x	x
L. gladiatum	Ch.				x				x	x	x
L. concavum	Ch.		x			x	x	x		x	
L. lineare	Ch.		x							x	
L. viscidum	Ch.		x		x		x	x	x	x	x
L. canescens	Ch.				x	x				x	
L. semiteres	Ch.	x		x		x				x	
L. carphoides	Ch.		x			x		x		x	
Carex appressa	Ch.	x				x				x	x
C. tereticaulis	Ch.	x				x				x	x
C. pseudocyperus	Ch.	x				x				x	x
Leptocarpus tenax	H.	x	x						x	x	x
L. Brownii	H.							x		x	x
Hypolaena fastigiata	H.	x	x	x	x		x	x		x	
Lepidobolus drapetecoleus	H.						x			x	
Trithuria submersa	Th.				x					x	x
Brizula gracilis	Th.	x			x	x				x	x
B. pumilo	Th.				x	x				x	
Centrolepis polygyna	Th.	x			x			x		x	x
C. aristata	Th.				x			x		x	x
C. fascicularis	Th.	x								x	
C. strigosa	Th.	x			x	x		x		x	x
Juncus bufonius	H.	x			x	x		x		x	x
J. planifolius	H.	x				x				x	x
J. caespiticius	H.	x				x				x	x
J. maritimus var. australiensis	Ch.	x	x	x	x	x		x		x	
J. pallidus	H.	x	x	x	x	x		x	x	x	x
J. polyanthemus	H.	x				x				x	x
J. pauciflorus	H.	x				x				x	
Luzula campestris	H.				x	x		x		x	x
Dianella revoluta	G.	x	x		x	x	x	x		x	x
D. laevis	G.		x	x	x			x		x	
Lomandra dura	G.					x		x	x	x	
L. effusa	G.					x		x	x	x	x
Burchardia umbellata	G.	x	x		x	x	x	x	x	x	x
Anguillaria dioica	G.	x				x		x		x	x
Thysanotus Patersonii	G.	x				x		x	x	x	x
T. tuberosus	G.	x								x	x
T. dichotomus	G.	x	x		x	x	x	x	x	x	x
Chamaescilla corymbosa	G.	x	x				x	x	x	x	x
Tricoryne elatior	G.		x				x	x	x	x	x
Bulbine semibarbata	G.		x		x			x		x	x
Dichopogan strictus	G.				x	x				x	x
D. fimbriatus	G.				x	x				x	x
Bartlingia sessiliflora	H.	x		x						x	x
Xanthorrhoea quadrangulata	M.			x	x						
X. Tateana	M.	x	x			x	x	x			
X. semiplana	Ch.					x	x	x			
Patersonia glauca	H.	x				x				x	
P. longiscapa	H.					x				x	
Orthrosanthus multiflorus	H.	x	x		x	x				x	x
Gastrodia sesamoides	G.	x								x	x
Calochilus Robertsonii	G.	x	x							x	x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
Thelymitra ixioides	G.	x				x				x	x
T. luteociliata	G.		x		x			x		x	
T. grandiflora	G.	x				x				x	
T. aristata	G.				x	x				x	x
T. longifolia	G.				x	x		x	x	x	x
T. paucifolia	G.	x				x				x	x
T. fuscolutea	G.	x	x							x	x
T. carnea	G.	x				x				x	x
T. flexuosa	G.	x				x				x	x
T. antennifera	G.	x	x		x	x		x		x	x
Microtis porrifolia	G.		x	x	x	x		x	x	x	x
M. parviflora	G.		x	x						x	x
Prasophyllum australe	G.		x			x				x	x
P. elatum	G.	x			x	x				x	x
P. patens	G.				x	x		x	x	x	
P. fuscum	G.				x	x		x	x	x	
P. nigricans	G.		x			x				x	
Corysanthes pruinosa	G.	x				x				x	
Acianthus caudatus	G.	x				x				x	
A. exsertus	G.	x			x	x				x	
Cyrtostylis reniformis	G.	x			x	x				x	x
Lyperanthus nigricans	G.		x		x		x	x		x	x
Eriochilus autumnalis	G.		x				x	x		x	
Leptoceras fimbriata	G.	x				x		x		x	x
Caladenia cardiochila	G.				x					x	
C. ovata	G.		x								
C. reticulata	G.		x		x	x				x	x
C. Patersonii	G.	x	x		x	x		x		x	x
C. dilatata	G.	x			x	x		x	x	x	
C. filamentosa	G.	x	x	x	x					x	x
C. bicalliata	G.				x						
C. Menziesii	G.	x				x				x	
C. latifolia	G.	x			x	x		x	x	x	x
C. carnea	G.	x	x		x	x		x	x	x	x
C. caerulea	G.	x								x	
C. deformis	G.	x	x	x	x	x	x	x	x	x	x
Diuris longifolia	G.	x	x	x	x	x				x	x
D. brevifolia	G.	x				x				x	
D. sulphurea	G.		x			x		x		x	
Pterostylis nana	G.	x	x	x	x	x	x	x	x	x	x
P. nutans	G.	x				x				x	
P. pedunculata	G.	x				x				x	
P. furcata	G.	x								x	
P. reflexa	G.	x				x				x	x
P. alata	G.	x			x					x	
P. obtusa	G.	x				x				x	
P. barbata	G.		x		x	x		x		x	
P. longifolia	G.				x					x	
P. vittata	G.	x	x	x	x	x		x	x	x	x
P. squamata	G.							x		x	
Casuarina stricta	M.	x			x	x		x	x	x	
C. Muelleriana .	N.		x	x	x		x	x	x	x	
C. striata	N.		x				x			x	
C. pusilla	N.					x				x	
Parietaria debilis	Th.		x		x	x		x		x	x
Urtica incisa	Th.	x			x	x			x	x	
Petrophila multisecta	N.	x	x		x						
Isopogon ceratophyllus	N.	x				x	x		x	x	
Adenanthos sericea	N.	x	x	x	x						
A. terminalis var. brevifolius	N.	x		x			x	x		x	
Conospermum patens	N.	x		x			x	x		x	
Persoonia juniperinus ..	N.						x			x	
Hakea vittata	N.		x					x		x	
H. rostrata	M.	x	x		x	x	x	x	x	x	
H. rugosa	N.	x	x		x	x	x	x		x	
H. ulicina	M.	x	x			x	x	x		x	

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
H. ulicina var. flexilis	M.	x	x			x				x	
H. vittata	N.							x		x	
H. multilineata	M.	x						x			x
H. cycloptera	M.		x					x			
Banksia marginata	M.	x		x		x	x	x		x	
B. ornata	N.	x	x	x	x	x	x	x		x	
Grevillea ilicifolia	N.	x	x		x			x		x	
G. parviflora	N.	x								x	
G. parviflora var. acuaria	N.	x								x	x
G. pauciflora	N.	x						x			x
G. quinquenervis	N.	x									
G. aspera	N.	x						x			x
G. lavendulacea	N.	x				x	x	x	x	x	
G. Rogersii	N.	x	x								
G. Huegelii	N.							x			x
Exocarpus cupressiformis ...	M.	x			x	x		x		x	x
E. stricta	N.							x	x	x	
Leptomeria aphylla	N.	x	x					x	x	x	
Choretrum glomeratum	N.	x	x	x	x		x	x	x	x	x
Ch. spicatum	N.	x							x	x	
Fusanus acuminatus ...	M.				x	x		x		x	x
F. persicarius	M.				x				x	x	x
Olax Benthamiana	N.	x						x	x		x
Rumex Brownii	Ch.	x			x			x	x	x	
Muehlenbeckia adpressa	N.				x					x	x
Rhagodia baccata	N.				x			x	x	x	
R. crassifolia	N.	x	x	x	x			x	x	x	x
R. nutans	N.				x			x		x	x
Chenopodium carinatum	Th.	x		x	x	x		x	x	x	x
Salsola Kali	Th.				x	x		x	x	x	x
Enchylaena tomentosa	N.				x				x	x	x
Salicornia australis . .	Ch.				x			x		x	x
Hemichroa pentandra	Ch.			x	x				x	x	x
Trichnium Beckerianum	Ch.		x					x	x		
Didymotheca thesioides	N.	x		x	x			x			x
Gyrostemon australasicus	M.		x	x						x	x
Mesembrianthemum australe	Ch.			x	x	x		x	x	x	x
Calandrinia volubilis	Th.				x			x		x	x
C. corrigioloides	Th.							x	x	x	x
C. calyptrata	Th.	x			x			x		x	x
Sagina apetala	Th.				x	x		x	x	x	x
Stellaria palustris	H.				x					x	
Spergularia marginata	Ch.				x			x		x	x
Clematis microphylla . .	H.				x	x		x	x	x	x
Ranunculus trichophyllus ...	H.	x						x		x	
R. rivularis	H.	x				x				x	
R. parviflorus	H.					x				x	x
R. lappaceus	H.						x		x	x	x
Cassytha glabella ...	E.	x	x			x	x		x	x	x
C. pubescens	E.	x	x		x	x	x	x	x	x	x
C. melantha	E.				x	x		x	x	x	x
Loranthus pendulus ...	E.					x		x	x	x	x
Papaver aculeatum	Th.				x	x		x	x	x	
Lepidium foliosum . . .	Th.	x				x			x	x	x
L. pseudo-ruderale	Th.			x	x			x	x		x
Hutchinsia procumbens	Th.				x			x		x	x
Drosera binata	G.	x				x				x	
D. glanduligera	Th.	x	x	x						x	x
D. Whittakeri	G.			x	x	x	x	x		x	
D. pygmaea	Th.	x			x	x	x	x		x	
D. Planchonii	G.	x	x		x				x	x	
D. auriculata	G.	x	x		x	x	x			x	
D. peltata	G.		x			x	x	x		x	x
Crassula Sieberiana	Th.	x			x	x		x	x	x	x
C. bonariensis	Th.	x								x	x
C. recurva	Th.			x						x	x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
C. macrantha	Th.				x	x				x	
Baucra rubioides	N.	x								x	
Pittosporum phyllaeroides	M.	x			x	x		x	x	x	x
Bursaria spinosa	M.	x				x		x	x	x	x
Marianthus bignoniaceus	N.	x				x		x		x	
Cheiranthera linearis	N.	x				x		x	x	x	
Ch. volubilis	N.	x									
Billardiera cymosa	N.	x	x		x	x	x	x	x	x	
B. scandens	N.	x	x		x			x	x	x	
Rubus parvifolius	N.				x	x				x	
Alchelmilla arvensis	Th.				x					x	
Acaena ovina	H.				x				x	x	x
A. sanguisorbae	H.	x			x	x				x	
Acacia armata	M.	x			x	x		x		x	x
A. anceps	M.							x	x	x	x
A. acinacea	M.	x						x		x	
A. microcarpa	M.				x			x	x	x	
A. spinescens	M.	x			x	x		x	x	x	x
A. dodonaeifolia	M.		x					x			
A. brachybotrya	M.				x			x		x	x
A. rhetinoides	M.	x	x		x	x		x	x	x	
A. ligulata	M.	x			x			x	x	x	x
A. rigens	M.							x	x	x	
Acacia myrtifolia	M.	x	x		x	x	x	x		x	x
A. pycnantha	M.	x			x	x		x		x	
A. notabilis	M.		x					x	x	x	x
A. calamifolia	M.				x				x	x	
A. rupicola	M.	x	x			x		x	x	x	
A. farinosa	M.		x	x				x		x	
A. verticillata	M.	x		x		x				x	
A. longifolia	M.				x			x		x	
Gompholobium minus	N.	x	x	x	x	x		x		x	
Viminaria denudata	M.	x				x				x	x
Daviesia corymbosa	N.	x				x				x	
D. ulicina	N.	x	x			x	x			x	
D. pectinata	N.	x						x		x	x
D. incrassata	N.	x						x		x	x
D. genistifolia	N.	x	x		x			x		x	
D. brevifolia	N.		x	x	x		x	x		x	x
Eutaxia microphylla	N.	x	x		x	x	x		x	x	x
Pultenaea daphnoides	N.	x	x		x	x				x	
P. scabra	N.		x							x	
P. teretifolia	N.		x					x			
P. teretifolia var. brachyphyllus	N.										
P. involvucrata	N.				x						
P. rigida	N.	x						x			
P. villifera	N.	x						x		x	
P. laxiflora	N.	x	x							x	
P. laxiflora var. pilosa	N.		x			x		x		x	
P. acerosa	N.			x	x			x	x	x	
P. acerosa var. acicularis	N.		x								
P. densifolia	N.		x					x			
P. trifida	N.	x	x				x				
P. trichophylla	N.							x			
P. vestita	N.	x						x			x
P. canaliculata var. latifolia	N.							x			
P. viscidula	N.	x								x	
P. tereteophylla	N.							x			
P. cymbifolia	N.		x								
Pultenaea trinervis	N.							x			
Phyllota pleurandroides	N.	x	x	x						x	
Dillwynia hispida	N.	x	x			x		x		x	
D. uncinata	N.							x	x	x	
D. floribunda	N.	x	x	x	x	x	x			x	
Platylobium obtusangulum	N.	x	x			x	x			x	
Templetonia retusa	N.	x	x					x	x		x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
Goodia lotifolia	N.	x	x	x				x	x	x	x
Lotus australis	H.			x					x	x	x
Swainsonia lessertifolia	H.	x	x		x	x		x		x	
Kennedya prostrata	N.	x	x			x	x	x	x	x	x
Hardenbergia monophylla	N.	x			x	x		x	x	x	
Geranium pilosum	H.				x				x	x	x
Erodium cygnorum	H.				x					x	x
Pelargonium australe	Ch.	x			x					x	x
P. var. erodioides	H.	x	x		x					x	
Oxalis corniculata	G.	x	x		x	x		x	x	x	x
Zieria veronicea	N.		x	x			x			x	
Boronia Edwardsii	N.	x									
B. caerulescens	N.			x			x			x	x
B. polygalifolia	N.	x								x	
B. filifolia	N.		x	x	x		x			x	
B. palustris	N.	x									
Correa aemula	N.	x								x	
C. alba	N.	x		x	x					x	
C. rubra	N.	x	x			x	x		x	x	
C. rubra var. glabra	N.	x	x							x	
C. decumbens	N.	x	x			x					
Asterolasia muricata	N.		x							x	
Eriostemon brevifolius	N.		x					x	x	x	
Phebalium pungens	N.	x								x	
Microcybe pauciflora	N.		x					x	x	x	x
Geijera linearifolia	N.				x					x	x
Tetratheca ericifolia	N.	x								x	
T. halmraturina	N.	x	x								
Tetratheca pilosa	N.					x				x	
Conesperma volubile	N.	x			x	x		x	x	x	x
C. calymega	H.	x	x		x	x	x	x		x	x
C. polygaloides	H.				x			x		x	x
Phyllanthus australis	N.	x	x		x	x			x	x	
P. thymoides	N.				x					x	
Adriana Klotzschii	N.		x		x	x				x	x
Poranthera microphylla	Th.	x			x	x		x	x	x	x
P. ericoides	N.	x	x		x					x	x
Micranthemum demissum var. microphyllum	N.	x	x								
Beyeria Leschenaultii	N.	x	x					x	x	x	
B. subtecta	N.				x						
Bertya rotundifolia	N.		x		x					x	
Stackhousia monogyna	Ch.	x	x		x	x	x	x	x	x	
S. spathulata	Ch.	x								x	
Dodonaea attenuata	N.	x	x		x			x		x	
D. Baueri	N.				x			x		x	
D. bursarifolia	N.	x						x	x	x	x
D. humilis	N.	x	x		x			x	x		
D. hexandra	N.							x			x
Pomaderris halmaturina	N.				x						
P. racemosa	N.				x			x	x	x	
P. obcordata	N.	x	x			x	x	x	x	x	x
P. flabellare	N.							x			
Trymalium Wayi	N.				x						
Spyridium spathulatum	N.		x		x			x	x	x	
S. thymifolium	N.	x						x			
S. vexilliferum	N.	x			x	x		x		x	x
S. vexilliferum var. latifolium	N.	x									
S. phylicoides	N.	x	x					x	x		
S. leucopogon	N.							x			x
S. eriocephalum	N.		x		x			x		x	
S. eriocephalum var. glabrisepalum	N.				x						
S. halmaturinum	N.	x	x		x						
S. halmaturinum var. scabridium	N.	x	x								
S. halmaturinum var. integrifolium	N.	x									
Cryptandra hispidula	N.	x	x				x				
C. leucophracta	N.		x				x	x	x	x	x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
C. Waterhousei	N.	x	x		x						
Hibiscus Wrayi	N.							x			x
Lavatera plebeja	Th.	x			x			x	x	x	x
Plagianthus spicatus	Ch.	x		x	x			x	x	x	
Lasiopetalum discolor	N.	x						x	x		x
L. Behrii	N.							x		x	
L. Baueri	N.		x		x	x		x		x	
L. Schultzenii	N.	x	x		x			x	x	x	
Thomasia petalocalyx	N.	x	x		x		x	x		x	x
Commersonia Tatei	N.							x			
Hibbertia sericea	N.	x	x		x	x	x			x	
Hibbertia sericea var. major	N.		x				x	x			
Hibbertia sericea var. scabrifolia	N.	x									
H. stricta	N.	x	x			x	x	x	x	x	x
H. stricta var. glabriuscula	N.		x				x	x	x	x	
H. stricta var. oblonga	N.	x									
H. Billardieri	N.	x	x			x	x		x		
H. virgata	N.	x				x			x	x	
H. virgata var. crassifolia	N.				x						
H. fasciculata	N.	x						x		x	
Hypericum gramineum	H.	x				x			x	x	x
Viola hederacea	H.	x				x				x	
Viola Sieberiana	H.	x								x	x
Pimelea glauca	N.	x	x			x	x	x	x	x	
P. stricta	N.		x			x				x	
P. spathulata	N.				x		x			x	
P. macrostegia	N.		x								
P. flava	N.	x	x		x	x	x	x	x	x	x
P. serpyllifolia	N.	x	x		x	x	x	x	x	x	x
P. curviflora	N.				x					x	
P. octophylla	N.	x	x	x	x	x	x	x	x	x	
P. phylicoides	N.	x	x		x	x				x	
Lythrum hyssopifolia	H.				x	x				x	x
Baekea ramossissima	N.	x			x	x			x	x	
B. crassifolia	Ch.						x	x		x	x
B. ericaea	N.				x					x	
B. Behrii	N.					x		x		x	x
Leptospermum coriaceum	N.	x						x	x	x	
L. scoparium	N.	x	x			x	x	x		x	
L. pubescens	N.	x	x			x		x		x	
L. myrsinoides	N.	x	x			x	x			x	
Callistemon rugulosus	M.	x	x	x	x	x			x	x	
Melaleuca gibbosa	N.	x	x		x	x	x			x	
M. decussata	N.		x			x		x	x	x	
M. squarrosa	N.				x					x	
M. acuminata	N.				x			x	x	x	x
M. squamea var. glabra	N.	x	x			x				x	
M. pubescens	N.		x		x			x	x	x	
M. uncinata	N.		x		x			x	x	x	x
M. fasciculiflora	N.	x	x				x		x		x
Eucalyptus obliqua	MM.	x				x				x	
E. diversifolia	M.	x	x		x			x	x	x	x
E. Baxteri	MM.	x	x			x	x	x		x	
E. odorata	M.				x			x	x	x	
E. leptophylla	M		x			x		x		x	
E. cneorifolia	M.				x						
E. oleosa	M.	x						x		x	x
E. cladocalyx	MM.	x			x			x			
E. cosmophylla	M.	x	x				x	x			
E. rostrata	MM.	x				x		x		x	x
E. viminalis	MM.	x				x				x	
E. angulosa	M.	x							x	x	x
E. conglobata var. anceps	M.	x						x			
E. dumosa	M.				x					x	
E. elaeophora	M.				x				x	x	
E. ovata	MM.	x				x				x	

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
E. leucoxylon	MM.	x			x	x		x		x	
E. calycogona	M.		x							x	x
E. fasciculosa	M.	x				x					
E. vitrea	MM.	x								x	
Darwinia micropetala	N.	x	x							x	
D. homoranthoides	N.							x			
Micromytus ciliata	N.	x								x	x
Homoranthus Wilhelmi	Ch.							x			
Thryptomene ericaea	N.		x		x						
T. Miqueliana	Ch.						x	x	x	x	
Calythrix tetragona	N.	x	x	x	x	x	x	x	x	x	x
Lhotkya glaberrima	N.		x				x				
Lhotkya glaberrima var. magnisepala	N.	x	x								
L. Smeatoniana	N.	x									
Epilobium junceum	Th.	x				x		x		x	
E. glabellum	H.	x	x		x				x	x	
Loudonia Behrii	Ch.	x	x		x					x	
L. aurea	Ch.							x			x
Halorrhagis tetragyna	H.	x	x			x	x	x		x	
H. teucrioides	H.	x	x	x				x	x	x	x
H. micrantha	Ch.	x								x	
H. elata	H.	x						x		x	
H. heterophylla	H.	x								x	
H. Brownii	H.	x								x	
H. acutangula	Ch.	x						x			
Myriophyllum amphibium	HH.	x				x				x	
M. elatinoides	HH.	x				x				x	
M. Muelleri	HH.	x	x					x		x	x
Centella asiatica	H.		x							x	x
Xanthosia pusilla	H.	x						x		x	x
X. dissecta	H.	x	x		x	x	x	x	x	x	
Hydrocotyle laxiflora	H.				x					x	
H. hirta	H.				x			x		x	x
H. tripartita	Th.	x	x							x	
H. comocarpa	H.	x									
H. callicarpa	Th.	x			x	x		x	x	x	x
H. crassiuscula	Th.	x			x			x			
Hydrocotyle capillaris	Th.				x			x	x	x	x
H. diantha	Th.	x									x
Didiscus pusillus	Th.				x			x	x	x	
Lilaeopsis australica	Th.		x							x	
Eryngium vesiculosum	Th.	x	x			x				x	
Daucus glochidiatus	Th.	x			x				x	x	x
Trachymene heterophylla	Ch.		x		x			x		x	
Apium australe	Ch.	x	x		x	x		x	x	x	
Styphelia exarrhena	N.		x					x			
Astroloma humifusa	N.		x			x		x	x	x	x
A. conostephioides	N.	x	x		x	x	x	x	x	x	x
Lissanthe strigosa	N.		x				x	x	x	x	
Leucopogon parviflorus	N.	x		x	x	x				x	
L. hirsutus	N.	x			x						x
L. concurvus	N.	x	x			x	x				
L. rufus	N.		x		x		x	x		x	
L. virgata	Ch.						x			x	
L. Woodsii	Ch.		x					x		x	x
Actrotriche serrulata	N.		x			x	x		x	x	
A. patula	N.				x			x	x		
A. cordata	N.		x					x	x	x	
A. depressa	Ch.	x	x		x					x	
A. fasciculiflora	N.	x				x					
Brachyloma ericoides	N.		x	x						x	
Epacris impressa	N.	x	x			x	x			x	
Sprengelia incarnata	Ch.	x				x				x	
Mitrasacme paradoxa	Ch.	x			x		x		x	x	x
Logania ovata	N.	x	x	x	x	x	x	x	x	x	x

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
L. insularis	N.	x									
Sebaea ovata	Th.	x	x		x			x	x	x	x
Erythraea australis	H.				x			x	x	x	x
Villarsia exaltata	HH.	x				x		x		x	
Convolvulus erubescens	Th.	x				x		x	x	x	x
Dichondra repens	H.				x	x			x	x	x
Wilsonia humilis	H.		x						x	x	x
Wilsonia rotundifolia	H.		x					x		x	x
W. Backhousei	H.		x							x	x
Halgania lavendulacea	Ch.	x						x	x	x	x
H. cyanea	Ch.							x	x	x	x
Myosotis australis	Th.	x			x	x				x	x
Ajuga australis	H.				x	x				x	
Scutellaria humilis	Ch.				x	x				x	
Prostanthera spinosa	N.	x	x			x	x			x	
P. aspalathoides	N.				x			x		x	x
P. chlorantha	N.		x				x	x	x	x	
Westringia augustifolia	N.				x			x	x	x	
Solanum simile	N.	x	x		x			x	x	x	x
S. hystrix	N.							x			
Lycium australe	N.				x				x	x	x
Nicotiana suaveolens	Th.				x			x	x	x	x
Anthocercis myosotidea	Ch.			x	x			x		x	
Mimulus repens	H.				x			x		x	x
Gratiola peruviana	H.	x				x				x	x
Veronica Derwentia	N.	x				x				x	
V. parkalliana	Ch.							x			
V. distans	Th.	x	x		x				x	x	x
V. calycina	Ch.	x								x	x
Euphrasia collina	Ch.	x		x		x		x	x	x	x
Utricularia dichotoma	HH.	x				x				x	
Polypompholyx tenella	Th.	x		x	x	x		x		x	
Myoporum insulare	N.	x	x		x			x	x	x	x
M. viscosum	N.	x	x	x	x	x		x	x	x	
M. parvifolium	Ch.	x		x				x		x	x
Eremophila Behriana	N.			x							
E. glabra	M.			x	x			x	x	x	x
Plantago varia	Th.	x			x	x		x	x	x	x
Opercularia scabrida	Ch.	x								x	x
O. varia	Ch.	x	x		x	x	x		x	x	
Asperula Gunnii	H.	x	x					x	x	x	
Galium umbrosum	H.				x	x		x	x	x	
Galium umbrosum var. muriculatum	H.	x			x					x	
G. ciliare	H.	x									
Lobelia rhombifolia	Th.	x	x							x	x
L. gibbosa	Th.	x	x	x				x		x	x
L. anceps	H.	x			x	x		x		x	x
Isotoma scapigera	H.							x	x		x
Pratia platycalyx	H.				x					x	
Wahlenbergia gracilis	Th.	x			x	x		x	x	x	x
Goodenia amplexans var. augustifolia	N.	x									
G. ovata	N.	x			x	x		x		x	
G. varia	Ch.	x		x				x	x	x	x
G. geniculata	Ch.	x	x		x	x		x	x	x	x
G. primulacea	Ch.			x				x			x
Selliera radicans	H.	x	x					x		x	
Velleya paradoxa	Ch.				x	x		x	x	x	x
Scaevola crassifolia	N.	x	x		x	x	x	x	x		x
S. aemula	Ch.	x	x	x	x			x	x	x	x
S. humilis	Ch.		x								
S. microcarpa	Ch.				x	x			x	x	
S. linearis	Ch.	x	x		x			x	x		
Dampiera lanceolata	Ch.	x		x	x					x	
Stylidium graminifolium	Ch.	x		x		x	x			x	
S. Tepperianum	H.		x								

	Growth Form.	W.	C.	D'E	D.	Fl.	Fl. G.	Pt. L.	Y.P.	Eastern Australia.	Western Australia.
S. calcaratum	Th.				x					x	x
S. despectum	Th.				x					x	x
S. perpusillum	Th.				x	x				x	x
Levenhookia pusilla	Th.				x			x		x	
Olearia tubuliflora	N.				x	x				x	
O. axillaris	N.	x	x		x	x			x	x	x
O. ramulosa	N.				x	x		x	x	x	
O. floribunda	N.		x		x			x		x	
O. teretifolia	N.	x			x	x				x	
O. rudis	N.	x	x		x			x	x	x	x
O. ciliata	Ch.		x		x			x	x	x	
Olearia lepidophylla . ..	Ch.		x				x			x	
Vittadinia australis	Ch.	x	x		x	x	x	x	x	x	x
Achnophora Tatei	Ch.	x	x								
Lagenophora stipitata	Ch.	x			x			x		x	x
L. Gunnii	Ch.				x				x	x	
Brachycome cuneifolia	Th.				x			x			
B. debilis	Th.	x						x		x	
B. exilis	Th.							x	x	x	
B. neglecta	Th.	x						x	x		
Siegesbeckia orientalis	Th.	x				x				x	x
Cotula filifolia	Th.	x			x			x	x	x	x
C. coronopifolia	Th.	x			x	x		x		x	x
C. australis	Th.				x			x		x	x
Centipeda Cunninghami	Ch.	x	x		x	x	x	x		x	x
Isoetopsis graminifolia	Th.				x				x	x	x
Myriocephalus rhizocephalus	Th.		x					x	x	x	x
Angianthus Preissianus	Th.				x			x	x	x	x
A. strictus	Th.				x					x	x
Calocephalus Drummondii	Th.							x	x	x	x
Cassinia laevis	N.		x		x				x	x	
C. arcuata	N.							x	x	x	x
C. spectabilis	Ch.			x	x				x	x	
Eriochlamys Behrii	Th.			x	x			x		x	x
Toxanthus Muelleri	Th.				x				x	x	x
Millotia tenuifolia	Th.				x			x	x	x	x
Ixiolaena supina	Ch.	x		x	x				x		
Ixodia achilleoides	N.	x	x	x	x	x	x	x		x	
Podosperma angustifolium ..	Th.		x		x			x	x	x	x
Podolepis rugata	Ch.	x	x	x						x	x
P. acuminata	N.	x								x	x
Helichrysum obtusifolium ...	Ch.	x	x				x			x	x
H. bracteatum	Ch.		x							x	x
H. leucopsidum	Ch.	x	x	x	x			x	x	x	x
H. adenophorum	Ch.	x	x							x	
H. apiculatum	Ch.	x	x			x	x	x	x	x	x
Helichrysum semipapposum	Ch.	x				x		x		x	x
H. retusum	N.				x					x	x
H. Blandowskianum	Ch.						x			x	
H. Baxteri	Ch.						x	x		x	
H. clipterum australe	Th.				x					x	
Gnaphalium luteo-album	Th.	x		x		x		x		x	x
G. japonicum	Th.	x	x		x			x		x	x
G. indutum	Th.	x			x			x		x	x
Stuartina Muelleri	Th.	x			x			x	x	x	x
Erechthites prenanthoides	Th.	x		x		x				x	x
E. picrioides	Th.	x						x			x
E. arguta	Th.				x					x	x
E. quadridentata	H.				x	x		x		x	x
E. hispidula	Th.					x		x	x	x	x
Senecio magnificus	N.	x								x	
S. Georgianus	N.		x							x	x
S. odoratus	Ch.	x			x			x		x	
S. Cunninghamii	N.	x	x					x		x	x
Cymbonotus Lawsonianus . .	Ch.	x			x					x	x
Microseris scapigerus	G.	x				x		x		x	x

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NOTES ON THE FLORA NORTH-WEST OF PORT AUGUSTA BETWEEN LAKE TORRENS AND TARCOOLA.

By J. Burton Cleland, M.D.
(Botanical Identifications and Confirmations by J. M. Black.)

[Read June 12, 1930.]

Plates V. to VII.

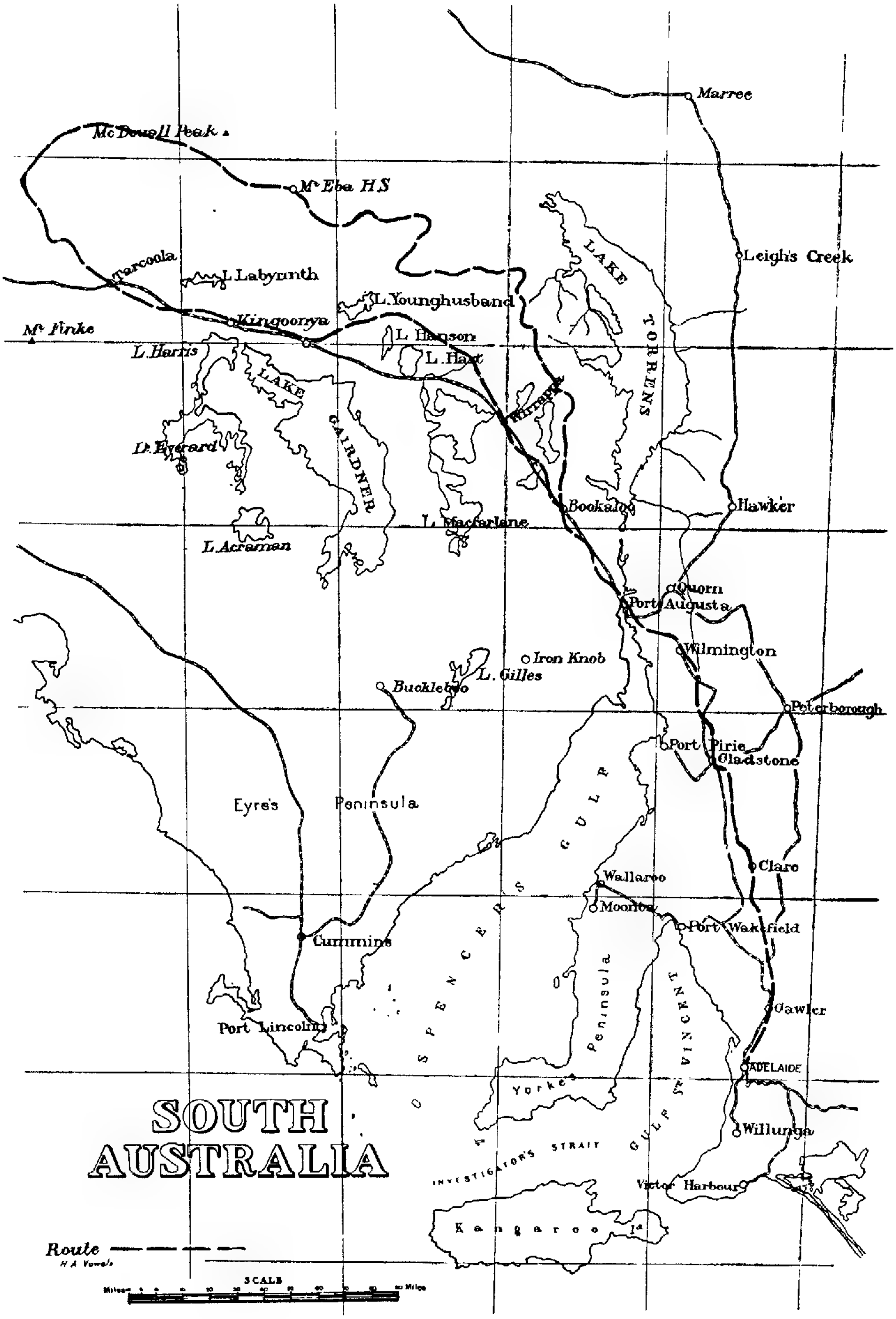
At the end of October and the beginning of November, 1929, the writer had the opportunity of accompanying Mr. E. Julius, the Conservator of Forests, and Mr. C. H. Goode, Pastoral Inspector, in making a rapid survey for commercial Sandalwood of the district north-west of Port Augusta. From Port Augusta the general direction of the East-West railway line was followed to Tarcoola, passing through Bookaloo, south of Pernatty Lagoon, round Lake Windabout, passed Bellamy's Well, north of Lake Hanson, and through Coondambo, Kingoonya, and Wilgena. We then proceeded west of north for about 80 miles, passing through Wilgena country out into the unoccupied lands. Turning now north-eastwards, our route reached to about 100 miles north of Tarcoola. We then turned in a south-easterly direction, passing through McDouall Peak Station, The Twins, Mount Eba, Mount Vivian, Parakeelya, and Chance's Swamp (Roxby Downs) to Andamooka Station, west of Lake Torrens. We then proceeded southwards through Arcoona and Yeltacowie to Bookaloo, and thence back to Port Augusta (see map). The distance thus covered by motor car was, approximately, 736 miles. I would like here to express our gratitude for many kindnesses received from Mr. and Mrs. Pick, of Coondambo; Mr. and Mrs. Taylor, of Kingoonya; Mr. and Mrs. MacBride, of Wilgena; Mr. and Mrs. Jacob, of McDouall Peak; Mr. and Mrs. Rankine, of Mount Vivian; Mr. and Mrs. Greenfield, of Roxby Downs; and Mr. and Mrs. Fowlis, of Andamooka.

The object of the expedition was, more particularly, to ascertain the distribution and abundance of commercial Sandalwood, *Eucarya spicata (Fusanus spicatus)*, and to try and find specimens of another species, *Santalum lanceolatum*. During the journey, notes were made of the botanical features of the country passed through, and a collection was made of the species of plants seen. Unfortunately, the long period of drought had affected the flora very adversely. The plants thus collected were later submitted for identification or confirmation to Mr. J. M. Black.

In spite of the weather having been so dry, the number of species noted (and mostly collected) was 149, with five varieties in addition. Only ten of the species were introduced. A new species of *Swainsona (S. dictyocarpa* Black) was found at Bitter Well, and a new variety of *Zygophyllum fruticulosum* (var. *brevilobatum* Black) north-west of Tarcoola. *Bergia perennis* is a new record for South Australia, and *Tephrosia sphaerospora* had previously been found only north of Cooper's Creek. Both species belong, also, to Central Australia.

INFORMATION REGARDING COMMERCIAL SANDALWOOD
(*Eucarya spicata,* formerly *Fusanus spicatus*).

On the route followed, Sandalwood country is entered at about 14 miles beyond Port Augusta. It may then be met with up to about 53 miles north to the neighbourhood of Pernatty Lagoon. All the merchantable stems have been


Marree
Mc Dowell Peak
Mt Eba H S
Leigh's Creek
Tarcoola
L. Labyrinth
L. Younghusband
LAKE TORRENS
Mt Finke
Kingoonya
L. Hanson
L. Hart
L. Harris
LAKE GAIRDNER
Dr Eyerard
Bookaloo
Hawker
L. Macfarlane
L. Acraman
Quorn
Port Augusta
Wilmington
Iron Knob
L. Gilles
Buckleboo
Peterborough
Port Pirie
Gladstone
Eyre's Peninsula
SPENCERS GULF
Clare
Wallaroo
Moonta
Port Wakefield
Cummins
Peninsula
Yorke
GULF ST VINCENT
Gawler
Port Lincoln
ADELAIDE
SOUTH AUSTRALIA
Willunga
INVESTIGATOR'S STRAIT
Victor Harbour
Kangaroo Id
Route
SCALE

"pulled." Only occasional small or distorted bushes have been left. There seems to be a very considerable waste of the smaller wood and the branches, which possibly may be worth collecting for the extraction of the oil. Quite a big proportion of each shrub that had been pulled was discarded.

At 54 miles a special inspection was made of the Sandalwood that had been pulled. Some dead trees were noticed. In this and in other parts inspected the Sandalwood has been hard pressed, and many plants have died. During the rabbit invasion some years ago, when these animals were desperate for food, they climbed up shrubs which gave them any foothold and sprawled out on the horizontal limbs, nibbling the accessible bark. In many places Sandalwood and some other bushes have been extensively rabbit-scarred in this way. Then, in addition, there has been the present prolonged drought, so that Sandalwood bushes, already handicapped by rabbit injuries, have now in addition to resist extreme lack of moisture. This probably accounts for the death of trees, some of which have only recently died. At Kingoonya, a photograph was taken of such a Sandalwood with the lower branches bare and dead as the result of injury by rabbits. (Plate V., fig. 1.)

At 81 miles from Port Augusta, Sandalwood had recently been gathered. In all these cases only the poorer specimens had been left. Sandalwood was again found east of Lake Hanson, and thence at intervals to East Well Homestead. Some of the shrubs were well developed—one was found 10 feet high. Here (near Lake Hanson) two species of *Loranthus* were found growing on the Sandalwood.

Between Coondambo and Kingoonya, further Sandalwood was seen, and at the latter place, quite near the station, a number of bushes were inspected, some severely injured by rabbits. Here, also, was seen an example of the Bitter Peach *(Eucarya Murrayana* or *Fusanus persicarius)*. This patch of Sandalwood is quite convenient to the station, and might form an admirable plot for observation. The Sandalwood in general occurs along, or at the foot of, the more sandy ridges in country containing Myall, Mulga, some Bullock-bush, Bluebush, etc.

Between Kingoonya and Wilgena no Sandalwood was seen. On passing out from Tarcoola into the Commonage, and passing through this in a northwesterly direction, only a few Sandalwood bushes were observed. In our course northwards of Tarcoola, Sandalwood disappeared or was very scanty. It was not seen on McDouall Peak Station, or thence to Mount Eba, being only encountered again when Parakeelya Station was entered. Here it grew in abundance, though some of the best had been pulled. This area was somewhat distant from a railway station.

Sandalwood was met with on the road from Mount Vivian to Parakeelya Station at about 18 miles, and then 11 miles of Sandalwood country was passed through. A scale insect was found here, infesting, particularly, Native Peach, but also Sandalwood. This may be a pest of serious import.

Passing southwards from Parakeelya Station to Arcoona Caves, and thence eastwards towards Chance's Lagoon, considerable quantities of Sandalwood had evidently been pulled, and some shrubs still remained. Large heaps of chips showed where the branches had been cleaned. Considerable quantities of oil must surely be present in these chips and the branches that are discarded. Occasional good trees were seen in this area.

Thereafter this Sandalwood was not seen again until some 30 or 40 miles north of Bookaloo.

The general impression we received as regards the Sandalwood is that the best trees have been removed from the more accessible areas visited by us, and in some of the more distant ones some of the largest bushes alone had been taken.

The Sandalwood is evidently dying out naturally, probably from drought and rabbits; the number of dead trees indicated this. Such death does not seem preventable. We saw no evidence of regeneration at all. No seedlings were noticed, and no half-grown bushes. All were evidently shrubs of many years' standing, perhaps twenty, thirty, or more years old at least. Rabbits and sheep probably give seedlings no chance at all. On Parakeelya Station a few seedlings of Native Peach were seen coming up in other shrubs, so it is possible that the Sandalwood may occasionally be able to grow from seed in these parts in spite of stock being present.

The pullers of Sandalwood only select suitable trees. The more twisted ones are left. It is probable that such trees would supply a sufficiency of seed-bearing bushes to help to maintain the species. It seems clear, if regeneration is to take place, that areas will have to be protected against rabbits and sheep or cattle. It seems important to shut off some small areas for experiment purposes to ascertain what success may attend the planting of seeds, and doubtless arrangements could be made at some of the stations for the adequate protection of such small areas.

INFORMATION AS REGARDS SANTALUM LANCEOLATUM.

Plate V., fig. 2, and plate VI.

As the west shore of Lake Torrens was approached a look-out was kept for this species. At Chance's Lagoon a small tree with a smooth bark, and very like a *Pittosporum,* was seen opposite Mr. Greenfield's homestead, growing up through a Mulga. It was in flower, and the flowers were obtained and proved to be this species.

At Andamooka Station this species was found in considerable numbers as small, slender, white-stemmed graceful trees, following along the beds of the dry watercourses, and in general closely resembling the *Pittosporum.* The trees grow to perhaps twenty or thirty feet high, and have quite an appreciable bole. They were found parasitic on the roots of Mulga, being attached by large haustoria nearly the size of a shilling, presenting a very striking picture. The trees look as though they could regenerate with ease, and numbers of young seedlings were seen. Where trees had been cut or pruned by cattle, coppicing tended to occur; suckering also took place. This species was found usually along the course of the dry watercourses on Andamooka and Arcoona Stations, or in the tableland type of country.

It appears that there are several varieties of this species met with in Queensland. One growing at Cape York, in the extreme north-east, has been exported to China. The one growing in the south-west of Queensland is probably similar to our South Australian kind. It does not seem to have been demonstrated as yet that this contains oil in commercial quantities. I have the permission of the Conservator of Forests to say that the Director of Chemistry, reporting on a sample of the wood that we had collected, found only 0·22 per cent. of Sandalwood oil in it, the ether extract being 1·45 per cent.

PLANTS RECORDED.

(An asterisk denotes an introduced species.)

PINACEAE.—*Callitris glauca* R. Br., Native Pine, north of Port Augusta, near Pernatty Lagoon, The Pines (Arcoona), Parakeelya, Roxby Downs, Andamooka, Arcoona, South Gap.

GRAMINEAE.—*Andropogon exaltatus* R. Br., Scent-grass, dwarfed plants in "crab-hole," tableland, Andamooka; *Iseilema membranacea* (Lindl.) Anderss., in "crab-hole," Andamooka; *Aristida adscensionis* L., in "crab-hole," Andamooka; *Stipa nitida* S. et H., 25 miles north of Pt. Augusta, Bitter Well (Coondambo), Kingoonya; *Pappophorum avenaceum* Lindl., in "crab-hole," Andamooka; *Eragrostis* *setifolia* Nees, in "crab-hole," Andamooka; *Glyceria ramigera* F. v. M., Cane-grass, in swampy places on tablelands, etc., almost throughout district; *Bromus arenarius* Labill., Sand-brome, 30 miles east of Coondambo; *Astrebla pectinata* F. v. M., Mitchell-grass, in "crab-hole," Andamooka; *Dactyloctenium aegyptium* (L.) Willd., in "crab-hole," Andamooka; **Bromus unioloides* H. B. et K., Prairie-grass, East Well; **Hordeum murinum* L., Barley-grass, East Well.

LILIACEAE.—*Thysanotus,* probably *T. Baueri* R. Br., Bellamy's Well (Oakden Hills).

AMARYLLIDACEAE.—*Crinum pendunculatum* R. Br., Murray Lily, Andamooka.

CASUARINACEAE.—*Casuarina lepidophloia* F. v. M., Black-oak, scattered especially on sand-ridges throughout the district (Karawaloo, south of Pernatty Lagoon, Kingoonya, Arcoona, South Gap).

PROTEACEAE.—*Hakea leucoptera* R. Br., Needle-bush, scattered throughout the district, 80 miles north of Tarcoola, Andamooka, Wilgena, Parakeelya; *Grevillea nematophylla* F. v. M., a single plant as a tree at Chance's Swamp (Roxby Downs). From 17 miles north-west of Tarcoola to 80 miles north, occasional shrubs or small trees were probably this species; also on McDouall Peak Station.

SANTALACEAE.—*Exocarpus aphylla* R. Br., north of Port Augusta, near Lake Hanson, between Kingoonya and Wilgena, The Twins; *Eucarya acuminata* (R. Br.) Spr. et Summ., Native Peach, scattered generally; *E. Murrayana* T. L. Mitch., Bitter Peach, one tree at Kingoonya; *E. spicata* (R. Br.) Spr. et Summ., generally distributed, except in the north-west part; *Santalum lanceolatum* R. Br., small tree like *Pittosporum phillyreoides,* in or near watercourses, chiefly on the tablelands, Andamooka, Arcoona, Roxby Downs, etc., all west of Lake Torrens.

LORANTHACEAE.—*Loranthus Exocarpi* Behr. (apparently) on *Pittosporum phillyreoides,* Chance's Swamp; probably also on *Melaleuca pauperiflora,* Lake Windabout, and on *M. uncinata,* 80 miles north of Tarcoola, though these may be *L miraculosus; L. Murrayi* F. v. M. et Tate on *Acacia aneura* and *Eucarya spicata,* Wirraminna; *L. gibberulus* Tate on *Grevillea,* probably *G. nematophylla,* 80 miles north of Tarcoola; *L. miraculosus* Miq. (?, fruit yellow) on *Santalum lanceolatum,* Andamooka; *L. quandang* Lindl., grey mistletoe, common on Myall *(Acacia Sowdenii)* almost throughout the district; *L. Maidenii* Blakely on *Acacia aneura* and *A. tetragonophylla,* Andamooka.

POLYGONACEAE.—**Emex australis* Steink., Wilgena; *Muehlenbeckia Cunninghamii* (Meisn.) F. v. M., Lignum, often present in swampy patches on the tablelands, etc.

CHENOPODIACEAE.—*Rhagodia spinescens* R. Br., east of Wilgena; *Chenopodium nitrariaceum* F. v. M., in dry "swamps," Coondambo, north of Tarcoola, Mount Eba, Parakeelya, Andamooka, **Chenopodium album* L., White Goosefoot, McDouall Peak, **Ch. murale* L., Nettle-leaved Goosefoot, Arcoona Station; *Atriplex angulatum* Benth., annual saltbush, South Gap; *A. velutinellum* F. v. M., Arcoona Caves (Parakeelya); *A. vesicarium* Howard, Bladder Saltbush, perennial, south of Bookaloo, Andamooka, east of Wilgena; *A. leptocarpum* F. v. M., Slender-fruited Saltbush, McDouall Peak Station; *A. halimoides* Lindl., Andamooka, Arcoona; *A. halimoides* var. *conduplicatum* F. v. M. et Tate, Andamooka, Arcoona; *A. spongiosum* F. v. M., Hop Saltbush, Bitter Well (Coondambo), McDouall Peak Station, east of Wilgena, Arcoona; *Bassia obliquicuspis* R. H. Anders., Coondambo, west of Lake Torrens; *B. patenticuspis* R. H. Anders., Arcoona Caves; *Kochia pyramidata* Benth., Bore 10 (80 miles north of Tarcoola); *K. tomentosa* (Moq.) F. v. M., Bore 10, 50 miles north of Tarcoola, Coondambo; *K. sedifolia* F. v. M., Bluebush, south of Bookaloo, Wirraminna, Coondambo, east of Wilgena, 80 miles north of Tarcoola; *K. Georgii* Diels, south of Bookaloo; *K. aphylla* R. Br., Cotton Bush, Andamooka; *K. triptera* Benth., 80 miles north of

Tarcoola; *K. triptera* var. *erioclada* Benth., north-west of Tarcoola; *Salsola Kali* L., Buckbush, Wilgena, north of Port Augusta, north-west of Tarcoola; *Enchylaena tomentosa* R. Br., Ruby Saltbush, Coondambo, 80 miles north of Tarcoola, Arcoona; *Arthrocnemum leiostachyum* (Benth.) Paulsen, Andamooka, Arcoona.

AMARANTACEAE.—*Trichinium obovatum* Gaudich., east of Wilgena; *T. erubescens* Moq., on tablelands, Andamooka.

PHYTOLACCACEAE.—*Codonocarpus cotinifolius* (Desf.) F. v. M., Native Poplar.

AIZOACEAE.—*Tetragonia eremaea* Ostenf., 25 miles north of Port Augusta, Wilgena; *Gunniopsis quadrifida* (F. v. M.) Pax, 65 miles north of Port Augusta, Andamooka, South Gap.

PORTULACACEAE.—*Calandrinia remota* J. M. Black, Parakeelya, 80 miles north of Tarcoola, 50 miles east of Coondambo (probably); *Anacampseros australiana* J. M. Black, south end of Lake Torrens.

CRUCIFERAE.—*Sisymbrium orientale* L., Wild Mustard, probably, a starved form, 25 miles north of Port Augusta; *Lepidium oxytrichum* Sprague, Bitter Well (Coondambo), The Twins; *Stenopetalum lineare,* R. Br., Bitter Well, The Twins; *S. lineare* var. *canescens* Benth., Coondambo.

PITTOSPORACEAE.—*Pittosporum phillyreoides* D C., occasional trees throughout the district (north-west of Tarcoola, Andamooka, Mount Vivian, Parakeelya, Roxby Downs, Courlay's Lagoon, Andamooka).

LEGUMINOSAE.—*Acacia Victoriae* Benth., Prickly Acacia, Phillip's Ponds, The Twins, Mount Eba, Andamooka, Yeltacowie; *A. salicina* Lindl., Broughton Willow, one tree, perhaps this species, with *Loranthus quandang* on it, on a creek, Arcoona; *A. ligulata* A. Cunn., Umbrella Bush, Andamooka, Parakeelya; *A. tetragonophylla* F. v. M., Dead Finish, Lake Windabout, north-west of Tarcoola, McDouall Peak, Mount Vivian, Courlay's Lagoon; *A. Sowdenii* Maiden (plate VII.), Myall, almost throughout the district, except on tablelands; *A. Oswaldii* F. v. M., in flower on Roxby Downs and Andamooka, flowers slightly sweet-scented but not like wattle-blossom, many flies buzzing round the trees, sometimes growing into a small tree, Courlay's Lagoon, near Lake Hanson, near Wilgena, near Tarcoola; *A. tarculensis* J. M. Black, Steel Bush, 14 miles east of Wilgena Station, Tarcoola, 30 miles and 60 miles north-west of Tarcoola; *A. aneura* F. v. M., Mulga, almost throughout the district; *A. aneura* approaching var. *latifolia* J. M. Black, 80 miles north of Tarcoola; *A. aneura* var. *latifolia,* 80 miles north of Tarcoola, Courlay's Lagoon, Kingoonya; *A. Burkittii* F. v. M., south of Bookaloo, near Lake Hanson, South Gap; *A. brachystachya* Benth., Umbrella Mulga, Bore 10 (80 miles north of Tarcoola), 17 miles north-west of Tarcoola, Kingoonya, Wirraminna, and generally scattered throughout the district on sandy rises. A number of Myall-like trees, some infested with a broad-leafed Loranth, lining a dry creek on Yeltacowie Station, appeared to be a species of Acacia. *Cassia desolata* F. v. M., flowers sweet-scented, Andamooka, Arcoona; *C. Sturtii* R. Br., 25 and 80 miles north of Port Augusta, near Lake Hanson, Parakeelya, 80 miles north of Tarcoola; *C. eremophila* A. Cunn. var. *platypoda,* Benth., 25 miles north of Port Augusta, 80 miles north of Tarcoola; *C. artemesioides* Gaudich., Wirraminna; *C. phyllodinea* R. Br., 25 miles north of Port Augusta, Wirraminna, Bore No. 10 (80 miles north of Tarcoola), Parakeelya Station, The Pines, South Gap; *Templetonia egena* (F. v. M.) Benth., Broombush, south of Bookaloo, Parakeelya; *Crotalaria dissitiflora* Benth., on sand ridges, Andamooka; *Lotus australis* var *parviflorus* Benth., Arcoona Caves (Parakeelya), in "crab-hole," Andamooka; *Tephrosia sphaerospora* F. v. M., flowers salmon-yellow, in sandy soil, Andamooka Station; *Swainsona canescens* (Benth.) F. v. M., Bitter Well (Coondambo); *S. dictyocarpa* J. M. Black, a new species of small size, Bitter Well.

GERANIACEAE.—**Erodium cicutarium* (L.) L'Her., "geranium," 25 miles north of Port Augusta, Bitter Well, in "crab-hole," on tableland on Andamooka.

Zygophyllaceae.—*Nitraria Schoberi* L., Nitre-bush; *Zygophyllumammophilum* F. v. M., Arcoona Caves (Parakeelya); *Z. fruticulosum* DC. var. *eremaeum* Diels, south of Bookaloo, north-west of Tarcoola; *Z. fruticulosum* var. *brevilobum* J. M. Black, a new variety, 17 miles north-west of Tarcoola.

Euphorbiaceae.—*Phyllanthus lacunarius* F. v. M., Andamooka; *Ph. Fuernrohrii* F. v. M., Andamooka; *Euphorbia Drummondii* Boiss., in "crab-hole," tableland, Andamooka, and 80 miles north of Tarcoola.

Sapindaceae.—*Heterodendron oleifolium* Desf., Bullock-bush, widely scattered throughout the district; *Dodonaea attenuata* A. Cunn., Bellamy's Well, Parakeelya, Courlay's Lagoon, Andamooka, The Pines, South Gap; *D. lobulata* F. v. M., Andamooka; *D.* sp. (pinnate leaves), Wirraminna.

Malvaceae.—*Lavatera plebeja* Sims var. *eremaea* J. M. Black, Arcoona Caves (Parakeelya Station); **Malva* sp., Marsh-mallow, McDouall Peak.

Elatinaceae.—*Bergia perennis* F. v. M. This species and *Peplidium Muelleri* were found growing together round the edge of the (dry) swamp at McDouall Peak Station. Both were prostrate herbs, after the fashion of *Euphorbia Drummondii*, indistinguishable from each other till dug up and examined. The deaths of some rams had been attributed to the eating of one or other of these.

Frankeniaceae.—*Frankenia serpyllifolia* Lindl., on the tablelands, Andamooka, a mass of delicate pinkish flowers.

Thymelaeaceae.—*Pimelea microcephala* R. Br., climbing up through other shrubs, north of Port Augusta, near Lake Hanson.

Myrtaceae.—*Melaleuca halmaturorum* F. v. M., Paper-bark Tea-trees round Chance's Swamp (Roxby Downs) were probably this species; *M. pubescens* Schau., Black Tea-tree, Chance's Swamp, etc.; *M. uncinata* R. Br., 80 miles north of Tarcoola, near Uro Bluff, McDouall Peak, Parakeelya; *M. pauperiflora* F. v. M., Lake Windabout—Tea-trees with rather papery bark at Lake Windabout and at Coondambo Station were probably this species; *Eucalyptus microtheca* F. v. M., Coolabah, Swamp Box, two trees at Chance's Swamp (Roxby Downs); *E. oleosa* F. v. M., Red Mallee, a clump 12 miles north-west of Tarcoola; *E. rostrata* Schl., Red Gum, one tree (probably *E. rostrata)* at McDouall Peak Station from seed said to have come from Lake Phillipson, one tree at Arcoona Station, numbers of trees lining creeks between Arcoona and Yeltacowie.

Halorrhagidaceae.—*Myriophyllum verrucosum* Lindl., in tank, McDouall Peak Station.

Umbelliferae.—*Daucus glochidiatus* (Labill.) Fisch., Mey at Avé-Lall., Native Carrot, in "crab-hole," Andamooka.

Convolvulaceae.—*Convolvulus erubescens* Sims, The Twins.

Labiatae.—*Teucrium racemosum* R. Br., McDouall Peak Station; *Prostanthera striatiflora* F. v. M., south end of Lake Torrens.

Solanaceae.—*Solanum ellipticum* R. Br., Coondambo; ? *S.* sp., no flowers, no prickles, Coondambo; *Lycium australe* F. v. M., Australian Boxthorn, north of Port Augusta, near Lake Hanson, Coondambo, Kingoonya, north of Tarcoola; *Nicotiana glauca* Grah., Tobacco Tree, Port Augusta, Phillips Ponds, Yeltacowie; *Duboisia Hopwoodii* F. v. M., Pituri, Bellamy's Well—animals feeding on it on an empty stomach are said to fall down dead in half an hour.

Scrophulariaceae.—*Morgania glabra* R. Br., 80 miles north of Tarcoola (not eaten by rabbits), Arcoona, Andamooka; *Peplidium Muelleri* Benth., prostrate herb on the edge of a dry swamp, McDouall Peak Station (see under *Bergia perennis,* Elatinaceae, *re* possibly poisonous).

Myoporaceae.—*Myoporum platycarpum* R. Br., Bookaloo, Coondambo, between Kingoonya and Wilgena, north-west of Tarcoola; *Eremophila oppositifolia* R. Br., Andamooka; *E. Paisleyi* F. v. M., near Lake Hanson, Wirraminna, between Wilgena and Tarcoola, 80 miles north of Tarcoola, Parakeelya, McDouall Peak, Roxby Downs; *E. Latrobei* F. v. M., Wirraminna; *E. longifolia* (R. Br.) F. v. M., Wilgena, 50 miles north of Tarcoola, Andamooka; *E. rotundifolia* F. v. M., east of Wilgena, 80 miles north of Tarcoola, between The Twins and Mount Eba; *E. Duttonii* F. v. M., Wirraminna, Parakeelya, Mount Vivian, 50 miles north-west of Tarcoola, Mount Eba, Coondambo; *E. maculata* (Ker.) F. v. M., Andamooka; *E. alternifolia* R. Br., Wirraminna, Coondambo; *E. glabra* (R. Br.) Ostenf., Tar Bush, Coondambo, McDouall Peak, 80 miles north of Tarcoola; *E. scoparia* (R. Br.) F. v. M., widely scattered, 25 miles north of Port Augusta, near Lake Hanson, between Kingoonya and Wilgena, near Tarcoola, Mount Vivian, Parakeelya, Roxby Downs, South Gap.

Plantaginaceae.—*Plantago varia* R. Br., Coondambo, in "crab-hole" on Andamooka.

Goodeniaceae.—*Goodenia subintegra* F. v. M., The Twins Station (in the garden); *Scaevola spinescens* R. Br., 60 miles north of Tarcoola, Andamooka; *S. collaris* F. v. M., in saline soil, 17 miles north-west of Tarcoola.

Compositae.—*Brachycome iberidifolia* Benth. var. *glandulifera* J. M. Black, sweet-scented, 25 miles north of Port Augusta, Bitter Well (Coondambo); *Minuria leptophylla* D C., Bellamy's Well, in "crab-hole" on Andamooka; *Calotis cymbacantha* F. v. M., south of Bookaloo, Bitter Well (Coondambo); *C. multicaulis* (Turcz) J. M. Black, east of Wilgena; *C. hispidula* F. v. M., in "crab-hole" on Andamooka; *Senecio brachyglossus* F. v. M., in "crab-hole" on Andamooka; *Helipterum Fitzgibbonii* F. v. M., 80 miles north of Tarcoola; *H. moschatum* (A. Cunn.) Benth., Bitter Well, Coondambo; *H. Charsleyae* F. v. M., Twins Station; *Ixiolaena leptolepis* (D C.) Benth., in "crab-hole" on Andamooka; *Helichrysum Cassinianum* Gaudich., pink bracts, Bitter Well (Coondambo); *Podolepis capillaris* (Steetz) Diels, north of Port Augusta, 17 miles north-west of Tarcoola, Andamooka; *Myriocephalus Stuartii* (F. v. M. et Sond.) Benth., The Pines, Bellamy's Well (Oakden Hills); *Angianthus pusillus* Benth., Bellamy's Well, Bitter Well (Coondambo); *Gnephosis cyathopappa* Benth., east of Wilgena; **Sonchus oleraceus* L., Sow Thistle, East Well.

DESCRIPTION OF PLATES.

Plate V.

Fig. 1. Commercial Sandalwood suffering in its lower part from injuries caused by rabbits climbing, in drought time, on the branches and gnawing the bark from their upper aspects. Kingoonya.

Fig. 2. Typical appearance of *Santalum lanceolatum* growing as slender, upright trees, usually near watercourses. Andamooka.

Plate VI.

Fig. 1. *Santalum lanceolatum*. Andamooka.

Fig. 2. Young *Santalum lanceolatum* attached by broad haustoria to roots of adjacent mulga (*Acacia aneura*). Andamooka.

Plate VII.

Panoramic view showing a remarkably handsome spreading S.A. Myall (*Acacia Sowdenii*) in the centre, the more umbrella-like Mulga (*Acacia aneura*) on the right, and the intricately-spreading Dead Finish (*Acacia tetragonophylla*) on the left. East Well, Coondambo.

The Map of Route is by Mr. H. A. Vowels; Photographs by Mr. E. Julius.

ON SOME COLEOPTERA FROM NORTHERN AUSTRALIA, COLLECTED BY DR. H. BASEDOW.

By Arthur M. Lea, F.E.S., Museum Entomologist.

[Read August 14, 1930.]

The South Australian Museum has recently received from Dr. H. Basedow, some insects he collected when leading expeditions to interior parts of Northern Australia. The localities are as follows:—

Horse-shoe Bend to MacDonnell Ranges, May-July, 1920 (Commonwealth Government Medical Relief Expedition).

Petermann Ranges, June, 1926 (First Mackay Exploration Expedition).

Interior Arnhem Land, July, 1928 (Second Mackay Exploration Expedition).

The most interesting capture was a remarkable weevil of a new genus, herein named *Basedowia basicollis.*

CICINDELIDAE.

Megacephala howitti Cast. Arnhem Land.

CARABIDAE.

Adotela concolor Cast. MacDonnell Ranges.
Calosoma schayeri Er. Arnhem Land, Finke River Valley, Petermann Ranges.
Carenum brevicolle Sln. Arnhem Land.
C. transversicolle Chd. Petermann Ranges.
Chlaenius australis Dej. Finke River Valley, Petermann Ranges.
Euryscaphus obesus Macl. Finke River Valley, MacDonnell Ranges.
Gigadema intermedium Gestro. Petermann Ranges.
Philoscaphus tepperi Blackb. Finke River Valley, Petermann Ranges.
Phorticosomus brunneus Blackb. Finke River.
P. grandis Cast. Arnhem Land, Finke River, Petermann Ranges.
P. horni Sln. Arnhem Land.

DYTISCIDAE.

Eretes australis Er. Arnhem Land.
Homoeodytes atratus Fab. Arnhem Land.
Hydaticus vittatus Fab. MacDonnell Ranges.
Rhantus pulverosus Steph. MacDonnell Ranges.

GYRINIDAE.

Macrogyrus latior Clark. MacDonnell Ranges.

HYDROPHILIDAE.

Hydrophilus albipes Cast. Finke River Valley.
Sternolophus nitidulus Macl. MacDonnell Ranges.

SCARABAEIDAE.

BOLBOCERAS CARPENTARIAE Macl. Arnhem Land.
CACOCHROA OBSCURA Blackb. Petermann Ranges.
HAPLONYCHA DECEPTOR Blackb. Petermann Ranges.
H. GRIFFITHI Blackb. Arnhem Land.
H. TINDALEI Lea. Arnhem Land.

Haplonycha rufocastanea, n. sp.

♂. Dark reddish-castaneous, with a bluish iridescence, more distinct on elytra than elsewhere. Sterna and parts of legs with long reddish-flavous hairs, upper surface glabrous, elytral fringe extremely short.

Head with crowded punctures, becoming sparse and small in front. Antennae eight-jointed, first joint longer than the four following combined, second stouter and slightly longer than third, fourth with one side narrowed to apex, fifth very short, somewhat produced internally, club with elongate lamellae, each almost as long as the other joints combined. Prothorax more than thrice as wide as long, sides strongly rounded; with numerous rather shallow punctures, about as large as on head, but much less dense, and becoming rather sparse on sides. Elytra with sides feebly dilated to beyond the middle; with regular but rather feeble geminate striae; punctures about as large as on pronotum but sparser. Pygidium with a feeble median line and with dense and small irregular punctures (almost shagreened). Second joint of hind tarsi slightly longer than first and the length of fifth. Length, 17 mm.

Petermann Ranges (unique).

Belongs to Blackburn's first section of the genus, and of the other species of that section *H. crinita* and *erythrocephala* have conspicuous prothoracic clothing, *H. ruficeps* and *neglecta* are larger and paler, with opaque pronotum, and *H. octoarticulata,* to which at first glance it appears to belong, has a conspicuous elytral fringe; on the type of this species the fringe is so short as to be practically invisible.

HETERONYX CASTANEUS Macl. Finke River.
H. MODESTUS Blackb. Finke River.
HYPHORYCTES MACULATUS Blackb. Arnhem Land.
LEPIDIOTA FLAVIPENNIS Lea. Arnhem Land.
ONTHOPHAGUS CONSENTANEUS Har. Finke River, MacDonnell Ranges.
TROX CROTCHI Har. Petermann Ranges.
T. FENESTRATUS Har. Arnhem Land.
T. LITIGIOSUS Har. Petermann Ranges.

ELATERIDAE.

AGRYPNUS MASTERSI Macl. Finke River, Petermann Ranges.
LACON CONSPICIENDUS Elst. Finke River.
MACROMALOCERA SINUATICOLLIS Blackb. Arnhem Land.

MALACODERMIDAE.

LAIUS MAJOR Blackb. Finke River.

BOSTRYCHIDAE.

BOSTRYCHOPSIS JESUITA Fab. Arnhem Land, Finke River, Petermann Ranges.

TENEBRIONIDAE.

ADELIUM TROPICUM Blackb. Finke River.
BRISES BLAIRI Cart. Arnhem Land.
B. TRACHYNOTOIDES Pasc. Petermann Ranges.
CHALCOPTERUS LONGIUSCULUS Blackb. Finke River.
HELAEUS DERBYENSIS Macl. Petermann Ranges.
H. INGENS Blackb. Petermann Ranges.
H. INTERIORIS Macl. MacDonnell Ranges.
H. SQUAMOSUS Pasc. Finke River.
HYPAULAX ORCUS Pasc. Arnhem Land, Finke River.
NYCTOZOILUS APPROXIMATUS Blackb. Arnhem Land, Petermann Ranges.
N. SLOANEI Blackb. Petermann Ranges.
ONOSTERRHUS GRANULATUS Cart. Petermann Ranges.
PTEROHELAEUS ALTERNATUS Pasc. Finke River Valley.

PTEROHELAEUS ARCANUS Pasc.

A specimen from Arnhem Land possibly represents a variety of this species. It differs from typical specimens in being darker, and by the suture and costae of elytra being without small shining granules.

SARAGUS INTRICATUS Champ. Finke River.
S. TRICARINATUS Blackb. Arnhem Land.

CURCULIONIDAE.

ACHERRES GRANULATUS Ferg. MacDonnell Ranges, Petermann Ranges.

Basedowia, n. gen.

Head wide. Eyes ovate, lateral, with fine facets. Rostrum very short, upper surface flattened; scrobes short, deep, and terminated near eyes. Antennae stout, scape shorter than funicle, most of the joints of the latter briefly cylindrical, club subovate. Prothorax in front about as wide as the median length, base more than twice as wide, with the hind angles produced backwards and embracing shoulders, ocular lobes wide. Scutellum minute. Elytra widely cordate. Metasternum short, episterna narrow. Abdomen with two basal segments moderately large. Legs moderately long, front coxae rather widely separated, slightly more than the middle ones, but less than the hind ones; femora rather stout, unarmed; front tibiae denticulate on lower surface, third tarsal joint widely bilobed, claws equal and close together. Apterous.

The rostrum, antennae, and legs leave no doubt that this genus is allied to *Polyphrades*, but the hind angles of the prothorax acutely produced backwards and embracing the shoulders, at once distinguish it from all the genera of the Leptopsides. The elytra are unusually wide and cordate. The separation of the front coxae is unusual in the subfamily, but in *Mandalotus* is of only specific importance.

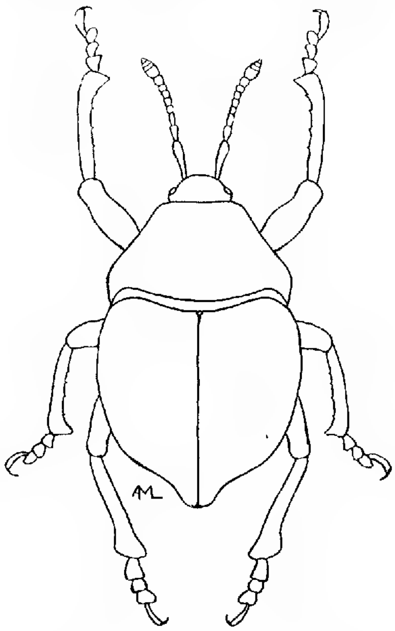
Basedowia basicollis, n. sp.

Black. Densely clothed with greyish scales.

Head with minute concealed punctures. Rostrum much wider than long, with a feeble median line, front with crowded punctures. Prothorax somewhat flattened in middle, sides obliquely dilated from apex to near base, and then drawn acutely backwards, with a feeble median line, with fairly large punctures, crowded together on sides, but less dense in middle. Elytra not one-fourth longer than wide, sides strongly rounded; with regular rows of fairly large punctures in shallow striae, interstices with dense and small punctures. Basal segment of abdomen slightly longer than second, the latter in middle about as long as third and fourth combined, and slightly longer than fifth. Front tibiae rather long and denticulate except near base, middle tibiae shorter and with fewer denticles, hind tibiae unarmed. Length, 6-8 mm.

Arnhem Land (abundant).

All the specimens are badly abraded, but from the scales left it is evident that in life the insects are densely squamose; on some specimens from which most



Basedowia basicollis, n. sp.

of the elytral scales are absent an almost regular row of small setae may be seen on each interstice, but these are normally concealed by scales. The muzzle seems to have a triangular space on which there are no scales, but it is not a shining plate as on many species of *Polyphrades* and *Cherrus*.

LEPTOPS CONTRARIUS Blackb. Petermann Ranges.
L. DUPONTI Boi., var. INTERIORIS Blackb. Arnhem Land, Finke River.
L. GRAVIS Blackb. Petermann Ranges.
MYLLOCERUS CINERASCENS Pasc. Petermann Ranges.
ONESORUS ALBATUS Lea. MacDonnell Ranges, Petermann Ranges.
O. PULLATUS Lea. Finke River.
O. TARSALIS Lea. Arnhem Land.
ORTHORHINUS CYLINDRIROSTRIS Fab. Arnhem Land.
POLYPHRADES SATELLES Blackb. Petermann Ranges.

Polyphrades farinosus, n. sp.

Black. Densely clothed with small white scales, interspersed with short setae; the tibiae with fairly long hairs.

Head with small granules and punctures, longitudinally strigose between eyes. Rostrum longer than wide, sides incurved to middle, upper surface rather widely concave, with a median carina interrupted near apex by a transverse elevation, but continued beyond it to join a curvilinearly triangular apical plate. Scape not as long as rostrum, four apical joints of funicle strongly transverse. Prothorax somewhat flattened, strongly transverse, sides strongly rounded and widest slightly nearer apex than base; densely granulate. Elytra elongate-subcordate, widest at about basal third, base conjointly arcuate, an obtuse swelling on each side at the basal fourth, its middle on the fourth interstice, suture subtuberculate at summit of apical slope; with rows of large punctures in shallow striae, the interstices multigranulate. Legs moderately long, front tibiae strongly denticulate, the others less strongly so. Length, 15-17 mm.

Finke River (three specimens).

It is with some doubts that I refer this species to *Polyphrades*, rather than to a new genus, but the claws are soldered together to near their tips, and the general outlines of the elytra are suggestive of *P. tumidulus* on a greatly enlarged scale. The scape is too short for the species to be referred to *Cherrus*. The head and rostrum are now almost glabrous, but were probably densely squamose on fresh specimens. The scales are unusually dense, and appear at first as if mixed with a whitish meal. Both prothorax and elytra are densely granulate, on the former the granules are sufficiently large to rise above the clothing, but on the latter they are too small to be seen before the scales have been abraded.

Polyphrades gibbipennis, n. sp.

Black. Densely clothed with greyish and whitish scales, mixed with numerous white, depressed setae.

Head with small punctures, base transversely corrugated. Rostrum slightly longer than its greatest width, transversely impressed at base, punctures normally concealed, apical plate large, sharply defined and with small punctures. Antennae moderately long, four apical joints of funicle strongly transverse. Prothorax strongly transverse, sides dilated from base to near apex and then rapidly narrowed to apex itself, densely granulate. Elytra at base no wider than base of prothorax, but sides rather strongly dilated to near the middle, and then strongly narrowed to tips, which are obtusely conjointly rounded; with rows of large punctures, appearing smaller through clothing, third interstice conspicuously elevated on basal fourth only, the adjacent ones also somewhat elevated there, suture slightly thickened at summit of apical slope. Tibiae denticulate on lower surface, the front ones more distinctly than the others. Length, 8-10 mm.

Finke River (three specimens).

Allied to *P. tumidulus*, but differs in having the elevated part of the third interstice much more pronounced, and the rostral plate much larger (longer than wide instead of strongly transverse). The elytra are somewhat like those of *P. farinosus* on a greatly reduced scale, but the rostrum is very different. The elytra are also somewhat like of those of *P. crassicornis*, but the prothorax, rostrum, and antennae are very different. Seen from the side, the base of the third interstice on each elytron appears as the crest of a distinct hump.

Polyphrades crassicornis Lea?

A specimen from the Finke River evidently belongs to the same species as three others from the Daly River, which are probably females of *P. crassicornis*; they differ from the types of that species in having the elytra longer and with the sides less dilated, and the third interstice on each not elevated near the base, the prothorax also is less dilated; but all these differences are possibly sexual only.

Phalidura grandis Ferg. Finke River Valley.

Sclerorhinus convexus Sln. Arnhem Land, MacDonnell Ranges, Petermann Ranges.

Talaurinus imitator Blackb. Arnhem Land, MacDonnell Ranges.

T. regularis Sln., var. solidus Sln. Arnhem Land, MacDonnell Ranges, Petermann Ranges.

Tentegia amplipennis, n. sp.

Black, antennae reddish. Moderately clothed with muddy brown scales and setae.

Head with large shallow punctures, each containing a stout seta. Rostrum stout, feebly curved, with large punctures close together, but not in rows. Antennae moderately long, two basal joints of funicle about as long as the five following ones combined. Prothorax moderately transverse, sides strongly rounded and notched near apex, which is widely produced in middle, with large punctures much as on rostrum, with a median carina traceable to apex but not to base. Elytra large, base trisinuate and not as wide as widest part of prothorax, each side of base with a triangular projection slightly clasping base of prothorax, near base with a sudden projection supplied with a curved row of subconical granules, the space there much wider than across prothorax; with rows of large but rather shallow punctures, becoming deeper on sides, the interstices with distinct but rather sparse granules, absent from the sides. Mesosternal receptacle rather large, front edge but slightly incurved. Metasternum and two basal segments of abdomen with large punctures, those of the second segment of the latter partly confluent, third and fourth segments very short. Legs long, middle femora rather strongly dentate near apex, the others unarmed, front tibiae long, the apical half strongly curved, hind ones very little shorter but almost straight, middle ones much shorter, third tarsal joint slightly narrower than second. Length, 8-12 mm.

Finke River (Dr. H. Basedow), Batchelor and Darwin (G. F. Hill).

The posthumeral projections on the elytra are somewhat as on *T. ingrata,* but the base is very different, and is not, in conjunction with the base of the prothorax, so sculptured as to conceal the middle femora from above, the middle femora are quite strongly dentate, but the others are edentate. The species is certainly very different from all other described ones of the genus, and should perhaps have been made the type of a new one.

The next species, although not taken by Dr. Basedow, is included here, as belonging to the same genus as *T. amplipennis.*

Tentegia quinquesinuata, n. sp.

Black, antennae reddish. Sparsely clothed.

Head with coarse crowded punctures. Rostrum stout, moderately curved, with coarse, crowded punctures in front, becoming lineate in arrangement between insertion of antennae and base. First joint of funicle slightly longer than second, the two about as long as the five following ones combined. Prothorax moderately transverse, sides strongly rounded, apex less than half the width of base; with coarse crowded punctures, in places granulate-punctate, with a short median carina. Elytra closely applied to prothorax, sides dilated just beyond base, and then rounded to apex, base with five sinuations on upper surface; a wide median incurvature, and two shorter ones, between the base of the third interstice on each elytron and the side; with rows of large punctures, the interstices each with a row of small shining granules, but more conspicuous at the base of the third, fifth, and seventh interstices than elsewhere. Mesosternal receptacle with rather coarse punctures, apical incurvature semi-circular. Metasternum very short. Two basal segments of abdomen with large, deep, irregular punctures, but absent from a median line on the first segment. Legs rather stout, femora grooved and edentate, third tarsal joint moderately bilobed. Length, 5 mm.

Queensland: Herberton (H. J. Carter).

Allied to *T. spenceri,* but smaller, more sparsely clothed, base of elytra different, and legs shorter and stouter. The base of the head, normally concealed, is transversely strigose.

CERAMBYCIDAE.

MICROTRAGUS ARACHNE Pasc. Arnhem Land.
PACHYDISSUS BOOPS Blackb. Petermann Ranges.
PHORACANTHA RECURVA Newm. Finke River, Petermann Ranges.
P. SEMIPUNCTATA Newm. Petermann Ranges.
RHYTIPHORA SAUNDERSI Pasc. MacDonnell Ranges.

CHRYSOMELIDAE.

CALOMELA PALLIDA Baly. Finke River.
C. WATERHOUSEI Baly. Petermann Ranges.
MEGAMERUS FEMORALIS Lea. MacDonnell Ranges.
OIDES PLANTARUM Blackb. Finke River.
PAROPSIS LATERALIS Blackb. Petermann Ranges.
P. PURPUREOVIRIDIS Clark. Finke River.
RHYPARIDA DIDYMA Fab. Finke River.
TOMYRIS VIRIDULA Er. MacDonnell Ranges.

COCCINELLIDAE.

ALESIA LINEOLA Fab. Finke River.
COCCINELLA ARCUATA Fab. Finke River.

AUSTRALIAN RESUPINATE HYDNACEAE.

By E. M. Wakefield, Royal Botanic Gardens, Kew, England.
(Communicated by J. B. Cleland, M.D.)

[Read September 11, 1930.]

Key to the Genera.

Acia Karst.—Receptacle resupinate, thin, waxy. Spines slender, subulate, generally entire, distinct or connate at the base. Spores hyaline. Cystidia none. Cystidioles (more or less hair-like bodies, possibly sterile basidia) sometimes present, usually small and thin-walled.

Grandinia Fr.—Receptacle resupinate, thin, membranaceous, pelliculose or crustaceous. Tubercles or spines obtuse, or occasionally pointed, entire. Spores hyaline or faintly yellowish. Cystidia absent. Cystidioles rarely present, but little differentiated.

Odontia Fr.—Receptacle resupinate, thin, membranaceous, waxy, crustaceous or mealy. Spines conical, ciliate or penicillate at the apex. Spores hyaline. Cystidia present.

Acia Karst.

Acia subceracea Wakef., n. sp.

Effusa, arcte adnata, subceracea, alutacea, margine indeterminato. Aculei sparsi vel conferti, subulati, ceracei, fulvescentes vel castanei, apicibus pallidioribus. Subiculum alutaceum, tenue, ceraceo-membranaceum. Basidia cylindrico-clavata, 4-sterigmatica, 12 — 20 × 4 — 5 μ. Sporae ellipticae, hyalinae, uno latere depressae, 5 — 6 × 2 — 2·5 μ. Cystidiola sparsa, interdum rariora, hyalina, subulata, 45 — 60 × 3 — 5 μ, ad 40 μ emergentia. Hyphae basales dense intertextae, hyalinae, non nodosae, 2 — 3·5 (— 4) diametro.

Hab.—Ad lignum cariosum. Mount Lofty, South Australia, Cleland "H" (type); Mount Lofty, South Australia, Cleland "G"; National Park, South Australia, Cleland "I," "K."

Allied to *Acia uda* and *A. denticulata*, but distinguished from the former by the strongly projecting, pointed cystidioles, and from both by the absence of any bright yellow colouring. In structure it is most closely allied to certain *Corticia* of the group Ceracea, as *Corticium ochraceo-fulvum* Bourd. & Galz. *A. fusco-atra* sometimes has similar but much smaller cystidioles, and is darker in colour.

A. subfascicularia Wakef., n. sp.

Effusa, tenuis, arcte adnata, ceracea, e fulvo umbrina. Aculei primo minuti, fulvo-ochracei, demum majores (ad 0·5 mm. longi) fasciculati, umbrini, apicibus albidis. Basidia clavata, 20 — 24 × 3 — 4 μ, 4-sterigmatica. Sporae hyalinae, ellipticae, uno latere depressae, polari-guttulatae, 4 — 5·5 × 2 — 2·5 μ. Hyphae laxe intertextae, subhymeniales tenuiter tunicatae 2 — 3 μ, basales crasse tunicatae ad 6·5 diametro. Hyphae in aculeis erectae, arcte adhaerentes, saepe crystallorum circumvestitae, 2 μ diametro.

Hab.—Ad corticem. Mount Lofty, South Australia, Cleland "W," May 5, 1928.

The colour of the young state is nearest to pale tawny-olive of Ridgway's Colour Standards; of the mature fungus snuff brown. In general appearance it resembles brown forms of *Acia fusco-atra*, but differs in the marked fasciculate spines, the much looser basal tissue, and in the abundant deposits of rather large, irregular crystals in the central tissue of the spines. *H. fascicularia* B. & C., of

North America, has similarly fasciculate spines, and is close to this species in structure, but differs in the paler colour and much smaller spines.

Grandinia Fr.

Grandinia Clelandii Wakef., n. sp.

Effusa, tenuis, arcte adnata, tomentoso-membranacea, alutacea, granulis confertis irregularibus concoloribus, ambitu indeterminato, pulverulento. Basidia clavata vel urniformia, 40 — 50 × 8 — 9 μ, sterigmata 4, 6 μ longa. Sporae ellipticae, hyalinae, 10 — 11 × 8 μ. Hyphae hyalinae, laxe intertextae, septato-nodosae, 2·5 — 4 μ diametro, ramulis erectis saepe apice vesiculoso-inflatis.

Hab.—Ad corticem. New South Wales, Cleland "A," 1928.

A very distinct species. The colour is uniformly warm buff, and the texture somewhat loose, giving the plant a pulverulent or tomentose appearance when viewed with a lens. In section, the most marked character is the abundant vesicular bodies in which some of the upward-growing hyphae terminate. These recall the vesicles of *Stereum purpureum*, and, like those, occur only in the subhymenial tissue. Both basidia and spores are large for the genus.

G. australis Berk., in Hook. Fl. Tasm., 1860, p. 257.

Syn.: *Hydnum pexatum* Mass., in Kew Bull., 1901, p. 157.

Irregularly effused, closely adnate, membranaceous, at first alutaceous (deep chamois) with scattered granules, finally becoming between raw sienna and buckthorn brown, very uniform in colour, with crowded granules. The yellowish pigment is soluble in a solution of potassium hydrate with the production of a rich vinaceous tint. Margin indeterminate, narrowly byssoid at first, yellowish or concolorous. Hymenium cracked when dry. Basidia clavate or urniform, 25 × 5 μ, with 4 sterigmata 2 — 5 μ long. Spores broadly elliptical, one side slightly depressed, 6 — 7 (— 9) × 4 — 5 μ. Cystidioles present, but scattered, sometimes fusiform, and pointed, at other times scarcely differing from young basidia, projecting little from the surface of the hymenium, about 30 — 35 × 8 μ. Basal hyphae branched, septate, with clamp-connections 3·5 — 4 μ in diameter.

Hab.—On bark. New South Wales, Cheesman, 1914, and Cleland "B," 1928; Victoria, Martin 867 and 1111, 1892; Gippsland, Mar., 1884, on *Eucalyptus obliqua;* Tasmania, Cleland "C," "E," 1928, Rodway 340 (type of *H. pexatum)* and type of *G. australis.*

This species resembles *Odontia Archeri* in the vinaceous colour which is produced when sections are treated with potash, but differs from that species in its more uniform colour and the absence of vivid yellow tints in the subiculum, and microscopically in the shape of the spores and the absence of embedded encrusted cystidia.

G. farinacea (Pers.) Bourd. & Galz.

Effused, thin, floccose or softly membranaceous, at first pure white, finally cream-coloured, margin byssoid or indeterminate. Spines sometimes subulate, sometimes reduced to granules, very soft and fragile, with projecting sterile hyphae at the apex. Basidia 6 — 12 — 21 × 3 — 5 μ, with 2 to 4 sterigmata 3 — 4·5 μ long. Spores subglobose or ovate, finely asperulate, 3 — 4·5 × 2·5 — 4 μ. Hyphae thin-walled, with clamp-connections, 1·5 — 4 μ in diameter, sometimes swollen to 7μ at the septa.

Hab.—On rotten wood and bark. Kuitpo, South Australia, Cleland "M," August 29, 1928; Adelaide, South Australia, Cleland "T," September, 1928.

Easily recognised by the rough spores. A very common European species.

Odontia Fr.

Odontia arguta (Fr.) Quél.

Syn.: *Hydnum argutum* Fr.

Effused, thin, membranaceous, dry, margin indeterminate, tomentose, whitish. Hymenium cream to deep ochraceous, with granuliform or subulate spines usually more or less penicillate at the apex. Basidia clavate, 20 — 30 × 5 μ, with 4 sterigmata, accompanied by small cystidia or cystidioles of varying form, sometimes rounded above and excreting a globule of resinous matter, sometimes subulate and strongly encrusted at the apex. Spores ovate, often one-guttulate, 5 — 5·5 (— 6) × 4 μ. Hyphae hyaline, with clamp-connections, 2 — 3 μ in diameter.

Hab.—On bark and dead wood. Pilliga Scrub, New South Wales, Cleland "U," October 15, 1928; Brown's River, Tasmania, Cleland "F," January, 1928; National Park, Tasmania, Cleland "P," January, 1928.

The specimens "F" and "U" show the capitate type of cystidia, while in "P" the characteristic small encrusted cystidia are present. Typical specimens of *O. arguta* from New Zealand are present in the Kew Herbarium.

O. Archeri (Berk.) Wakef., comb. nov.

Syn.: *Corticium Archeri* Berk., in Fl. Tasm. II., 1860, p. 260; *Kneiffia Wrightii* B. & C., in Journ. Linn. Soc., X., 1869, p. 327; *K. chromoplumbea* B. & Br., in Journ. Linn. Soc., XIV., 1873, p. 62; *Corticium chrysocreas* B. & C., in Grevillea, I., 1873, p. 178; *Odontia Wrightii* (B. & C.) Burt, in Ann. Mo. Bot. Gard., XIII., 1926, p. 270.

Broadly effused, firm, fairly thick, but not waxy, closely adnate, at first thin, even or more or less papillate, later with distinct spines, becoming much thicker, and, when dry, often cracked into small areolae. Hymenium variable in colour, yellow ochre when young and actively growing, but becoming cinnamon-buff or olive-buff, then avellaneous or wood brown with age. Margin indeterminate, at first buff-yellow or Empire yellow, later concolorous with the hymenium. Subiculum similarly bright yellow at first, but in old specimens the tissue exposed in the cracks often appears white, probably on account of the abundant excretion of crystals from the tissues.

The structure in section is very characteristic, but can only be observed well in young specimens. Numerous cystidia are present, both embedded in the tissues and projecting slightly from the hymenium. These are small, shortly fusiform, thin-walled and hyaline at first, 18 — 20 × 6 — 8 μ. Later the embedded cystidia become strongly encrusted with a deep yellow, apparently resinous excretion, which is soluble in a solution of potassium hydrate with the production of a vinaceous tint. It is insoluble in lactic acid, and the structure is best observed in sections mounted in this medium. The encrusted cystidia eventually occupy considerable space in the subhymenial tissues, and appear to be vesicular bodies, as described by Burt for *Corticium chrysocreas*.

Basidia 15 — 20 × 4·5 μ, with 4 sterigmata, 3 μ long. Spores hyaline, elliptical, one side depressed, sometimes 2-guttulate 4·5 — 5 (— 6) × 2 — 2·5 μ. Basal tissue at first somewhat compact, later the hyphae appear to be loosely interwoven, hyaline, thin-walled 3 — 4 (— 5) μ in diameter. The tissue in older specimens contains much mineral matter in the form of crystals, often forming masses in the central tissue of the spines.

Hab.—On bark. Mount Lofty, South Australia, Cleland "V," May 5, 1928, and "S," June 23, 1928; Mosman, Sydney, New South Wales, Cleland "D," May 4, 1919; Brown's River, Tasmania, Cleland "Q," January 30, 1928.

Known also from Ceylon, Cuba and the United States. A species very variable in appearance according to age. Young plants are easily recognisable from their brilliant yellow tints, but older specimens are best detected roughly by treating sections with a solution of potash, when there is always an evanescent vinaceous tinge. The cystidia and spores distinguish it from *Grandinia australis*. *Corticium Archeri* Berk., as to the type specimen, is an old cracked form, with now no yellow visible to the eye. Burt has distinguished *Odontia Wrightii* from *Corticium chrysocreas* on the ground that it possesses no vesicles. The type specimen of *O. Wrightii* was originally a young, thin specimen with few cystidia. It has been, at some time, treated with an alcoholic poisoning solution which has destroyed the yellow colouring matter. Nevertheless, careful examination of sections shows some trace of the embedded, encrusted bodies having been present, and the typical thin-walled conical cystidia occur in the hymenium. There are at Kew recent American specimens which are strongly odontioid in habit, and at the same time show the internal structure which is typical of "*Corticium chrysocreas*." As *Archeri* is the earliest specific epithet so far traced, it has been adopted for the species.

SPECIES EXCLUDENDAE.

Grandinia glauca Cooke.

This is not a true *Grandinia*, the spines being fascicles of sterile brownish hyphae covered with deposits of crystals. The fungus may be placed in the genus *Epithele*. At the same time, the structure is so closely allied to that of species of *Grammothele*, such as *G. grisea* B. & C. and *G. cineracea* Bres., that it is possible that it may be a state of a species of *Grammothele*, just as *Kneiffia grisea* belongs to *G. grisea*, according to Bresadola. The Australian plant, however, both the type specimen and a recent collection by Dr. Cleland, shows no trace of the development of either pores or true hydnoid spines, and is certainly distinct from *G. cineracea* in its longer spores, which are cylindric-ellipsoid, one side depressed, $8-9 \times 2-2{\cdot}5\ \mu$.

Odontioid forms occur in certain species of *Corticium*. Such forms have been observed in *C. lividum*, *C. bombycinum*, and *Peniophora setigera* from Australia.

THE GEOLOGY OF ORROROO AND DISTRICT.

By Professor Walter Howchin, F.G.S.

[Read September 11, 1930.]

Plates VIII. and IX.

The present paper is based on field notes made during various visits to the district, extending from 1905 to the present year. The exposed rocks belong, in part, to the Adelaide Series, ranging from the Glen Osmond Lower Slates, as the lowest visible member, and pass up to the lower members of the Purple Slates Series. The respective series are well defined, agreeing perfectly with the type district. The most interesting horizon is the Sturtian Tillite, which is present in the most extensive and impressive development known within the State. The beds follow in anticlinal and synclinal folds, rising in places to considerable elevations, and are sometimes truncated by faulting or subaerial erosion, showing very fine sections. The deformations are chiefly in the form of block faulting and shatter zones.

The principal localities herein described are:—

I. ORROROO TO PEKINA HILL.

The township of Orroroo is situated on the Tapley's Hill Banded Slates and in close proximity to the Brighton Limestone Series. The banded slates have a hard and siliceous texture with cubical jointing and make excellent building stones. They can be studied in the Pekina Creek and along the hillsides. General dip, about 25°-30° E.N.E. The bedding is strongly defined and is sometimes ripple-marked. A zone of intense crush and acute folding can be seen in the creek near the township. About a mile from the township, on the main road to Pekina, the banded slates are seen to dip beneath the limestone series. The latter, in its upper portion, is a strong, blue, crystalline limestone, intersected with veins of calcite, and is underlain by the less pure and more siliceous limestones carrying the peculiar vermiculate-like structures seen on the same horizon to the south of Adelaide. The beds have a strong exposure of about 200 yards across the strike, and their purer beds were at one time worked for flux by the Broken Hill Mines Company. The strike of the limestone is a little to the right of the Pekina Creek, where it passes under the alluvial cover of the plains on the northern side of the township. At the quarry it has a dip E.S.E., and is overlain by a quartzite.

The limestone can be easily traced along the strike which crosses the main road to Pekina, about half a mile to the S.S.E. of Pekina Head Station, situated at the extreme south-eastern corner of the Hundred of Coomooroo. Near the homestead mentioned, a cave exists in the limestone with a perpendicular entrance, which is said to have been explored for some distance without finding a termination. The limestone was followed for about two miles. The banded slates, which rise from beneath the latter, occurring with some slight variation as to texture and dip, are continuous to the Pekina Range. In a small tributary off the main creek the angle of dip rose to 85°. In the same direction, and within about a mile of the range, the dip fell to 5°, and for a short distance appeared to be horizontal. In an approach to the Pekina Range the banded slates give place to the underlying Sturtian Tillite, which will be described in the next section.

The more recent geological features, in proximity to Orroroo, include lacustrine deposits laid down in a lake that is now extinct. The sediments line the

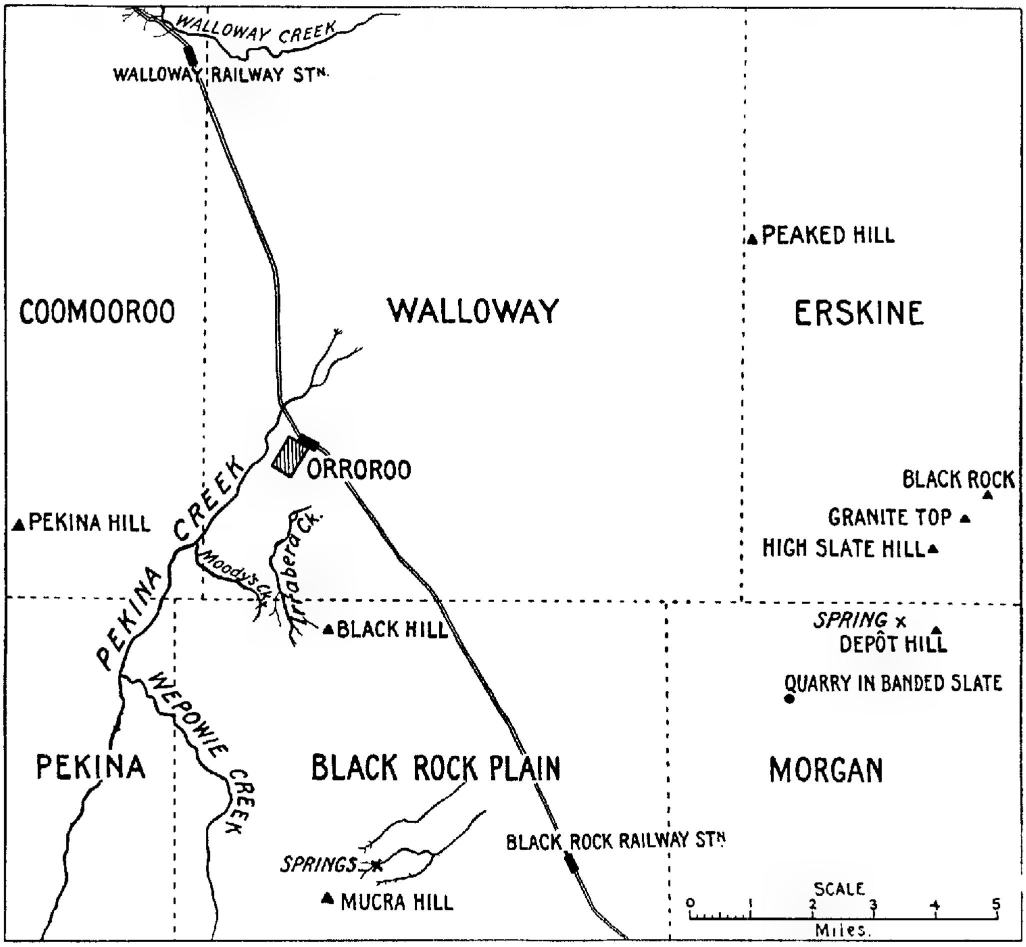


Fig. 1.
Locality Map.

banks of the present Pekina Creek high above the present line of drainage. [See Howchin, W., Trans. Roy. Soc. S. Aust., vol. xxxiii., 1909, p. 253.]

II. PEKINA RANGE AND THE BLACK HILL RANGE.

(Fig. 2.)

The two ranges run, approximately, parallel to each other. Pekina Range passes through most of the Hundred of Pekina, in a north-easterly direction, and ends near Pekina Hill, the highest point in the range, in the Hundred of Coomooroo. The line of section taken was from Pekina Hill, following a south-easterly direction through the Black Hill Range to the scarp of the latter, facing east, at a point about four miles to the southward of Orroroo. The Black Hill which gives the name to the range, must be distinguished from the Black Rock, which gives its name to a range on the opposite side of the plain. The section is in the form of a well-defined geosyncline. [See fig. 2.]

The present section begins where Section I. ended, but at a divergent angle towards the south-east. In rising to the Pekina Range, a rubbly quartzite was met with passing into tillite grits, followed by a normal tillite which forms the most of the range, including Pekina Hill, where the observations were made. The erratics were not so numerous as seen in some exposures, but one very strongly striated boulder was obtained.

Moody's Creek, which takes its rise in the northern portions of the Hundred of Black Rock Plain, after crossing the south-western angle of the Hundred of Walloway, makes its junction with the Pekina Creek at the south-eastern angle of the Hundred of Coomooroo. This creek supplies the best available section across the strike of the beds, and was, therefore, followed to its head. The bed of the creek is, mostly, in the Purple Slates Series (having a bluish tinge), and carrying thin quartzites. The beds roll in a succession of short anticlinal and synclinal folds, with the upper limits of the Brighton Limestone exposed in the nip of the folds. In Section 186 [Hd. of Black Rock Plain] there is a patch of limestone 80 feet wide, probably brought in by a fold.

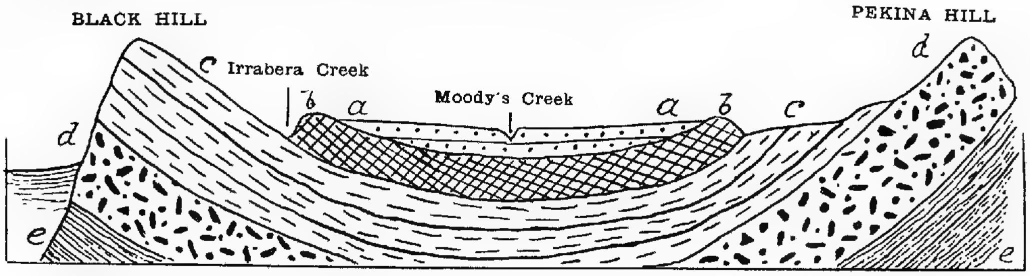


Fig. 2.

Geological Sketch-Section of Geosyncline connecting the Pekina Range and the Black Hill Ranges. [Six miles.]

(a) Purple Slates Series; *(b)* Limestone (Brighton Series); *(c)* Banded Slates (Tapley's Hill Series); *(d)* Sturtian Tillite; *(e)* Glen Osmond Upper Slates.

The Irrabera Creek takes its rise near the head waters of Moody's Creek, and flows in a northerly direction. The Irrabera, in Section 186, exposes the junction between the Brighton Limestone (which is strongly developed on its western banks) and the Tapley's Hill Slates which occupy the eastern banks. Following an easterly course, the last-named slates form the rise to the Black Hill, which consists almost entirely of beds of this horizon, ending abruptly in a steep scarp bordering the plains.

About a mile to the southward of the point reached, at the base of the scarp (about the dividing line between Sections 182 and 147E), the tillite is exposed in the banks of a small creek, giving a section showing the junction of the tillite with the overlying Tapley's Hill Banded Slates. The section was covered by the talus slope from the hills, and would not have been seen had it not been for the creek's action in eroding the talus. The tillite is evidently exposed at the base of the range, in places, as by traversing the flats further to the northward, numerous fragments of the tillite were observed scattered over the paddocks mixed with other detritus.

III. THE MUCRA RANGE.

(Figs. 3, 4 and 5.)

The Mucra Range, following a north and south direction, rises gradually from the plain two miles to the westward of Black Rock Railway Station. Instead of calling it a "range," it would be better described as a plateau having a scarp face towards the east. The ground geologically examined, and now described, is situated about five miles to the southward of the section shown in fig. 2. It covers an area of about three miles in an east and west direction, extending from the alluvium of the plain on the east, to a little beyond Mucra Hill on the west; and about one and a half miles in a north and south direction. Although of limited area, it is of more than ordinary interest on account of the deformations to which the area has been subjected by faulting, crush zones, displacements, and repetitions of the beds. It is also of interest on account of the exceptional extent to which the Sturtian Tillite is developed in surface features. The vertical range in the geological succession is slight, passing up from the slates that underlie the Glen Osmond-Mitcham Quartzite, to the Tapley's Hill Banded Slates that overlie the tillite.

Three creeks intersect the area by which shallow sections of the beds can be obtained. The Mucra Springs Creek is the most important, and is fed by springs that have their outlet near the head waters of the stream. The springs have a constant flow and are incidental to the faulted condition of the ground. Sweet's Creek (or Tank Creek) is situated a little to the southward of the Mucra Springs Creek, and unites with the latter at a lower level. This creek is also fed by a spring. The third creek is McNaughton's Creek, situated on the northern side of the Mucra Springs Creek. The three creeks are lost by absorption in the alluvium of the plain at the base of the range.

Two systems of faulting can be recognised within the area. A major fault has an east and west direction, while several other faults have a strike north and south, being, approximately, at right angles to the major east and west fault. The latter is opposed to the general strike of the beds, and is, therefore, a dip fault which breaks the continuity of the beds, while those in a north and south direction form strike faults, which repeat the beds. The prevailing dip is westerly, or south-westerly, sometimes at a high angle, and is, in a few cases, locally reversed.

In taking a general view of the field, it is seen that the great E. and W. dip fault has thrown the whole field on the northern side of this fault to the eastward, while several strike faults have repeated the beds, once on the southern side and twice on the northern side of the main fault. This can be seen in figs. 4 and 5. There is, therefore, only one main quartzite horizon in the field, split up into four sections with some secondary occurrences that will be explained later.

The important east-west fault divides the field into two parts, a southern and a northern section, which require to be considered separately.

Description of the Geological Field.

(A). GEOLOGY OF THE SOUTHERN SIDE OF THE DIP FAULT.

(a). Tapley's Hill Slate.

The main road between the Black Rock township and Wepowie Creek passes over a col in the range, a little to the southward of Mucra Hill. The country between the latter and Wepowie Creek is level and cultivated, the surface soil being derived from the decomposition of the Tapley's Hill Slates which overlie the tillite and form the highest geological horizon within the area under consideration. The slates are well exposed along the banks of the creek above mentioned, passing up into the Brighton Limestone.

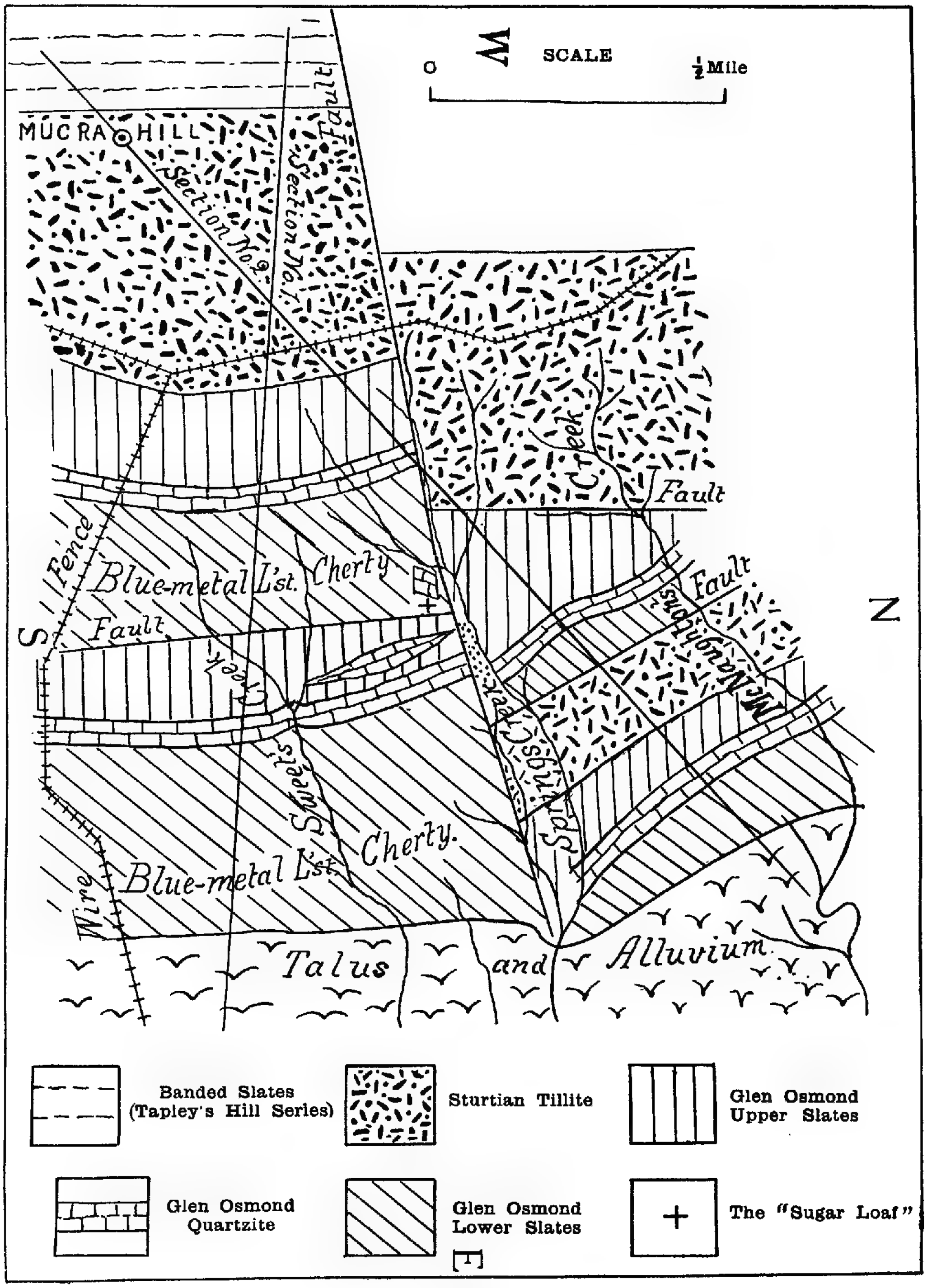


Fig. 3.

Geological Sketch-Plan of Mucra Springs Reduced Scarp.

[The line of No. 1 Section should have been drawn a little further to the northward than that shown on the Map, as seen in fig. 4.]

(*b*). Sturtian Tillite.

To reach Mucra Hill, the Wepowie road is followed to the top of the rise and, at a five-road junction, the north road is taken, followed by the first turn to the east to Mr. MacMahon's homestead in Section 19, Hd. of Black Rock Plain.

Near the residence mentioned, a hill, situated in a gap of the range, shows prominent exposures of tillite in a line of outcrop that is continued to Mucra Hill (a trig. station) with fine exposures of a typical kind, which, by the eye, can apparently be traced for miles in a northerly direction. The tillite has a great spread to the eastward, reaching to the wire fence that follows the edge of the plateau, having a width of a little over half a mile.

The ground is more or less under cultivation, with ridges of the tillite rising in places and patches, some of them several acres in extent, so thickly strewn with erratics as to make ploughing impossible. The erratics reach a size up to six feet in length, too heavy to shift, but near the boundary, at the edge of the plateau, some have been dragged to the fence. Near the centre of the ground there is a ridge of tillite with an apparent dip to the north-west at 70°. The base of the tillite, on the southern side of the main east-west fault, is near the edge of the plateau, on the eastern side of the boundary fence, where a small quartzite occurs. This latter may prove to be either the upper limits of the underlying slate, or a lenticle in the tillite, near its base. Not much attention was devoted to the erratics, but those seen were mostly quartzites and included some porphyries; one limestone boulder was recognised, granite erratics were apparently rare.

(*c*). Slates beneath the Tillite (= Glen Osmond[1] Upper Slates).

The ground falls rapidly from the edge of the plateau towards the east, forming an exposure of the Glen Osmond Upper Slates in a thickness of about 150 feet. These slates have a laminated structure and a bluish-black colour. Dip, W. 20° N. at 60°.

(*d*). The Quartzite (= Glen Osmond Quartzite).

The slope of the ground from the edge of the plateau, cutting the basset edges of the slates, just described, becomes arrested by the presence of a strong quartzite which rises above the normal level in a very broken ridge, having a strike, approximately, north and south. The outcrop is very sharply truncated by the east-west fault, showing a bold scarp to the headwaters of the Springs Creek, 100 feet in height, with the faulted tillite transverse to its base.

All the main quartzites within the area are of precisely similar type—fine-grained, mottled, and extremely brittle. The latter feature is no doubt the effect produced by the powerful earth movements which have occurred within the area. The stone splits freely under the hammer, fracturing in all directions with many smooth and slickensided faces. The evidences of fracture, from crush, can be seen in the general rock structure by groups of cracks and open spaces in the main portions of the stone. This brittleness is especially seen in the great isolated monolith that goes by the name of the "sugarloaf," to be described later.

(*e*). Slates below the Quartzite (= Glen Osmond Lower Slates).

These slates follow in regular order below the quartzite. They can be distinguished from those above the quartzite by the occurrence within their limits

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[1] In the type district, the quartzite, with its attendant upper and lower slates, occurs both at Glen Osmond and Mitcham, forming two anticlines, separated by a syncline by which the quartzite dips below the surface, to reappear in a return fold at Mitcham, so that the beds in these contiguous localities are on the same geological horizon.

of calcareous zones that carry more or less cherty nodules and layers. This is a well-marked feature of the beds as developed near Adelaide, and is distinguished as the "blue-metal" limestone. Its occurrence in the present section is a good guide to the particular horizon represented. Further references to the subject will be found below.

The slates just defined are determined by a strike fault with a north and south direction, which had the effect of repeating the beds, as described in the next paragraph.

Repetition of the Beds (Southern Side).

(Fig. 4.)

(1). *Faulted Upper Slates.*—The strike fault mentioned in the preceding paragraph had the effect of a down-throw by which the slates above the quartzite, as well as the quartzite itself, were once more brought within the limits of the section, and the upper slates were placed unconformably against the lower slates.

(2). *Faulted Quartzite.*—This outcrop of the main quartzite makes a very strong and high ridge with a strike roughly accordant with the one to the westward, of which it is a repetition. On the northern side it is cut by the great fault that runs in a line with the Springs Creek, and to the southward its elevated outline can be traced by the eye as extending for several miles.

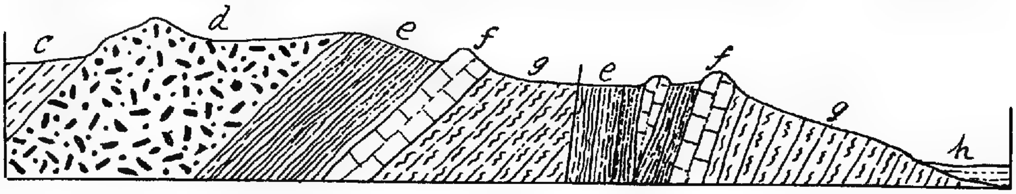

Fig. 4.

Geological Sketch-Section, No. 1, of the Mucra Springs Area. Southern side of the main East-West Fault. [One and a half miles.]

(c) Banded Slates (Tapley's Hill Series); *(d)* Sturtian Tillite; *(e)* Glen Osmond Upper Slates; *(f)* Glen Osmond Quartzite; *(g)* Glen Osmond Lower Slates; *(h)* Alluvium of the Plain.

In the dislocation and sheering to which these rocks were subjected, the quartzite on the westward side, near the fault plane, was broken, carried forward, and left out of alignment with the main mass. There are two such isolated fragments. One of these is situated on the right bank of the Springs Creek, about mid-distance between the two main outcrops and is locally known as the "sugar-loaf." It is a very remarkable object—an isolated monolith, in angular outline, vertical walls, and considerable elevation, covering an acre of ground. It appears to have been severed from its bed in the western outcrop, dragged along the fault plane, and left stranded in its isolated position. A trail of broken and mashed rocks can be traced from the base of this castle-like rock in a south-easterly direction.

The other illustration of these isolated fragments occurs on the western side of the eastern outcrop of quartzite and runs parallel with the latter. [See figs. 3 and 4.] It is separated from the main quartzite by about 100 yards, and is almost, at its thickest part, a rival in size to the latter. It is lenticular in outline, with a length of about 20 chains, attenuated at either end by decreasing thickness and brecciated rock material, running out before reaching the Springs Creek, on the northern side, and a small creek on the southern. It appears to owe its origin to a secondary strike fault which has duplicated the quartzite at close quarters and, for a limited length, in lenticular form.

The southern extremity of this lenticular quartzite reaches the northern branch of Sweet's Creek, and a few broken and mashed stones can be traced across the creek, where it ends. About 100 yards further up the creek from this point there is a break in the slates; the dip, which is normally south-westerly to west, is changed to the south-east, and a little higher up it is reversed to the west-north-west at 55°. This probably represents the position of one of the strike faults that has repeated the beds.

(3). *Faulted Lower Slates.*—These beds are conformable with the main quartzite outcrop under which they dip, and with which they are united in one and the same faulted block. They also include the "blue-metal" limestone and cherts proper to this bed. The slates follow the slope of the ground, and are ultimately obscured by the alluvium of the plains.

(B). GEOLOGY OF THE NORTHERN SIDE OF THE DIP FAULT.

(Figs. 3 and 5.)

The geological features on the northern side of the great dip-fault are more varied and complex than those on the southern side of this fault, involving a great throw to the eastward and a more extended repetition of the beds.

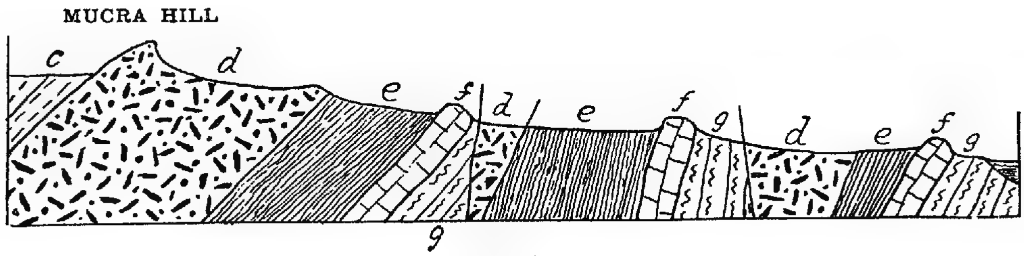

Fig 5.

Geological Sketch-Section, No. 2, of the Mucra Springs Area.
The Section cuts the main East-West Fault obliquely. [One and a half miles.]
(c) Banded Slates (Tapley's Hill Series); *(d)* Sturtian Tillite; *(e)* Glen Osmond Upper Slates; *(f)* Glen Osmond Quartzite; *(g)* Glen Osmond Lower Slates.

(a). Faulted Tillite (Upper Exposure).

The fault, above mentioned, enters the valley where the central stream of the Springs Creek takes its rise, and for some distance the creek follows closely the line of faulting. At the head waters the division between the slates, on the right bank of the creek, and the tillite, on the left bank, is quite sharp. On the bank side, not far from the fault plane, a large quartzite erratic is set in the tillite, which measures 5 feet 6 inches by 3 feet 6 inches by 3 feet 6 inches. The main body of the tillite is thrown about 25 chains to the eastward of its former boundary—that is, to about mid distance between the truncated quartzite and the "sugarloaf" that are situated on the other side of the fault plane. It is here ended by a strike-fault having a direction a little east of north. The fault plane carries much quartz, a quantity of micaceous iron and fault-rock that is dark-coloured and very siliceous, passing to chert in places. This north south fault crosses the creek to the southern bank; the hard siliceous rock (forming the crush-rock of the fault plane), by its superior resistance to stream erosion, forms a waterfall, about six feet in height, while the fault dies out, apparently, against the east-west dip-fault on the southern side.

(*b*). Slates beneath the Tillite.

These are well exposed in the creek below the waterfall caused by the north-south fault. They show smooth bedding planes with a dip at 45°, and are situated a little above the "sugarloaf." Just below the latter, in the creek, the slates are much disturbed and mashed, having a dip of 65° to the west. On the right bank there is an old washout that has been filled with layers of sediment that have undergone induration so as to resemble older rocks, and, at first sight, might be regarded as an overthrust on the slates. At one spot, slates and thin quartzites are in vertical position with a strike nearly north and south, being divergent from the normal, north-west.

The position of these slates—between the tillite and the quartzite—suggests that they represent the Glen Osmond Upper Slates, but the evidences of faulting at the eastern margin of the tillite, and, probably, near the "sugarloaf," prove considerable disturbances that are difficult to define.

(*c*). The Northern Faulted Quartzite, No. 1.

The quartzites at the "Springs" are of peculiar interest. In a casual observation the quartzite on the southern side appears to cross the creek and ascend the hill on the northern side, but this is not the case. The respective outcrops certainly represent the same geological horizon but, stratigraphically, they are a long way out of alignment with each other. The east-west dip fault divides them. The true alignment of the northern ridge of quartzite is not with the quartzite that faces it on the opposite side of the creek, but with the truncated limb that appears on the southern side of the fault a quarter of a mile higher up the stream. The strike of the two beds of quartzite at the "Springs" is not exactly coincident, as the northern branch meets the creek about the thickness of its own diameter (50 feet) to the eastward of the southern branch. The northern line of exposure follows a strike to the north-west, curving round, and crosses McNaughton's Creek, about half a mile distant.

There appears to be a chain of springs in the bed of the creek, the most important being the one marked on the map near the junction of the two opposed quartzites, where the remains of a drinking trough can be seen. The locality is very much disturbed. Near the fault, in the creek and on the sides of the hill, the quartzites are reduced to a crush-breccia, the same features extending in a south-westerly direction, taking in the trails associated with the isolated fragments of the "lenticle" and "sugarloaf" described above.

(*d*). Slates between the Quartzite and Lower Tillite.

In a normal succession (with a westerly dip) the slates, as underlying the quartzite, may be regarded as the equivalent of the Glen Osmond Lower Slates. The beds, which have an exposure of about 250 yards, are much disturbed and broken, mostly pitched at a high angle, sometimes vertical, or even reversed, with a strike directed east and west, and a dip, south. In this disturbed area, one large piece of slate was seen to be strongly grooved and slickensided. The slates are separated from the underlying tillite by a fault plane, and there is some reason to think that the tillite overrides the slates. The line of fault is marked by the presence of ironstone, with a strike N.W. and S.E., and can be traced for a considerable distance.

(*e*). Faulted Tillite (Lower Exposure).

The position of the repeated tillite in the section gives evidence of a very considerable downthrow on the eastern side of the fault. In the normal order of succession the Tapley's Hill Banded Slates should rest on the tillite, but instead of this the Glen Osmond Lower Slates have that position, while the Glen Osmond Quartzite and Upper Slates are cut out, but reappear in their normal position later in the section (see fig. 5).

The tillite has a surface exposure of about 500 yards across the strike. In its basal portion it is dark-coloured and siliceous, but throughout the greater portion it is buff-coloured, in which the darker coloured erratics, worn down by the stream action to a level, show out very conspicuously against the lighter coloured matrix. At about half distance along the surface a boulder, fixed in the tillite, measures 6 feet by 4 feet, consisting of reddish, siliceous, quartzite, much veined with quartz and, in places, showing false-bedding. The tillite is limited on its southern side by faulting, but, on the northern, extends in that direction to, at least, McNaughton's Creek. Taking in the faulted portions, the tillite has a spread across the strike of a mile and a half, one of the largest areas for this particular rock within the State.

(*f*). Slates below the Tillite.

Rising from beneath the tillite are bluish and dark-coloured slates with a dip S.W. at 50°. They correspond to the Glen Osmond Upper Slates, and have an exposure of about 250 yards.

(*g*). Northern Faulted Quartzite, No. 2.

In descending order from the last-named slates, is a repetition of the same quartzite that outcrops higher up the valley. Its position can be fixed in Section 132, just above the junction of a tributary on the right bank, which has a course almost parallel with the main stream. The quartzite strikes the creek tangentially, and from its being partially on its strike gives a section 160 yards in length. The dip is W.S.W. at 15°, with a N.W. strike. The outcrop forms a ridge which is directed towards the main range about a mile distant. It is not seen outside the creek on the right bank, as on that side the alluvium of the plain obscures outcrops. The lithological features of the quartzite are exactly similar to those already described with reference to other exposures of the same rock.

(*h*). Slates below the Faulted Quartzite, No. 2.

Rising from beneath the quartzite (just described), in Section 132, near the north-eastern angle of Section 149E, are slates corresponding to the Lower Glen Osmond horizon. They can be seen in the creek bed, for about 100 yards, with a dip S.W. at 40°. They are much weathered and bleached, as they form the margin of the older rocks as the latter disappear under the alluvium of the plain.

McNaughton's Creek.

This creek has a parallel direction with the Mucra Springs Creek, situated on its northern side, and at a distance of about half a mile. The tillite which is seen in the head waters of the Mucra Springs Creek (on the western side of the north and south fault) continues to McNaughton's Creek, in its upper reaches. Dip of beds, S.S.W. at 45°. The boundary fault on the eastern limits of the tillite, also goes through to McNaughton's Creek, on the same line of strike. The fault zone is marked by ferruginous quartzite and ironstone, which has an apparent dip to N.E. at 75°. Just below the fault plane, blue slates show in the creek with a dip S.W. at 40°. The thick quartzite, in its eastern throw, follows the ridge from the Springs, crosses the creek and makes a prominent feature on the north-western side of the creek, having a dip S.W. at 36°. Then follows a thick blue slate with thin beds of quartzite, dip S.W. at 35°; under which rises another thick quartzite, and this again underlain by more blue shale which continues to a junction with the tillite in its second or eastern occurrence. The latter is a quarter mile in breadth and continues northward to McNaughton's boundary fence, indicated on the map by the public road. The tillite is underlain by laminated slates, dipping S.W. at 60°, and these again underlain by quartzite.

Sweet's Spring Creek (or Tank Creek).

(So named from a stone tank that was formerly supplied by means of a pipe led from a spring higher up.) The Creek is situated nearly half a mile to the southward of the Mucra Springs Creek, with which it unites at a lower level. Rising to the foothills are outcrops of slate and buff-coloured limestones with chert, up to six inches in diameter. A ferruginous quartzite outcrops on a low hill with dip W. 20° N. at 60°. In a small creek, behind the ruins of Sweet's house, slates strike S. 20° W. in vertical position, or slightly to the west. Two hundred yards above the first outcrops in the creek there is a crush-rock, 42 yards wide, in the creek. It shows no regular bedding. Parallel lines may be recognised in short distances, but the great mass of the rock is shattered. A break of 50 yards occurs in which no rocks are seen, following which are slates, showing a small fault plane in beds much broken and penetrated by small quartz and mineral veins. Anticlinal folding gives reversed dips E.N.E. and W.S.W. Small waterfalls occur in the creek, above which is a quartz reef, 4 feet 6 inches in thickness, penetrating slates with Fe_2O_3. A little higher up, close to the road leading to the Spring, the slates have a dip W. at 45°, which increases to 64° in the direction W. 20° N., becoming vertical and reversed near the Spring. The water issues at the junction of the slates with thin quartzites, the latter having a dip W. at 80°. These quartzites are followed, in ascending order, by slates and buff-coloured dolomitic limestones which are seen on the rise to the plateau, with an important quartzite 60 feet thick near the crest.

Section Taken Along the Old Post and Wire Fence.

A fourth traverse of the range was made by following the "post and wire fence," marked on the map, that passes up from the township to the Mucra Plateau. The route was parallel to those already described, and half a mile to the southward of Sweet's Spring Creek. Some fragments of chert were observed on ploughed land in a paddock before reaching the stony rise. Near the dividing line between Sections 131s and 149E a mallee scrub marks the first rise in the foothills. Here the first exposure of rock is seen as decomposed laminated slate (or shale), carrying bands of black chert *in situ*, evidently the parent rock from which the distributed fragments met with at a lower level were derived.

Higher up, near the top of the next ridge in the foothills, a number of prospector's holes in the slate afforded some evidences. They showed the slates to be very fissile and split with smooth faces. In the excavation the dip showed W. at 50°. Further on, the dip changed a little to the north of west, and at a higher angle—in places, apparently, vertical. At some horizons calcareous zones occurred.

No alteration of geological features occurred till the path cut through the first high ridge with a quartzite, about 50 feet in thickness. This quartzite is the same as the quartzite cut in the Mucra Creek section by the east-west fault at the "Springs."

Superior to the quartzite, last mentioned, there are more laminated slates (or shales) and on the rise towards the watershed marked calcareous horizons are seen in the slates forming an earthy-bluish-impure limestone, divided up into layers about six to twelve inches each; some of a blackish colour similar to that of the "blue-metal limestone" near Adelaide, which occurs there in the slates between the Thick Quartzite [Black Hill and Stonyfell] and the Glen Osmond Quartzite.

Near the summit of the scarp, forming the water-parting, there is another important quartzite which forms the southerly extension of the quartzite which is truncated by the east-west fault at the head of the Mucra Springs Creek. Resting on this quartzite is a flaky slate, about 50 feet in thickness, which separates the quartzite from the tillite that immediately succeeds it in position. The bed corresponds to a similar one that separates the quartzite from the tillite as described above in its northern extension.

IV. THE BLACK ROCK RANGE.

(Fig. 6, pl. viii., and pl. ix., fig. 1.)

This range, situated 168 miles to the northward of Adelaide, and about four miles in length, is the most conspicuous highland for many miles around, rising steeply from the level of the plain. The sky-line of the range forms a jagged contour arising from the differential weathering of its geological elements, as well as the block-faulting to which the range has been subjected. The beds are included in the Adelaide Series, and the vertical succession extends from the Glen Osmond-Mitcham Lower Slates to the Tapley's Hill Slates, with the intermediate horizons of the Gleh Osmond-Mitcham Quartzite, the Glen Osmond Upper Slates, and the Sturtian Tillite. These will be considered in their ascending order.

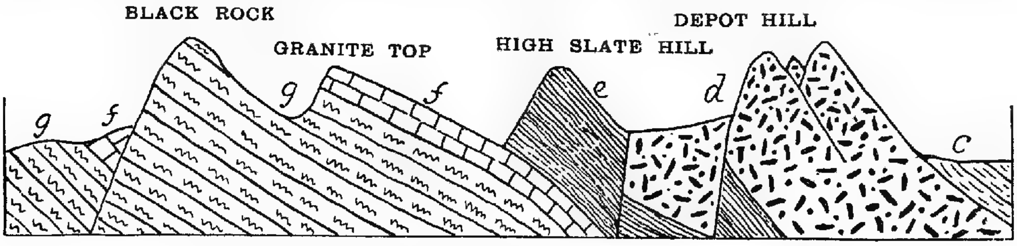

Fig. 6.

Geological Sketch-Section of the Black Rock Range. [6 miles.]

(c) Banded Slates (Tapley's Hill Series); *(d)* Sturtian Tillite; *(e)* Glen Osmond Upper Slates; *(f)* Glen Osmond Quartzite; *(g)* Glen Osmond Lower Slates.

(a). Black Rock.

Horizon: Lower Slates of the Glen Osmond-Mitcham Series.[2]

The Black Rock, the highest point of the range, has a trig. cairn on its summit with the official record of 2,800 feet above sea level. It is situated a little over 11 miles, in a direct line eastward, from the township of Orroroo, and rather less than that from the Black Rock Railway Station. The base of the hill is estimated to be 1,680 feet above sea level, giving the height of the hill, from its base, as 1,120 feet.

The most accessible path by which to reach the height is on the southern side of the hill, up what is known as the Granite Creek (to be referred to presently) —a side that has been thickly covered with sheoak trees, but which are now nearly all dead from the effects of the parasitic plant, *Loranthus.*

[2] The so-called "slates" of the Adelaide Series might often be better designated shales, as they frequently show a fine lamination and split on the bedding planes. The same beds, in other situations, develop a coarse cleavage and split more readily at an angle to the bedding. As it would be inconvenient to call the same bed in one place a shale and in another a slate, it is better to adopt a single term, although the particular bed might be more appropriately called a shale.

Black Rock is shown on the map of the Hundred of Erskine, placed on the northern boundary of Section 24. It is composed of a very compact slate, of a dark-bluish colour, finely laminated and very uniform. The bedding is marked by numerous very regular and parallel lines, strongly coherent but at intervals fissile by which the rock is divided into flags, a few inches in thickness, and is sometimes massive. On the southern side of the hill the beds show a dip slope of about 40° in a westerly or south-westerly direction, decreasing in the angle of dip towards the summit. At the crest, the rock, bared to the weather, has developed a rough kind of cleavage at a high angle, not seen in less weathered portions of the rock. At first sight this might be taken as a change in the angle of dip, but careful observation shows the bedding lines as transverse to the cleavage planes.

The northern face of the hill is a very pronounced fault scarp, very steep, with a ledge a short distance down from the crest, and a raised broken ground at the base, several hundred feet below. The bed of quartzite, which caps Granite Top, on the southern side, although absent from the crest of the Black Rock, is seen on the faulted segment, having been thrown down in conjunction with the underlying slate.

(b). GRANITE TOP.

Horizon: Glen Osmond-Mitcham Quartzite.

A very strong and siliceous quartzite overlies the Black Rock Slates, and in consequence of an eroded gap in the slates causes the quartzite to take the form of a lofty and scarped face not much below the height of Black Rock. The popular name of "Granite Top," although a misnomer, as there is nothing of granite about it, has become stereotyped by the name having been placed on the Government Map, in Section 24, Hundred of Erskine. Its striking prominence is due to its resistance to weathering, coupled with the stream action of the Granite Creek, which takes its rise on the south-eastern flanks of Black Rock, having cut a gap between the quartzite and the slates near the summit, and then cutting through the quartzite at a lower level, by which the latter caps the valley on both sides, the dip slope giving a reduced height on the western side.

The quartzite is a light-coloured, siliceous, and piebald stone by the presence of small flakes of white felspar, a very characteristic feature of the Mitcham Quartzite. The original quartz grains, by metamorphic action, have been blended and fortified by introduced silica in optical continuity that approaches the structure of a quartz-rock. The rock is massive and has a slight tendency to spheroidal fracture. The thickness of the bed is estimated at about 60 feet, but this is uncertain, as the base of the bed is obscured by talus. The bed has a slight pitch downwards as it passes under the overlying slates of the "High Slate Hill" at the level of the road and creek [see pl. ix., fig. 1].

(c). HIGH SLATE HILL.

Horizon: Upper Slates of the Glen Osmond-Mitcham Series.

This hill, shown on the map as situated in Section 7N (Hd. of Erskine), is in a direct line with Black Rock and Granite Top, following a south-westerly direction. It is an isolated, pyramidal hill, about 600 feet in height, with steep faces on all sides, especially on the north side which shows the basset edges of the slate rock.

On the descent from the Black Rock, a course was shaped around the eastern base of the hill to its southern side. The beds show the same features of an earthy slate as seen in the corresponding horizon in the type district. The steepness of the hill on its southern face is caused by the great downthrow of the glacial beds on that side, the fault having carried down the underlying slates with the tillite, making an unconformable junction between the two.

(d). Stuart's Lookout and Depôt.

Horizon: The Sturtian Tillite.

The site is marked on the official map as "Depôt Hill" [Sec. 135, Hd. of Morgan]. The local statement is that it formed a camping ground and lookout for the explorer, J. McDouall Stuart. It is probably correct, but the latter begins his "Journal" from a position further north. The site forms a narrow valley at the head of which are two peaks, the higher one known as the "Lookout," and the other, which is slightly lower, as the "Depôt Hill." Near the head of the valley is a permanent spring of good water which it is assumed formed the camping place.

There is an extraordinary development of the tillite in the north-western portion of the Hundred of Morgan. The beds are exposed on the western boundary of the Hundred in Sections 101 N and 101 S, and continue in a gradually rising range (or spur) for a distance of six miles, reaching a maximum height in the Depôt and Lookout peaks [see pl. viii., figs. 1 and 2]. Towards the head of the valley (in the neighbourhood of the spring) the outcrops are very massive and rugged, rising to a height of about 500 feet, formed of tillite throughout. The erratics are numerous, mostly sharply angular, and were observed up to two feet in diameter. They consist mostly of quartzite, with a good number of granites, metamorphic rocks, basic igneous rocks, and one limestone example was seen. Near the head of the valley the tillite extended up the south-eastern elevation, as well as on the north-western, passing under kaolinized slates. The line of junction between these two beds crosses the valley diagonally, passing over to the north-western side.

On rising to the crest of the Depôt Hill, it was seen that the range on its north-western side was bounded by an almost vertical scarp caused by a downthrow on that side comprising some hundreds of feet. This broken segment extends northwards to the limits of the High Slate Hill, as stated above, having a length co-extensive with the range (six miles or more), and a breadth, reaching the southern flanks of the High Slate Hill, of one and a half miles, the most extensive exposure of the Sturtian Tillite, in one mass, known within the State.

(e). Post Glacial Slates.

Horizon: Tapley's Hill Banded Slates.

About three miles to the south-westward of the Depôt Hill, on the flanks of the tillite spur, a quarry has been worked in the overlying slates by Mr. Lloyd Haynes, on his farm in Section 121 E, near its northern boundary. The quarry is in kaolinized banded slates, having a dip E.S.E. at 35°. The rock splits easily on the bedding planes and shows ripple marks on some faces. The tillite is exposed on the rise behind the quarry. At about 100 yards in the direction of the dip a quartzite a few feet in thickness is included in the slate, and from its superior hardness forms a slight elevation in the contour. With a change in the geological nature of the country the surface, to the southward, assumes a flat and featureless aspect.

It appears that the Depôt spur is really a faulted block as distinct from the main range, the latter having a dip to the west or south-west, while the Depôt spur shows a dip to the E.S.E., the result of the great downthrow being to give the spur a tilt to the eastward.

The tillite dips under the alluvium on the eastern side of the Orroroo plains, and reappears at the base of the ranges on the western, as described above, in a distance of six miles.

V. THE PEAKED HILL RANGE.

(Fig. 7, and pl. ix., fig. 2.)

The Peaked Hill takes its name from its shape, rising on all sides to a central peak. It is a conspicuous object when viewed across the plain from Orroroo, a distance of eight miles in a straight line, and is about the same distance from the Depôt Hill in a north-westerly direction. Its position on the map is close to the western boundary of the Hundred of Erskine, Section 69, and about mid-distance between the northern and southern limits of the Hundred [pl. ix., fig. 2].

The beds exposed, in ascending order, are: *(e)* the Glen Osmond Upper Slates; *(d)* the Sturtian Tillite, which takes in most of the hill, divided by a quartzitic zone into two sections; and *(c)* the Tapley's Hill Banded Slates, which pass into low ground. The hill owes its prominence entirely to the presence of the tillite and quartzites which possess greater resistance to weathering than the associated slates. The dip is northerly, and, as this is opposed to the dip of the Black Rock Range, it probably forms part of an anticlinal fold of which the respective prominences are the complementary curves.

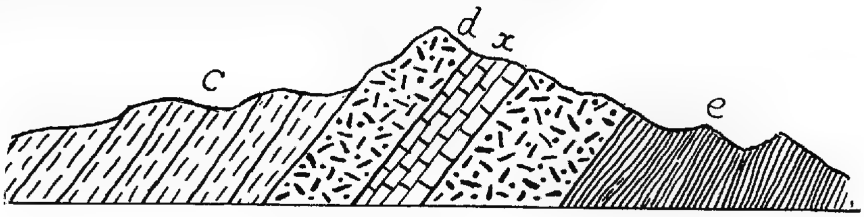

Fig. 7.

Geological Sketch-Section of the Peaked Hill.
(c) Banded Slates (Tapley's Hill Series); *(d)* Sturtian Tillite;
(x) Quartzite in Tillite; *(e)* Glen Osmond Upper Slates.

The range, of which the Peaked Hill forms a part, continues in a northerly direction through the Hundred of Erskine to the boundary of the Hundred of Yalpara, where it subsides to lower ground. Following on the same line of strike, in a north-north-easterly direction, a further exposure of the tillite was observed in the Hillpara Creek, at a distance of nine miles from the Peaked Hill. The bed of the creek, as well as the adjoining hillsides, consist of the Sturtian Tillite. One granite erratic in the bed of the creek measured three feet.

VI. WALLOWAY AND OLADDIE.

(Figs. 8 and 9.)

The Walloway Railway Station is situated seven miles to the northward of Orroroo. The adjacent township is marked "Rye" on the official map. As the position is on the edge of the alluvial plain geological sections are of a restricted kind, being limited to the railway cutting, near the railway station, and the banks of the Walloway Creek. The latter takes its rise on the western slopes of the Oladdie Hills, near Eurelia, and after flowing in a south-easterly direction for about ten miles (mostly in a course adjacent to the railway), it takes a sudden turn to the east and is soon lost in the plains. From the limited amount of rock exposures the vertical range of the beds is restricted to few horizons.

The dominant geological feature of the locality is the Brighton Limestone Series. To the southward the latter occurs near Orroroo, as described above, and in a north-north-easterly strike, crosses the railway line, a little beyond the Walloway Railway Station, and intersects the Walloway Creek, immediately adjoining, where an interesting section of the beds occurs. [Fig. 8.]

The lowest member of the Adelaide Series, seen in the creek, consists of the Tapley's Hill Banded Slates. On the eastward side they are cut off by the alluvial sediments of the plain. In a westerly direction they continue for about a quarter of a mile at a high angle of dip, having an average pitch of 75°, reaching the vertical in places. Towards their upper limits they become calcareous, but more or less siliceous, showing the "vermiculate" structure, often seen at this horizon, and are sometimes earthy. These impure beds pass up into more definite limestones, as usually occurs in the Brighton Series. The limestone is generally of a bluish tint, or nearly black, in colour, often carrying veins of calcite, and, in places, becomes of a pinkish or buff colour. The calcareous zone continues for several hundred yards. In the railway cutting the limestone is exposed for about 80 yards with a dip W. 10° N. at 83°.

The limestone ends in the creek quite suddenly with a dip W. at 78°, and is followed by an alluvial bank for about 100 yards, at the end of which the Purple Slates Series makes its appearance. Passing through the culvert under the railway line, and following the bed of a small tributary to the main creek, a better view of these beds can be obtained. Here the strong limestone ends abruptly with a small scarp face and, after a few yards of talus, the overlying Purple Series is seen with thin reddish quartzites and an arenaceous limestone, followed by reddish laminated slates that have a dip W. at 72°, the section being closely similar to the Purple Slates Series in other parts of the State.

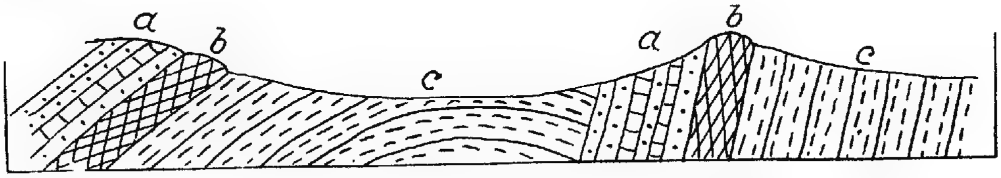

Fig. 8.
Geological Sketch-Section, Walloway Creek.
(a) Purple Slates Series; *(b)* Limestone (Brighton Series);
(c) Banded Slates (Tapley's Hill Series).

Within 100 yards from the main limestone a strike fault cuts off the purple slates and brings to the surface the laminated and banded slates of the Tapley's Hill and Brighton Series. The beds, which at first have a low dip to the east-north-east, change a little higher up to west-north-west at an angle of about 15°, and, finally, at a mile distance, pass under the second outcrop of the Brighton Limestone. Taken as a whole, the section reveals an anticline broken by a fault with a very considerable downthrow.

Geological Section between Walloway and Eurelia.

The railway between the two stations mentioned runs so close to the margin of the Walloway Creek that it is easy to observe the geological features exposed in the creek from the train while in motion. In this way the following observations were made. The most striking feature seen in the seven miles' journey between the two places was a further fault and repetition in the Brighton Series, as shown in the following sketch-section. [Fig. 9.] After passing over the Purple Slates Series for some distance, the siliceo-calcareous beds of the upper part of the Tapley's Hill horizon were in view, showing a dip to the north-west. This dip ultimately brought to the surface the Brighton Limestone, which, in a short distance, was cut by a fault-plane on its northern side. This fault brought the Tapley's Hill beds, by a down-cast, up against the limestone, so that the latter had the Tapley's Hill beds both above and below it. The Tapley's Hill beds, in the faulted area, showed at the surface for about a mile, giving some evidence of crush, and were then succeeded once more by the Brighton Limestone, being the fourth exposure of this limestone in succession within the limits of about five miles. Following on the limestone the Purple Slates Series also once more came into view, and henceforth became the constant surface feature for an indefinite distance in a northward direction.

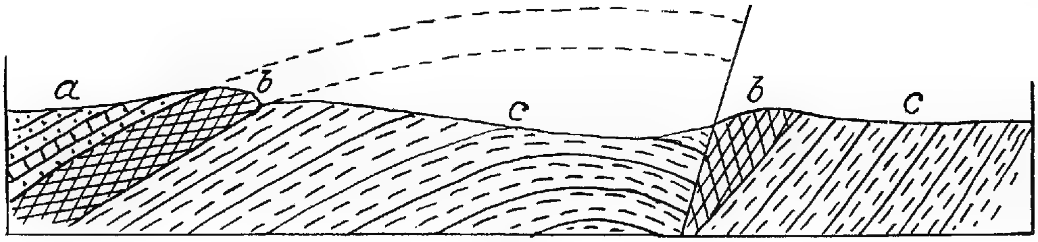

Fig. 9.
Geological Sketch-Section in Walloway Creek, between Walloway and Eurelia.
[Sketched from the train while in motion.]
(a) Purple Slates Series; *(b)* Limestone (Brighton Series);
(c) Banded Slates (Tapley's Hill Series).

Ancient Alluvium.—At a point nearly opposite the township of Walloway (Rye) the creek bed and sides are occupied by a great mass of very siliceous consolidated gravels and sands. The thickness of these beds is not shown, but they greatly exceed the dimensions of the present creek's deposits. They are seen in regular bedded masses in vertical faces up to 20 feet, and exhibit a continuous outcrop along the creek for more than a quarter of a mile. Higher up the stream they are seen to rest on the eroded edges of the Adelaide Series, and, easterly, they become obscured in the recent sandy clays of the plain.

Oladdie Hills.

The Oladdie Hills form an isolated group of highlands situated in a north-easterly direction from Walloway, at a distance of about twelve miles. Mr. Knight, of Walloway, kindly acted as my guide. The hills mentioned (lying to the eastward of the strike of the Brighton Series, that have a westerly dip in the Walloway district) gave promise of containing some of the lower members of the Adelaide Series, which proved to be the case. Following the main north-east Johnburgh road, the Oladdie Creek, which forms the main artery of drainage for the group, was passed in Section 83, Hundred of Oladdie. Taking advantage of a branch road that led to the hills, and passing up a small creek that crossed the road, the base of the hills was reached in a quarter of a mile. Here, thin-bedded calcareous and siliceous slates showed themselves with a dip to west-south-west at 25°. On reaching the second heights, about two-thirds from the top, the tillite was met with, and at the crest of the hill, hard siliceous slates and quartzites. No opportunity occurred to make a more particularized examination of the ground. Mr. Knight stated that the tillite continues in a north-easterly direction, past the Oladdie Head Station, on the eastern side of the Prince Alfred Mine, and about four or five miles on the western side of the Baratta Head Station, covering a distance of 70 miles.

ACKNOWLEDGMENTS.

The author is much indebted to the Rev. E. M. Ingamells, B.A., and the Rev. B. S. Howland, for facilities afforded in visiting the localities mentioned in this paper and for the interest they, respectively, manifested in obtaining the required geological data.

DESCRIPTION OF PLATES.

Plate VIII.

Fig. 1. North face of Depôt Hill and Faulted Block in the foreground. With the exception of the clear edge of slate, on which the camera rested, the entire view consists of Tillite.

Fig. 2. Longitudinal view of the Depôt Range (5 miles) with Faulted Block in the foregound. With the exception of the clear edge of slate, on which the camera rested, the entire view consists of Tillite.

Plate IX.

Fig. 1. Portion of Black Rock Range. Crest of "Granite Top," showing Glen Osmond Quartzite resting on Glen Osmond Lower Slates. View taken nearly parallel to the direction of strike.

Fig. 2. "Peaked Hill," situated east of Orroroo and in line with the Black Rock Range, from which it is distant seven miles. View of portion of the Tillite Outcrop.

[*Photographs by Author.*]

NOTES ON SOME SOUTH AND CENTRAL AUSTRALIAN MAMMALS.

Part I.

Petaurus breviceps, Thalacomys lagotis, Petrogale lateralis.

By H. H. Finlayson, S.A. Museum.

[Read September 11, 1930.]

1. *Petaurus breviceps*, the smallest of the Phalangeridae in which the flying membrane is sufficiently developed to permit of gliding flights of some duration, has a wide distribution throughout the eastern forest tract of Australia, from Cape York to Tasmania,(1) and as the variety *papuanus* occurs in New Guinea as well.

In the stringy-bark forests of the Portland district of Western Victoria it is plentiful, and as large tracts of very similar country are to be found in the adjacent South-Eastern district of this State, its apparent absence from, or at any rate, great rarity in, South Australia, has long been a matter of note.

On several occasions I have seen captive examples in the border towns of Frances, Naracoorte and Penola, but in each case these pets had been brought across from Victoria. It is said, by residents, to occur in the pine plantations between Penola and Mount Gambier, but whether this is so or not, Wood-Jones' statement in 1924, that "there is no definite record of it having been taken in S.A." has remained true till the present (Mammals of S.A., pt. ii., p. 194). It is satisfactory, therefore, to be able at last to report the taking of two individuals in South Australian territory, a clear 30 miles west of the Victorian border.

The first specimen (an incomplete skin), for which I am indebted to Mr. James Clifford, of Furner, was obtained in July, 1929, at the Diamond Swamp, in the Hundred of Short; and the second, for which I have to thank Mr. Walter Foster, of Naracoorte, was got at Callendale, in the Hundred of Coles, about 10 miles north of the first locality. These places are about midway between the border at Comaum and the coast at Nora Crina Bay, and both constitute small oases of big timber and grassland on one of the broadest stretches of heath in the district—a heath which extends with practically no break from this point to Penola.

The gentlemen named are both familiar with the fauna of the district, and as this is the first occasion that they have observed the animal, it appears certain that it is only just invading this country as a result of a slow westerly drift from some of its Victorian strongholds. The heath is not well suited to its habits, and this perhaps sufficiently accounts for its long confinement to the border district; a few miles further east, however, it will reach a much richer type of country, where the dwarf stringy-barks are replaced by well-grown red and blue gums, and here it may be expected to increase rapidly if it receives any tolerance from the settlers.

(1) It was introduced into Tasmania in 1835, and the general belief that it had no place in the *indigenous* fauna of the island appears to rest ultimately on the statement of Gunn, that "no species of *Petaurus* is indigenous to Tasmania" (Proc. Royal Soc. Tasmania, vol. i., p. 253, and Tasmanian Journal, vol. ii., p. 458). Whether the fauna of so rugged and inaccessible a country was sufficiently well known at the time to justify this sweeping statement, may be doubted, the more so as its distribution at present appears to be as wide as any of the undoubtedly indigenous mammals.

2. In October, 1929, the S.A. Museum received a small collection of mammals made by Mr. R. Williams, in the Musgrave Ranges, near the south-western border of Central Australia. The chief interest of the collection centres in a rabbit bandicoot which was obtained at Opparinna Spring,[2] about 50 miles north-east of Mount Woodroffe. The specimen is an aged female with partly furred pouch young, and on examination proves to be referable to *Thalacomys lagotis* (Reid).

In 1905, Oldfield Thomas (Ann. and Mag. Nat. Hist. (7), xvi., 1905, p. 426), on the evidence afforded by a specimen from Killalpaninna, on Cooper's Creek, S.A., described a new species of Bilby, somewhat closely allied to *Th. lagotis* under the name *Th. sagitta,* and in so doing he appears to have been under the impression that the new species was the South Australian representative of *Th. lagotis,* the latter being confined to Western Australia. Wood-Jones, in his comprehensive paper on the genus, in 1923 (Records of the S.A. Museum, vol. ii., No. 3, 1923), in correcting this, pointed out that the new species, *Th. sagitta,* was confined to the far northern districts of South Australia and to the centre, while *lagotis,* identical with the Western Australian animal, was the characteristic species of the "more watered and more fertile districts of the southern portion of South Australia."

As a consequence of these and other remarks derived from the latest work on the genus, it would seem to be implied, that *(a) Th. lagotis* is absent from the central districts, and *(b)* the earlier records of *Peragale lagotis,* by Baldwin Spencer and Sanger, apply to *Th. sagitta* (Thos.) rather than to *Th. lagotis* (Reid).

The Opparinna specimen (S.A. Museum, number M2569) has the following *approximate* dimensions (taken from the filled skin). Head and body, 360 mm.; tail, 200 mm.; ear, 75 mm.; pes, 90 mm. It is thus considerably smaller than the average adult female *lagotis* from Western Australia, and little larger than *sagitta.* From the latter, however, it is at once distinguished by several characters, both external and cranial. The pelage is almost exactly as in the western *lagotis,* the black portion of the tail is considerably longer than the white, and the lower surface of the pes is black throughout its posterior two-thirds.

In the skull[3] it resembles *lagotis,* and differs from *sagitta* in that *(a)* the nasals reach to within 2 mm. of the interlachrymal line; *(b)* the molar series has a rounded outline without the even posterior divergence of *sagitta;* and *(c)* the molar teeth are very large.

The large size of the molars is the most notable feature of the skull and identifies it very positively with *lagotis* since the teeth in this species, although they vary in size within rather wide limits, are always markedly larger than in any other form.

The transverse diameter of M^2 in the skull under consideration is 5·5 mm., as against 4·0 mm. for the corresponding tooth in the *sagitta* skull, measured by Wood-Jones (S.A. Museum, reg. number M.1622); an extraordinarily large difference in skulls which differ but little in basal length.

It is to be regretted that Mr. Williams was unable to obtain an adequate series of this interesting Bilby, but as the characters on which the identification

(2) Not to be confused with Opparinna Well, 75 miles south of this locality, in country traversed by the Elder Expedition.

(3) The palate has been damaged so that it is not possible to test the site of the last molar, relative to its posterior margin—a feature, held by Wood-Jones to have specific value within the genus, but which in *lagotis,* at least, appears to be rather variable and considerably influenced by age.

rests are quite pronounced, the record of this single specimen may perhaps suffice to reinstate *Th. lagotis* in a somewhat dwarfed form, as a member of the Central fauna.

3. The rock wallaby obtained by the Horn Expedition in the MacDonnell Range was assigned by Baldwin Spencer to *Petrogale lateralis* Gould, with the remark that "all the specimens seen were of the typical colouration." (Horn Expd. Report, "Mammals," p. 15.)

These specimens were obtained at Paisley's Bluff, 37 miles west of Alice Springs and 1,200 odd miles from the type locality in the Swan River district of Western Australia. From a consideration of this immense distance, and in view of the subsequent separation by Oldfield Thomas of two insular races of *Pt. lateralis,* as full species under the names *Pt. hacketti* and *Pt. pearsoni,* it seems very likely that a critical examination of adequate series of rock wallabies from the centre and south-western Western Australia, would reveal much greater differences than have so far been described. The more so as Stirling and Zietz (Trans. Roy. Soc. S.A., vol. xvi. (1892-1896), p. 155) had already noted that the rock wallabies obtained by the Elder Expedition in the Barrow Range, 450 miles west-south-west of Alice Springs, were more conspicuously marked than those from the latter place.

The material available in Adelaide is inadequate for such a comparison, and the purpose of the present note is to record certain colour variations, either subspecific or seasonal in character, which occur within a comparatively small area of the centre itself, and to draw attention to the need for a complete revision of the species, by those who possess material from the type locality.

In August of last year, while acting as a member of the Adelaide University Anthropological Expedition to Hermannsberg, Mr. H. M. Hale obtained for the S.A. Museum a series of five skins and skulls of rock wallabies which had been brought in by the blacks from Koporilya Spring, 10 miles west-south-west from the Mission Station. These skins, while showing the characteristic markings of *lateralis,* are distinguished at once by the strikingly parti-coloured nature of the dorsal surface; the contrast between the light areas of the neck and shoulders on the one hand, and dark lumbar area on the other, being much enhanced from what usually obtains.

When compared with skins taken at Alice Springs and Simpson's Gap (80-100 miles east), the following differences are noticeable. On the neck and shoulders the colour is a clear ashy grey, free from any fulvous suffusion, and markedly grizzled by the presence of a white sub-terminal band on the guard hairs. The fur is harsher and less silky in texture on these parts, and recalls somewhat the condition in the *penicillata* group.

The colour of the lower back varies slightly in the different skins, but in the darkest (M.2683) it is a dull purplish-brown (near Ridgway's Carob Brown), and in all is very different from the luminous fawny brown hues of the more easterly skins. The axillary patch, and the nuchal, loreal and lateral stripes are individually more strongly developed, but in a general view the skin appears sombre. The tail is darker throughout its length, and for its distal half is quite black above and below—much as in *hacketti* but with shorter brush hairs. The carpus and metacarpus are yellowish-brown and strongly contrasted with the much darker digits; in the Alice Springs material the whole of the manus is a dull uniform brown with little differentiation of the digits. On the other hand, the pes in the Koporilya specimens is darker and the terminal ungual tuft not conspicuously contrasted with the toe.

The skulls are those of males, and the four which are undamaged are from very old individuals in which the fourth molar has undergone considerable wear and is 5 mm. or more in advance of the posterior margin of the palate. For comparison with this material, a series of seven skulls in a similar dental stage has been available, derived from Alice Springs and Simpson's Gap, and the mean value of the chief cranial measurements is appended. The Alice Springs skulls, unfortunately, are incompletely sexed, and most of the discrepancies which this comparison brings to light are probably assignable to this cause. Although the Koporilya skulls are uniformly large and heavy, a detailed comparison, point for point, fails to give any indication of structural differences of importance, and the largest males of each series are in very close agreement (see table).

There is, thus, no question of more than subspecific differences involved, and since the more westerly skins were taken in August and the easterly in October, it is possible that the differences in pelage noted may represent the extremes due to a seasonal change. Oldfield Thomas refers in several papers to the "bleached" or "faded" condition of certain rock wallaby skins, but no change so marked as that which is dealt with herein appears to have been previously described.

Skull Dimensions of *Petrogale lateralis* (in millimetres).
(Aged individuals only; P^4 and M^4 in place.)

	Mean of Four Koporilya Skulls (♂).	Mean of Seven Alice Springs and Simpson's Gap Skulls ♂ + ♀.	Largest Koporilya ♂ M. 2682 S.A. Mus.	Largest Alice Springs ♂ M. 1813 S.A. Mus.
Greatest length	104	96	107	107
Basal length	92	86	94	96
Zygomatic breadth	54·6	52·5	54·5	53
Nasals length	48	43	50·5	49
Nasals greatest breadth	14	13	14	14
Depth of muzzle	16	14·3	16·5	18
Constriction	12	11·7	13	12
Palate length	61	57	62	61·5 (ca)
Palate breadth inside M^2	16·6	16	16·5	17
Palatal foramina	5·4	6	5·5	5·5
Diastema	18	16·8	19·5	19
Basicranial oxis	28	27	28·5	30·5
Basifacial oxis	67·4	59	68·5	68
Facial index	239	221	240	222
Molars 1–3	16·7	16·6	16·0	15 (ca)
P^4	7·0	6·5	7·0	7·0

Two individuals, measured in the flesh by Mr. Hale, gave the following results:—

	Head and Body.	Tail.
M. 2682	546 mm.	495 mm.
M. 2683	559 mm.	584 mm.

ABSTRACTS OF THE PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

(Incorporated)

FOR THE YEAR FROM NOVEMBER 1, 1929, TO OCTOBER 31, 1930.

ORDINARY MEETING, NOVEMBER 14, 1929.

The VICE-PRESIDENT (Dr. Charles Fenner) in the chair, and 27 Members present.

Minutes of the Annual Meeting were read and confirmed.

CORRESPONDENCE—

A letter of acknowledgment from the President (Dr. L. Keith Ward), thanking Fellows for having re-elected him as President for a further term, was read.

A letter from the Secretary, Department of Home Affairs, Commonwealth of Australia, stating that free transport to the value of £25 was granted over the Commonwealth railways for foodstuffs, for the aborigines of the Hermannsberg district, was read.

MOTIONS—

Mr. Roach moved, and Mr. Bailey seconded: "That the name of the Acting Honorary Secretary, Mr. Ralph W. Segnit, be forwarded to the Savings Bank of S.A. for the purpose of operating on the Society's Account." Carried.

Mr. Kimber moved: "That this Society records its great appreciation of the action of the Board of Governors in purchasing the splendid collection of shells of the late W. L. May, of Tasmania." Mr. Kimber said that we are aware that this State is very fortunate in having such a generous citizen as Sir Joseph Verco, who assisted so liberally in defraying the cost of the May collection. Our obligations to Sir Joseph have been added to recently, as he has purchased and presented to the Museum the very fine collection of the late Messrs. W. T. Bednall and E. H. Matthews. These collections, in addition to that invaluable one of Sir Joseph's, are now in the National Museum, and make our conchological collection a very valuable one.

The CHAIRMAN extended an invitation to the Fellows of the Society, on behalf of the President of the Royal Geographical Society of Australia (S.A. Branch), to be present at a lecture to be delivered by Mr. C. T. Madigan, on December 2, in connection with his recent Air Survey Expedition over part of Central Australia.

ELECTION OF FELLOW.—Worsley C. Johnston, Government Agricultural Inspector, Riverton. A ballot was taken and Mr. Johnston was declared elected.

NOMINATION AS FELLOW.—Rev. Napoleon Henry Louwyck, Minister of Religion, The Rectory, Yankalilla, was received.

PAPER.—"Notes on Australian Polyplacophora, No. 1, by EDWIN ASHBY, F.L.S., M.B.O.U., and BERNARD C. COTTON.

EXHIBITS.—Mr. RALPH W. SEGNIT exhibited an Ivory Gull, *Pagophila eburnea,* which he collected in Ice Fiord, Spitzbergen, during the Oxford University Expedition to Spitzbergen in 1921. Mr. ARTHUR M. LEA exhibited two drawers of very interesting insects recently obtained from Papua. They included some of the largest and most remarkable species from that little-known country. The Rev. J. C. JENNISON exhibited some artifacts from an aboriginal camp site near Baldina Creek, Burra district, S.A. He said that the collection, numbering 50 specimens, included chipped-back knives, so-called "spear heads," scrapers and drills. The whole region, apparently for miles along both banks of Baldina Creek, above and below the spring at the Broken Hill road crossing, though stony ground, had been used as camp sites. The enormous quantities of stone implements scattered everywhere is evidence of the use of this place as a camp area for a very long period. Mr. A. E. EDQUIST exhibited a seedling mallee, three years of age. The specimen showed the development of the swollen stem, commonly known as "mallee root." The mallee root is really a swollen portion of the stem from which branches grow in a ring. The specimen was grown from seed collected from Kangaroo Island.

Mr. A. A. SIMPSON then moved that this Society communicate with the Minister of Railways, requesting that a list of the protected fauna be placed in all railway stations in South Australia for the information of the public. The motion was seconded by Dr. Morgan, and carried unanimously.

The CHAIRMAN announced that a satisfactory agreement had been reached with reference to the use of part of the central room, between this Society and the Royal Geographical Society of Australia (S.A. Branch).

Dr. T. D. CAMPBELL put forward a suggestion that one or two meetings in the year be devoted to special subjects, with a view to encouraging discussions. Dr. T. D. Campbell then moved, and Mr. Arthur M. Lea seconded, that this matter be placed before the Council. Carried.

ORDINARY MEETING, APRIL 10, 1930.

THE PRESIDENT (Dr. L. Keith Ward) occupied the chair, and 41 Members were present.

Minutes of the Ordinary Meeting, held on November 14, 1929, were read and confirmed.

THE PRESIDENT referred to the irreparable loss caused by the death of Professor T. Brailsford Robertson. He said Professor Robertson was a most distinguished investigator, his genius being directed towards the solving of some of the most important national problems. His decease left Australia much the poorer.

THE PRESIDENT then referred to the successful return of the "Discovery" from the Antarctic, and on behalf of the Society congratulated Sir Douglas Mawson, a former President, and Professor T. Harvey Johnston, Vice-President of the Society, on their successful trip. They would await with interest the scientific results of the expedition, confident that they would fully justify the arduous work which had been undertaken.

The attention of the Fellows was then directed to the Rules governing the presentation of papers to the Society for reading. The President laid special stress on the "Suggestions to Authors," and the time of lodging the papers for consideration by the Council.

THE RESIGNATION OF THE SECRETARY (Dr. R. H. Pulleine) was placed before the Fellows and accepted. Nominations were then called to fill the vacancy. Mr. B. S. Roach nominated, and Dr. R. H. Pulleine seconded, the name of Mr. Ralph W. Segnit. There being no other nomination, the President declared Mr. Segnit elected.

THE SECRETARY read a notice received from the Secretary of the A.A.A.S., requesting that delegates be appointed for the meeting to be held in Brisbane from

May 28 to June 4, 1930. Dr. Charles Fenner moved, and Dr. R. H. Pulleine seconded, that Mr. Ernest H. Ising and Mr. C. S. Piper, M.Sc., be elected delegates. Carried.

The President referred to correspondence received from the Secretary of the Royal Society of Victoria, relating to a conference to be held at the Brisbane meeting of the A.A.A.S., to discuss the advisability of the federation of the Royal Societies of Australia, and asking for two delegates to be appointed. It was agreed that two delegates be appointed, and that they report the result of the conference to the Society at a later date. Dr. R. H. Pulleine moved, and Mr. B. S. Roach seconded, that the President (Dr. L. Keith Ward) and Dr. Charles Fenner be elected delegates. Carried.

The President said that the suggestion brought forward by Dr. T. D. Campbell to hold one or two meetings a year for the purpose of discussion on selected subjects, had been referred to the Council, who recommended the suggestion to the Members and had set aside the May Ordinary Meeting for the purpose. Dr. T. D. Campbell then gave a brief outline of his idea. The subject would be "The Antiquity and the Primitiveness of Man in Australia," and would be taken up in the form of four short lecturettes.

Election of Fellow.—Rev. Napoleon Henry Louwyck, Minister of Religion, The Rectory, Yankalilla. A ballot was taken and Napoleon Henry Louwyck was declared elected.

Papers—

"The Major Physiographic Features of South Australia, by Charles Fenner, D.Sc.

"Additions to the Flora of South Australia, No. 28," by J. M. Black. In the absence of the author this paper was read by Mr. J. G. Wood, M.Sc.

"Physiological and Mental Observations on the Australian Aborigines," by R. H. Pulleine, M.B., Ch.M., and Professor H. H. Woollard, M.D.

"Physiological and Psychological Observations on the Australian Aborigines, Parts I.-V.," by H. K. Fry, D.S.O., M.B., B.S., B.Sc.

Ordinary Meeting, May 8, 1930.

The President (Dr. L. Keith Ward) occupied the chair, and 69 Members and visitors were present.

Minutes of the Ordinary Meeting held April 10, 1930, were read and confirmed.

The President read a letter received from the local Secretary of the Council for Scientific and Industrial Research relating to the Catalogue of Scientific and Technical Periodicals in Australian libraries.

The President referred to the passing by death of Francis H. Snow—a Fellow of this Society.

Nomination as Fellow.—Una Hayston Mitchell, B.Sc., School Mistress, Presbyterian Girls' College, Glen Osmond, was read.

Paper.—"Contributions to the Orchidology of Papua and Australia," by R. S. Rogers, M.A., M.D.

Composite Lecture.—"The Primitiveness and Antiquity of Man in Australia." Four very interesting and instructive lectures were delivered by:—

Dr. L. Keith Ward gave an account of "Earliest Man and his probable Entrance into Australia by way of the Islands to the North and North-west of Australia," and exhibited charts and diagrams showing the geological age as determined by various authorities of his entry.

Dr. Charles Fenner gave a summary of the "Earliest Known Relics."

Dr. T. D. Campbell gave an account of the "Human Remains" found in Australia, for which antiquity has been claimed, and exhibited a cast of the Talgai skull.

Mr. N. B. Tindale gave a brief summary of the latest views on the "Cultural Status of the Aborigines," illustrating his remarks by a series of original diagrams depicting the distribution of various ethnological phenomena.

The President thanked the lecturers for their very interesting addresses, and expressed regret that time did not allow for any discussion, and declared the meeting closed at 10.15 p.m.

Ordinary Meeting, June 12, 1930.

The President (Dr. L. Keith Ward) occupied the chair, and 36 Members and visitors were present.

The Minutes of the Ordinary Meeting, held May 8, 1930, were read and confirmed.

The President referred to the presentation to the Society of two volumes, "Tomb of Tutankhamen," by the Rev. Henry Louwyck, and asked that the thanks of the Society be recorded for the gift.

Motions—

It was proposed by Mr. B. S. Roach, seconded by Mr. W. H. Selway, that a letter of congratulation be sent to Professor J. R. Wilton on having the high honour of the Sc.D. degree conferred on him by the University of Cambridge, and that the same be recorded in the minutes. Carried.

Professor T. Harvey Johnston moved, and Professor J. A. Prescott seconded, that the congratulations of the Society be tendered to Sir Douglas Mawson on being the recipient of the Mueller Medal from the A.A.A.S., and that the same be recorded in the minutes. Carried.

The President then expressed the sincere thanks of the Society to the Secretary, Mr. Ralph W. Segnit, for the improvements to the lay-out and lighting of the Society's rooms. Great credit was due to Mr. Segnit, both as to the conception and the way in which the work had been carried out. Carried with acclamation.

Election of Fellow.—Una Hayston Mitchell, B.Sc., Presbyterian Girls' College, Glen Osmond. A ballot was taken, and the President declared Miss Mitchell duly elected.

Nominations as Fellows.—Frank Vernon Collins, B.V.Sc., Commonwealth Veterinarian, Green Road, Woodville; Thomas Talbot Colquhoun, M.Sc., Lecturer and Demonstrator in Botany, Adelaide University; Frederick John Hall, Engineer, Adelaide Electric Supply Coy. Ltd., Adelaide; Garth Palmer Ockenden, Student, 11 Ailsa Street, Fullarton Estate; Professor Herbert John Wilkinson, B.A., Ch.M., M.D., University of Adelaide.

Papers—

"Notes on the Flora North-west of Port Augusta, between Lake Torrens and Tarcoola," by J. Burton Cleland, M.D.

"An Analysis of the Vegetation of Kangaroo Island and the Adjacent Peninsulas," by J. G. Wood, M.Sc.

Exhibits.—Mr. Arthur M. Lea exhibited species of the prickly pear moth, *Cactoblastis cactorum*, received from Mr. A. P. Dodd, with some photographs showing how prickly pears were completely destroyed by it. Also, some remarkable Orthopterous insects from a cave on Flinders Island (Bass Strait), received from Mr. H. H. Finlayson, and some sheet lead which had been used on underground telephone cables, showing the destructive work of white ants. Mr. Edwin Ashby exhibited roots of *Arum aroidea*.

Ordinary Meeting, July 10, 1930.

The President (Dr. L. Keith Ward) occupied the chair, and 56 Members and visitors were present.

Minutes of the Ordinary Meeting, held June 12, 1930, were read and confirmed.

Sir Joseph Verco Medallist.—The President then addressed the Members as follows:—

"The most pleasing of the duties which must be performed by the Council of this Society is the selection of one of its Fellows for the award of the Sir Joseph Verco Medal for distinguished scientific work. The time has come for the submission to the Society of the name of the second recipient.

"The choice of the Council has been unanimous, and has fallen on one of its senior Fellows who is not at present in South Australia, but who is representing this Society at an important conference in Great Britain. I refer to Mr. John McConnell Black, who is a Fellow of many years' standing, and at the present time a member of the Council.

"In submitting his name to the Society for its verdict, your Council would have me express its deep appreciation of the service to science, and to the State, by Mr. Black, whose wise counsel has been available at all times to the Society in its corporate capacity, and to the many individual Fellows who have had occasion to consult him.

"Mr. Black is a man of many parts. Educated in Scotland, England, and Dresden, he came to Australia in 1877 and engaged in farming in the Baroota district for the next five years. For the following 20 years he was on the literary staff of the Adelaide Press, and, after withdrawing from this work, concentrated his energy mainly upon the study of the systematic botany of South Australia. But he has not neglected the claims of literature to which his early training and more mature study have held him captive. An accomplished linguist, he is an authority on the structure of languages generally.

"Mr. Black's contributions to the Society have been distinguished for the modesty with which they have been presented as for their crisp clarity. His labours have been such that they have been completed but for a strong sense of devotion to science and fine ideals. To him the achievement of his aims has certainly been a great reward. But your Council asks you to record the appreciation of the value of this work to science by the award of the highest honour at your disposal.

"At the moment Mr. Black is representing this Society at a conference convened in Cambridge to deal with botanical nomenclature, and we are fortunate in having so distinguished a representative.

"At the desire of the Council, I am asking the Director of the Botanical Gardens (Mr. J. F. Bailey) to address you with regard to Mr. Black's contributions to botany, and I am asking a former President of this Society, who is himself a foremost authority on the orchids of Australia, Dr. R. S. Rogers, to support the proposal."

Mr. J. F. Bailey said:—

"Mr. President.—It affords me much pleasure to propose to the Members that the decision of the Council in recommending that the Sir Joseph Verco Medal be awarded to John McConnell Black be adopted.

"Mr. Black has always taken a keen interest in botanic nomenclature, and is at present in England with the object of attending the International Botanic Nomenclature Congress to be held in Cambridge next month, as the Australian representative on the Committee.

"It is scarcely necessary for me to remind the Members of the great amount of work carried out by Mr. Black in making known the flora of this State, for in this connection his name has been prominently before the Society for many years.

"In recognition of his services in the cause of botany, the Council of the Adelaide University appointed Mr. Black as Honorary Lecturer in Botany at that institution.

"In 1909 Mr. Black published an illustrated work on "The Naturalized Flora of South Australia," and this has been of great value to the man on the land, as it deals with many of the weeds with which he has to contend.

"Mr. Black has visited many parts of this State at his own expense in pursuit of material for his favourite study, and the results of his investigations have, from time to time, been embodied in papers presented to this Society and published in its Proceedings. During some of these journeys Mr. Black, who is an expert linguist, acquired a knowledge of native languages in certain districts which enabled him to compile the vocabularies to be found in the Proceedings of this Society. By this means he obtained much useful information regarding the uses to which certain plants were applied by the aborigines.

"When the South Australian Branch of the British Science Guild arranged for the publication of handbooks on scientific subjects relating to South Australia, it was only natural that Mr. Black's aid should be sought to prepare the one on the flora. This huge task he willingly agreed to undertake, and last year the fourth and last part was issued. In this publication the author has not only described many new species, but has compared, and in many cases augmented, the descriptions of those already brought under notice by other botanists, and these factors have combined in giving to the botanic world a publication that is proclaimed as the standard work on the State's flora. While referring to this work, it is but fair to add that the section devoted to Orchidaceae was entrusted to, and ably treated by our friend Dr. R. S. Rogers, one of our former Presidents, and who is the recognised Australian authority on this family of plants.

"Not only do we respect and esteem Mr. Black for his work in the realm of botany, but also for his willingness at all times to give freely from his vast store of knowledge to those seeking his advice on the subject. Our friend also possesses the charm of endearing himself to those with whom he comes in contact.

"It is, therefore, fitting that the Members recognise Mr. Black's merit by awarding him this coveted medal, and I have pleasure in again proposing that this course be adopted."

Dr. R. S. Rogers, in seconding the motion, said:—

"The people of South Australia are deeply indebted to Mr. Black for the elucidation of their flora, a purpose to which he has devoted nearly thirty years of his life.

"At first his scientific researches were chiefly directed to the alien plants of this country, and his "Naturalised Flora of South Australia" (1909), the first of its kind available in the Commonwealth, is an excellently conceived and well executed handbook of great economic importance.

"Since his election as a Fellow of this Society (1907), he has contributed 28 botanical papers, and has added to our census upwards of 100 new plants.

"During the seven years, 1922-1929, he devoted practically the whole of his time and energies to a critical review of the indigenous flora of this State, and as a result of his researches, has presented us with an exhaustive handbook of the "Flora of South Australia"; modern in its treatment and generously illustrated with his own drawings. This work, which contains many original features, has evoked the praise of critics throughout the botanical world. I venture to predict that it will be the standard work of reference for at least the next 50 years."

The motion was supported by Professor T. Harvey Johnston, and then put to the meeting, and the President declared that the motion was unanimously carried.

The President then read a letter received from Sir Joseph Verco in connection with the making of this award.

ELECTION.—A ballot was taken and the following were declared duly elected as Fellows:—Frank Vernon Collins, B.V.Sc.; Thomas Talbot Colquhoun, M.Sc.; Frederick John Hall; Garth Palmer Ockenden.

NOMINATIONS.—The following nominations for Fellows were read:—Lewis George Morris, Optometrist, Beehive Building, King William Street, Adelaide; Albert James Whitelaw, School Teacher, c/o Norwood High School, Kensington; Edward Victor Dix, Civil Servant, Glynde Road, Firle; Walter Richard Birks, B.Sc., Principal, Roseworthy Agricultural College; Stephen Denis Garrett, B.A., Plant Pathologist, Waite Agricultural Research Institute, Glen Osmond; Professor Herbert John Wilkinson, B.A., M.D., Ch.M., University, Adelaide.

LECTURETTES.—"Fossil Man in the Murray Valley?" Five lecturettes on some researches and excavations at Tartunga and Devon Downs, illustrated with lantern slides and exhibits, were presented by:—

MR. H. M. HALE, who gave a "Resumé of the Investigations."

MR. N. B. TINDALE dealt with the "Human Remains and Associated Artifacts," and on behalf of Dr. T. D. Campbell, some "Dental Notes."

DR. CHARLES FENNER described the "Physiographic Aspect."

MR. H. H. FINLAYSON described the "Mammal Remains."

In the discussion which followed, PROFESSOR W. HOWCHIN made reference to the thorough manner in which the investigations had been carried out, and said that it stands as one of the finest efforts put forward in Australia in connection with this subject. He agreed that antiquity can be claimed for the results presented, and suggested that in lieu of the term "distinct cultures," as used by Mr. Hale and Mr. Tindale, the term "different series of occupation" be substituted.

DR. R. PULLEINE referred to the remark made by Mr. Finlayson, that some doubt existed as to whether the early aborigines had used the so-called Tasmanian Devil *(Sarcophilus)* as food, and referred to the collection of materials he had brought back from Tasmania, in which were bones of the mammal, some burnt and charred, and included evidence that the early Tasmanians had probably used this animal as food.

THE PRESIDENT congratulated the investigators on their very interesting and important work, and said that the geologist had great difficulty in determining the exact "time factor" in connection with the geological deposits. The results were an example of good co-ordination and teamwork in scientific investigations, and equalled any similar work carried out in Europe. Dr. Ward expressed the sincere thanks of the Society to the Lecturers for offering such a splendid contribution towards the evening's meeting.

ORDINARY MEETING, AUGUST 14, 1930.

THE PRESIDENT (Dr. L. Keith Ward) occupied the chair, and 20 Members were present.

Minutes of the Ordinary Meeting, held on July 10, 1930, were read and confirmed.

The President informed the Members that he had sent a cable to Mr. J. M. Black, notifying him that he had been awarded the Sir Joseph Verco Medal by this Society, and having received a cable reply thanking the Fellows for the honour conferred.

The President then expressed the appreciation of the Members of this Society of the honour conferred on Mr. J. M. Black on his having been elected an Associate of the Linnean Society of London.

Ballot as Fellows.—A ballot was taken, and the following were declared duly elected by the President:—Professor Herbert John Wilkinson, B.A., M.D., Ch.M.; Lewis George Morris; Albert James Whitelaw; Edward Victor Dix; Walter Richard Birks, B.Sc.; Stephen Denis Garrett, B.A.

Nominations as Fellows.—The following nominations were read:—Jack Sargent Hosking, B.Sc., Assistant Chemist, Waite Agricultural Research Institute, 90 Cross Roads, Myrtle Bank; Anne Irene McFadyen, B.Sc., Teacher, Walford House School, Unley.

Paper.—"On Some Coleoptera from Northern Australia. Collected by Dr. H. Basedow," by Arthur M. Lea, F.E.S.

Exhibits.—Mr. Arthur M. Lea exhibited a drawer of Orthoptera from New Guinea, including some Katydids with remarkable leaf-life wings and some walking-stick insects nearly one foot in length. Professor T. Harvey Johnston exhibited two whale-darts, and a whaling-bomb, and gave an interesting account of their uses in connection with the whaling industry in the Antarctic waters. Dr. Charles Fenner exhibited a series of volcanic bombs from Buninyong, Victoria, and two somewhat exceptional examples of glaciated rocks of the Pleistocene from Western Tasmania. The President said that it was possible to obtain from some places boulders having two sets of glaciated markings, one set being from a later period of glaciation than the first, and in answer to Mr. Lea gave a brief account of the latest researches in connection with the obsidian bombs found in Central Australia. Dr. T. D. Campbell exhibited a series of deciduous teeth taken from the native rock shelter floor excavated by Messrs. Hale and Tindale. Along with these were the corresponding deciduous teeth of an orang-outang, and of modern white children. The Australian infants' teeth showed extraordinary pithecoid characteristics with regard to size and form.

The President exhibited the following:—

Stichtite, a chromiferous magnesium hydroxycarbonate, occurring as irregularly shaped masses, veins and blebs in serpentine at Dundas, Tasmania, in the neighbourhood of the Adelaide mine. Weathered surfaces are dark brown, but the fresh mineral ranges in colour from lilac to deep purple. The mineral is built up of radiating tufts and plates about crystals of chromite. It is allied to hydrotalcite, pyroaurite and brugnatellite. The name was given in complimentary reference to the late S. Sticht, General Manager of the Mount Lyell mine.

Rodingite, a rare rock from the Dun Mountain, near Nelson, in New Zealand, occurring in the form of dykes which penetrate the dunite which is an ultrabasic igneous rock composed almost wholly of granular olivine. Rodingite consists essentially of greenish-white grossularite (lime-alumina garnet) and diallage; and the grossularite is in many places altered to prehnite. Bell, Clarke and Marshall, who determined the rock, regard it as a differentiation product of the peridotite; rather than as the result of the assimilation of limestone by the magnesian magma.

Dunite, from the Dun Mountain, Nelson, New Zealand, consisting essentially of olivine, with which a little chromite is associated.

Ribbon-stone, a variety of banded flint, composed largely of granular chalcedony together with some opal. Found on the surface of the Cambrian limestone of North Australia, whence it has been set free by weathering. Some specimens exhibit a very deep patina, others are polished by drifting sand and show the typical desert varnish.

Ozokerite, natural wax from a depth of 6,000 feet in the Springleigh bore, Queensland, which has a total depth of 7,008 feet.

Petrol, condensed from natural gas at a depth of 3-7,000 feet at Roma, Queensland.

Crude Petroleum, from Taranaki, New Zealand.

Stellite is an alloy composed essentially of cobalt, chromium and tungsten, which was discovered as a direct result of research carried out with the object of finding a use for the cobalt of Ontario. On the development of the rock silver ores found in 1903 at Cobalt, 330 miles north of Toronto, stocks of the metal cobalt accumulated and could not be disposed of for the manufacture of pigments and special steels. Systematic investigations resulted in the production of this alloy, which is used to a small extent in the preparation of rustless cutting tools, but extensively to replace high-speed tool steels. Stellite will retain its hardness almost to bright red heat—a temperature far above that at which steel softens. On cooling, the heated stellite retains its hardness. It cannot be annealed and cannot be machined except by grinding. Stellite, on account of its extraordinary resistance to abrasion, is used today on the teeth of calyx boring bits. The stellite is applied by the process of welding with the oxy-acetylene flame, which causes the fusion of the alloy and the steel at, approximately, the same temperature (2,336° F). A boring bit, the teeth of which are armed with stellite, was exhibited, as well as a rod of the alloy itself. Bits armed in this manner are in use by the Department of Mines of South Australia.

Ordinary Meeting, September 11, 1930.

The President (Dr. L. Keith Ward) occupied the chair, and 30 Members were present.

Minutes of the Ordinary Meeting, held August 14, were read and confirmed.

Elections.—Jack Sargent Hosking, B.Sc., and Anne Irene McFadyen, B.Sc., as Fellows. A ballot having been taken, the President declared them duly elected.

Nomination.—James Tinsley Gray, Pharmacist, Orroroo, as Fellow.

Papers—

"The Geology of Orroroo and Surrounding District," by Professor Walter Howchin, F.G.S.

"Notes on Some South and Central Australian Mammals," by H. H. Finlayson.

"Descriptions of Australian Resupinate Hydnaceae," by E. M. Wakefield, Communicated by Professor J. B. Cleland, M.D.

Exhibits.—Mr. Arthur M. Lea exhibited a drawer of weevils from New Guinea of the sub-family Brachyderinae, many of which were brilliantly coloured. Mr. C. T. Madigan exhibited specimens of fossilized vegetables, which were presented to him by Mr. O'Grady, Arltunga, and said they were obtained from a place about 7½ miles E.S.E. from the Battery of Arltunga Goldfields. The President said the specimens were of a fossilized fern, which he thought came from Paddy's Plain, between Bitter Springs Gorge and Arltunga Goldfields. Professor Walter Howchin suggested that one of the specimens was *Osmundites,* related to the existing "Royal Fern" *(Osmunda),* of which better specimens had been obtained from the interior, probably from the "Desert Sandstone."

ANNUAL MEETING, OCTOBER 9, 1930.

THE PRESIDENT (Dr. L. Keith Ward) occupied the chair, and 24 Members were present.

Dr. D. S. DAVIDSON, of Pennsylvania University, who is studying the Australian Aborigines in Northern Australia, was welcomed as a visitor by the President.

Apologies were received from Professor J. A. Prescott and Mr. H. M. Hale.

Minutes of the Ordinary Meeting, held September 11, 1930, were read and confirmed.

THE SECRETARY presented the Annual Report for the year 1929-1930. The adoption was moved by Dr. T. D. Campbell, and seconded by Rev. J. C. Jennison, and carried.

THE TREASURER (Mr. B. S. Roach) presented the BALANCE-SHEET. The adoption was moved by Dr. Chas. Fenner, seconded by Mr. Bailey, and carried. The President expressed the thanks of the Society to Mr. Roach for the valuable services he had rendered to the Society as the Hon. Treasurer.

ELECTION OF OFFICERS FOR THE YEAR 1930-31.—Nominations were called and the following elected:—*President*, Dr. Charles Fenner; *Vice-Presidents*, Professor T. Harvey Johnston, M.A., D.Sc., and Professor J. A. Prescott, M.Sc., A.I.C.; *Secretary*, Mr. Ralph W. Segnit, M.A., B.Sc.; *Treasurer*, Mr. B. S. Roach; *Editor*, Professor Walter Howchin, F.G.S.; *Members of Council*, Mr. A. M. Lea, F.E.S., Mr. J. F. Bailey, Mr. C. T. Madigan, M.A., B.Sc.; *Auditors*, Mr. W. C. Hackett and Mr. O. Glastonbury.

Mr. James Tinsley Gray, Pharmacist, Orroroo, was elected a Fellow of the Society.

Mr. James Irvine Miller, C.E., Crystal Brook, S.A., was nominated as a Fellow.

THE PRESIDENT, on behalf of the Society, expressed the hope that Sir Douglas Mawson and Professor T. Harvey Johnston would enjoy health and success in connection with the second cruise of the Australian and New Zealand Antarctic Expedition.

Dr. R. LOCKHART JACK received the congratulations of the Society on having had the D.Sc. degree conferred on him by the University of Adelaide.

A letter received from Mr. J. M. BLACK was read, expressing appreciation for the honour conferred on him by this Society in awarding him the Sir Joseph Verco Medal for 1930.

EXHIBITS.—Professor WALTER HOWCHIN exhibited the vertebra of an Ichthyosaurian from the so-called "coprolite bed" near Cambridge, England. The vertebra can be distinguished, partly, by its large size, the *Ichthyosaurus* being the largest of all the sea-going reptiles during the Mesozoic Era; also on account of its narrowness and biconcave shape. It was a very powerful swimmer, with a voracious habit. They existed in Australasian seas, as their remains are found in the Trias of New Zealand and the Cretaceous of Australia. One nearly complete skeleton, found at Marathon, Queensland, measures 25 ft. in length. Professor Howchin also showed an Ichthyosaurian coprolite. It has become a habit to call all phosphatic nodules "coprolites," many of which are of concretionary origin, but the specimen exhibited is a true coprolite, showing the twist of the gut and the polished enamelled scales of the ganoid fishes on which the reptile had dined, embedded in the faecal matter. Dr. T. D. CAMPBELL exhibited some pebbles and shell fragments collected on the sandy beach of Franklin Island. They presented a highly polished surface, as if they were varnished. Other unpolished stones from the same locality were shown. The President suggested that the polish was a "phosphatic film" covering the pebbles. Mr. ARTHUR M. LEA exhibited two drawers of beetles of the family "Tenebrionidae," mostly from

New Guinea and Fiji, many of which were closely allied, if not identical, with Queensland species. Also two species of remarkable gall insects of the genus *Apiomorpha,* one of which constitutes an important article of aboriginal food; and a striking mantis *Idolum diabolicum* from the Anglo-Egyptian Soudan, sent by the Rev. D. N. McDiarmid and presented by Sir Joseph C. Verco. Mr. N. B. Tindale exhibited some native foods from MacDonald Downs, Central Australia. Two species of grass seeds accumulated by a small species of ant are gathered by the Iliaura natives, winnowed, ground, and cooked as a rough cake in the ashes. Also the honey of a native bee *(Trigonia)* much relished by the natives. Mr. Tindale also showed a photograph of a native relief map, voluntarily made by an Iliaura native to demonstrate the positions of various waterholes and hills in his country; and a series of photographs showing a native preparing the seed-cake. Mr. C. T. Madigan exhibited a fossilized log of wood from the Waterhouse Ranges, south of Alice Springs, and the largest stone axe in Australia, measuring 10 inches by $8\frac{1}{2}$ inches, from Birdsville; and the smallest stone axe from an australite made by a native child.

ANNUAL REPORT

FOR THE YEAR ENDED SEPTEMBER 30, 1930.

The average attendance of Fellows at the meetings held during the year has been 39.

The President, Dr. L. Keith Ward, received the congratulations of the Society on his having been awarded the W. B. Clarke Medal by the Royal Society of New South Wales.

Sir Douglas Mawson and Professor T. Harvey Johnston were welcomed and congratulated by the Society on their safe return from the first cruise of the Antarctic Expedition.

Professor J. R. Wilton received the congratulations of the Society on his having had the Sc.D. degree conferred on him by the University of Cambridge.

During the year Dr. Robert Pulleine tendered his resignation as the Honorary Secretary of the Society, and Mr. Ralph W. Segnit was elected to the vacancy.

Mr. J. M. Black, a member of the Council, was granted leave of absence to enable him to visit England and the Continent. During his absence the Fellows of the Society awarded him the Sir Joseph Verco Medal for 1930.

Sir Douglas Mawson received the congratulations of the Society on being the recipient of the Mueller Medal from the Australian and New Zealand Association for the Advancement of Science.

Mr. J. M. Black has been elected an Associate of the Linnean Society of London.

The Board of Anthropological Research, Adelaide University, sent another expedition to the Interior. The following Fellows of the Society accompanied the expedition:—Professor T. Harvey Johnston, Dr. R. Pulleine, Professor J. B. Cleland, Dr. T. D. Campbell, Mr. Herbert M. Hale, Mr. N. B. Tindale, Dr. H. K. Fry, and Professor H. J. Wilkinson.

Mr. Frederick Chapman, an Honorary Fellow, received the congratulations of the Society on being the recipient of the Lyell Medal from the Geological Society of London.

A re-arrangement in the layout of the Society room and improvements to the lighting were effected during the year, and a new set of book shelves purchased for the library. The use of half the Central Room in conjunction with the Royal Geographical Society of Australasia (S.A. Branch) is much appreciated.

During the year two of the Ordinary Meetings were devoted to special subjects, in the form of Anthropological lectures, which were largely attended. The first was a composite lecture dealing with "The Primitiveness and Antiquity of Man in Australia." The following Fellows read short papers:—Dr. L. Keith Ward, Dr. Charles Fenner, Dr. T. D. Campbell, and Mr. N. B. Tindale. The second subject was entitled "Fossil Man in the Murray Valley," at which the following Fellows contributed short lectures:—Mr. Herbert. M. Hale, Mr. N. B. Tindale, Dr. Charles Fenner, Dr. T. D. Campbell, and Mr. H. H. Finlayson.

Geological papers were contributed by Dr. Charles Fenner and Professor Walter Howchin.

Zoological papers were read by Edwin Ashby, H. H. Finlayson, and Arthur M. Lea.

Botanical papers were presented by J. M. Black, Dr. R. S. Rogers, Professor J. B. Cleland, J. G. Wood, and Miss E. M. Wakefield, her paper being communicated by Professor J. B. Cleland.

Anthropological papers were read by Dr. H. K. Fry, Dr. Robert Pulleine. and Professor H. H. Woollard.

The membership of the Society shows a slight increase. Fellows elected during the year, 15; 6 Fellows resigned, 4 died, and 1 was removed. The membership roll at the close of the year is as follows:—Honorary Members, 5; Fellows, 161; Associate, 1. Total 167.

During the year the Society has suffered loss by death of four Fellows, namely, Professor T. Brailsford Robertson, Mr. Francis H. Snow, Mr. W. A. Magarey, and Mr. A. S. Hirst.

An Obituary Notice of Professor Brailsford Robertson, written by Professor Kerr Grant, appears at the close of this Report.

The Council has met on nine occasions, the attendance being as follows: Dr. L. Keith Ward, 4; Professor T. Harvey Johnston, 5; Dr. Charles Fenner, 9; Mr. B. S. Roach, 9; Professor Walter Howchin, 9; Mr. Ralph W. Segnit, 8; Mr. J. M. Black, 2; Professor J. H. Prescott, 5; Mr. J. F. Bailey, 7; Mr. Arthur M. Lea, 7; Sir Joseph C. Verco, 0; Dr. T. D. Campbell, 8.

The absence of the President from four meetings was due to his appointment as a member of the Coal Commission, which necessitated his absence from the State. In April Mr. J. M. Black was granted leave of absence to visit England and the Continent; Dr. T. D. Campbell was in the interior of Australia during the August meeting; Professor T. Harvey Johnston was away from three meetings due to his absence from the State in connection with the Antarctic Expedition, and was in the interior of Australia during the August meeting; Mr. Ralph W. Segnit was on official duty in the North during the July meeting; and Sir Joseph C. Verco was prevented from attending for health reasons.

L. Keith Ward, *President.*
Ralph W. Segnit, *Secretary.*

OBITUARY NOTICE.

T. BRAILSFORD ROBERTSON, D.Sc., Ph.D.

Thorburn Brailsford Robertson died on January 18 of this year. His death was a sacrifice to the spirit of devotion to his duty, which animated his whole life.

Confined to his home at Mount Lofty by an attack of influenza, he insisted—despite all the urging which affection and solicitude could bring to dissuade—in motoring to Adelaide to give his personal attention to the progress of an extraction which he had put in train prior to his illness. The temperature on that day was 106° in the shade. Pneumonia supervened, and later asthma—an enemy of his boyhood's days. Every effort was made to save him, even to the extent of flooding the whole of the sick-room with oxygen, but all to no avail.

The only portion of Robertson's life story with which the writer has direct acquaintance is that during which he held the Chair of Physiology and Biochemistry at the Adelaide University. For the remainder, he owes his information to numerous press notices and to conversations held with his old friends and associates.

Brailsford Robertson was born in Edinburgh in 1884, but came with his parents to South Australia at the age of ten. His early education was received from private tuition and at Miss Stanton's private school at Glenelg. Incidentally, he was severely critical of modern methods of education, and was fond of quoting a saying: "By education genius is turned into mediocrity." He entered upon the Science course at Adelaide University in 1902. I have been told and can well believe that, not having the necessary qualification for matriculation at that date, viz., a pass in either Latin or Greek, he began upon the study of the latter language three weeks before the date of the examination, in which he triumphantly acquitted himself. This may, perhaps, in part explain the contempt which he often expressed—not indeed for a knowledge of foreign languages—ancient or modern—but for that deplorable ineptitude in their use which rewards the schoolboy's strenuous struggle of several years with their grammatical forms and syntatical irregularities.

Robertson's objective from the outset appears to have been the study of biological science. But he told me once that early in his student days he came to the conviction that little progress in any attack on the fundamental problems of the phenomena of life could be successful unless founded upon the conceptions and laws of the basic sciences: mathematics, physics, and chemistry. This conviction it was which, after graduating at Adelaide with first-class honours in physiology, took him to the University of California, there to sit at the feet of the great physiologist and biochemist, Jacques Loeb, whose recent success in artificially fertilising the ova of sea-urchins had attracted world-wide attention.

Robertson's ability was evidently not lost upon his teachers at Berkeley, for immediately after graduating as Ph.D. in 1907 he was appointed an assistant professor of chemistry, and later in the same year to the same rank in the department of physiology. While teaching at California he carried out experimental researches on the functions and biochemistry of the pituitary gland. This work resulted in the discovery of a substance, extractable from the gland, which had a remarkably powerful stimulating action on the growth of tissues. Robertson gave this extract the name of "Tethelin."

In 1910 Robertson paid a short visit to South Australia and married then Miss Jane Winifred Stirling, third daughter of Sir Edward Stirling.

In 1918 he accepted the offer of the Chair of Biochemistry at the University of Toronto, and in the following year, on the demise of his old chief, he was invited by the Council of Adelaide University to succeed him in the Chair of Physiology. The contrast between the ample facilities made for the teaching of the biological sciences in American Universities and the meagreness of the provision made for the same end at Adelaide must, I think, have impressed Robertson very acutely, and he lost no time in urging upon the Council the necessity for a new laboratory and a re-organisation and increase of the teaching staff. He had his own peculiar and effective way of getting what he wanted. Within a year he had secured from the University Council a promise to erect a new building for physiology and biochemistry, and towards the expense of its erection a very handsome monetary contribution from the heirs of the late John Darling. The "Darling Building" for the medical sciences was completed in 1922. Robertson's genius for detail—without the closest attention to which, as Napoleon once said, no project can succeed—is to be seen in a hundred features of the internal design and fittings of this fine laboratory. Here he began his long series of experiments on the influence of various supplementary food factors on the growth of mice, breeding for that purpose a special strain of white mice.

Mainly by Robertson's personal efforts a sum of no less than £7,000 was raised by private subscription from public-spirited citizens of South Australia to provide the necessary financial support for this experimental work. This sum now constitutes the Animal Products Research Foundation of the University of Adelaide. One very tangible return for this benefaction was made when immediately after the discovery of the "Insulin" treatment for diabetes thousands of doses of this extract were prepared for the use of sufferers in South Australia.

He carried on concurrently with this work and, of course, with his teaching duties likewise, various other experimental investigations, mainly on the problems of growth of unicellular organisms. I am not competent to comment critically on the value or importance of the results obtained from the point of view of a biologist, but speaking as a physicist I would say that the discovery of the identity—or at least close similarity—of the law of growth both for unicellular and for polycellular organisms with the law of progress of an autocatalytic chemical re-action must be a fact of fundamental significance in biology. Yet Robertson was aiming, as he disclosed to me in our not infrequent discussions about his work, at a much deeper probing into the nature of vital processes. He realised that neither dietetic nor ordinary environmental influences do, as a rule, penetrate the very citadel of life—the nucleus of the cell—and I recollect a long discussion, prior to my visit to England in 1927, on the question of the possibility and of the technique of making an attack on this impregnable citadel by the agency of the radiations from radium or other radio-active substances. How sound his intuition was in selecting such a line of attack has since been demonstrated by the discovery by American geneticists, that the number of mutations in the offspring of a species of fruit-fly (for example) can be enormously increased by irradiation of the eggs with X-rays or gamma-rays. In 1927, however, the current of Robertson's scientific activity was turned into a new channel by his acceptance of an offer from the Commonwealth Council of Scientific and Industrial Research to become chief of a department of Animal Nutrition. Under his direction a laboratory was erected on the University grounds facing Victoria Drive, and here, with the help of a small band of assistants, he planned and inaugurated a plan of experimental work in the field and in the laboratory. The final objective of this work is to augment the wealth which Australia derives from the sheep-breeding industry, but Robertson rightly insisted that this result would be most surely and effectively reached by a broad scientific inquiry into the relations which exist between the various dietetic factors and the growth of the animal or the quantity and quality of its wool. On these lines the work has been proceeding, and already results have been obtained which testify to the soundness of his views and indicate the possibility of large economic returns.

Robertson's interests were by no means confined to the bounds of his special science. He read widely, though eclectically, both in scientific and imaginative literature. Such a book as Upton Sinclair's "Arrowsmith," in which the commercialism sometimes associated with scientific research in

America is scathingly arraigned, gave him huge delight, and one of his latest essays published in the "Hibbert Journal" deals trenchantly with the same theme.

Robertson's published works, in addition to the very numerous papers descriptive of his experimental researches, include text books on "The Physical Chemistry of the Proteins" and "The Principles of Biochemistry." He took an active part in the social life of the University, and was instrumental in founding the Graduates' Association, the University Club, and the Medical Sciences Club. The "Australian Journal of Experimental Biology and Medical Science," which serves as the organ of publication for all Australian workers in this field, was established under the aegis of this last body.

In 1926 Robertson was honoured by election to the Reale Accademia Nazionale of Italy.

"His life was gentle and the elements
So mixed in him that Nature might stand up
And say to all the world, 'This was a man!' "

KERR GRANT.

THE SIR JOSEPH VERCO MEDAL.

The Council, on August 23, 1928, having resolved to recommend to the Fellows of the Society that a medal should be founded to give honorary distinction for scientific research, and that it should be designated the Sir Joseph Verco Medal, was submitted to the Society at the evening meeting of October 11, 1928,

and at a later meeting, held on November 8, 1928, when the recommendation of the Council was confirmed on the following terms:—

REGULATIONS.

XI.—The medal shall be of bronze, and shall be known as the Sir Joseph Verco Medal, in recognition of the important service that gentleman has rendered to the Royal Society of South Australia. On the obverse side of the medal shall be these words: 'The Sir Joseph Verco Medal of the Royal Society of South Australia,' surrounding the modelled portrait of Sir Joseph Verco, while on the reverse side of the medal there shall be a surrounding wreath of eucalypt, with the words: 'Awarded to..for Research in Science,' the name of the recipient, and the year of the award. The Council shall select the person to whom it is suggested that the medal shall be awarded, and that name shall be submitted to the Fellows at an Ordinary Meeting to confirm, or otherwise, the selection of the Council, by ballot or show of hands. The medal shall be awarded for distinguished scientific work published by a Member of the Royal Society of South Australia."

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1930.

RECEIPTS.

	£ s. d.	£ s. d.
To Balance, October 1, 1929		755 10 7
,, Subscriptions	145 19 0	
,, Field Naturalists' Section	33 15 0	
		179 14 0
,, Grants from S.A. Government—		
On Subscriptions	127 13 9	
For Printing Reports and Scientific Investigations	150 0 0	
		277 13 9
,, Use of Room by other Societies	4 2 6	
,, Sale of Publications	16 8 2	
		20 10 8
,, Interest—		
Savings Bank Account	27 17 9	
Transferred from Endowment Fund	185 7 4	
		213 5 1
		£1,446 14 1

PAYMENTS.

		£ s. d.	£ s. d.
By Transactions—			
Printing		375 12 6	
Illustrating		105 18 9	
Publishing		12 4 10	
			493 16 1
,, Library—			
Librarian		104 8 0	
Bookbinding		30 4 0	
Customs Duties		1 8 8	
Catalogue Council of Science		1 4 0	
New Shelves		42 15 0	
			179 19 8
,, Sundries—			
Cleaning and Lighting		7 13 10	
Printing, Postage and Stationery		14 13 0	
Insurance		6 15 0	
Small Repairs		0 4 0	
			29 5 10
,, Balance, September 30, 1930—			
Savings Bank of South Australia		668 14 1	
Bank of Australasia	£85 0 2		
(Less Outstanding Cheques)	11 3 9		
		73 16 5	
Cash to Bank		1 2 0	
			743 12 6
			£1,446 14 1

Audited and found correct,,

O. GLASTONBURY, A.A.I.S., A.F.I.A. } Hon.
W. CHAMPION HACKETT } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 3, 1930.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).
ENDOWMENT FUND.

As at September 30, 1930.

(Capital £4,069 6 10d.)

	£	s.	d.	£	s.	d.
1929—October 1.						
To Balance, S.A. Government Stock	4,064	18	9			
Savings Bank	4	8	1			
				4,069	6	10
1930—September 30.						
„ Interest Received				185	7	4
				£4,254	14	2

	£	s.	d.	£	s.	d.
1930—September 30.						
By Revenue Account				185	7	4
„ £500 S.A. Government Stock @ 3%	292	8	9			
„ £2,000 S.A. Government Stock @ 3¾%	1.997	10	0			
„ £900 S.A. Government Stock @ 5¼%	900	0	0			
„ £875 S.A. Government Stock @ 5½%	875	0	0			
				4,064	18	9
„ Savings Bank Account				4	8	1
				£4,254	14	2

Audited and found correct,

O. GLASTONBURY, A.A.I.S., A.F.I.A. } Hon.
W. CHAMPION HACKETT } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 3, 1930.

THE ENDOWMENT AND SCIENTIFIC RESEARCH FUND.

1902.—On the motion of the late Samuel Dixon it was resolved that steps be taken for the incorporation of the Society and the establishment of an Endowment and Scientific Research Fund. Vol. xxvi., pp. 327-8.

1903.—The incorporation of the Society was duly effected and announced. Vol. xxvii., pp. 314-5.

1905.—The President (Dr. J. C. Verco) offered to give £1,000 to the Fund on certain conditions. Vol. xxix., p. 339.

1929.—The following are particulars of the contributions received and other sources of revenue in support of the Fund up to date:—

SUMMARY OF THE ENDOWMENT FUND.

(Capital £4,069 6s. 10d.)

Contributions.

	£	s.	d.	£	s.	d.	£	s.	d.
Donations—									
1908, Dr. J. C. Verco	1,000	0	0						
1908, Thomas Scarfe	1,000	0	0						
1911, Dr. Verco	150	0	0						
1913, Dr. Verco	120	0	0						
Mrs. Ellen Peterswald	100	0	0						
Small Sums	6	0	0	2,376	0	0			
Bequests—									
1917, R. Barr Smith ...	1,005	16	8						
1920, Sir Edwin Smith ...	200	0	0	1,205	16	8			
Life Members' Subscriptions				225	0	0			
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*Interest on investments has, in the main, been transferred to general revenue for the publication of scientific papers. See Balance-sheets.

GRANTS MADE IN AID OF SCIENTIFIC RESEARCH.

	£	s.	d.
1916, G. H. Hardy, "Investigations into the Flight of Birds"	15	0	0
1916, Miss H. A. Rennie, "Biology of *Lobelia gibbosa*"	2	2	0
1921, F. R. Marston, "Possibility of obtaining from Azine precipitate samples of pure Proteolytic Enzymes"	30	0	0
1921, Prof. Wood Jones, "Investigations of the Fauna and Flora of Nuyts Archipelago"	44	16	7

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FOR THE YEAR ENDED SEPTEMBER 30, 1930.

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presented by the respective governments, societies, and editors.

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ROYAL SOCIETY OF SOUTH AUSTRALIA
(INCORPORATED).

SECTION III.—PAPERS.
(Approved October 8, 1923.)

1. No paper which has not been previously approved by the Council shall be brought before the Society.

2. Every paper brought before the Society shall be immediately delivered to the Secretary.

3. The Council shall at its next or at a subsequent meeting decide whether such paper will be published.

4. If the Council decides to publish the paper in whole or in part, it and all copyrights thereof shall become the property of the Society, such copyrights to include all plates, maps, diagrams, and photographs reproduced in illustration of the paper; and all blocks used in such reproductions shall be the property of the Society. All manuscripts and original illustrations must be returned to the Editor with the corrected proofs.

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6. If the Council decides not to publish a paper, either in whole or in part, the same shall be returned to the author, if he so desires.

7. All papers and other contributions published by the Society shall be subjected to editing by the Editor.

8. The author of any paper published by the Society shall be entitled to receive free of cost 25 copies of the same, and to obtain additional copies (not exceeding 75, unless the Council shall determine otherwise) upon paying the extra cost thereof. Every such copy shall include a statement that it is taken from the publications of the Society.

9. All contributions and excerpts intended for publication by the Society shall be clearly typed or written on one side of the paper only, and in accordance with the "Suggestions for the Guidance of Authors" published by the Society, ready for the printer.

10. A proof shall be submitted (if possible) to the author, who shall be allowed to make any slight amendments without cost, but if the corrections are excessive they must be paid for by him.

11. In order to secure correct reports, all papers and other contributions laid before the Society must be accompanied by short abstracts.

ROYAL SOCIETY OF SOUTH AUSTRALIA
(INCORPORATED).

SUGGESTIONS FOR THE GUIDANCE OF AUTHORS IN THE PREPARATION OF MSS. TO BE SUBMITTED TO THE SOCIETY.

1. The manuscript must be clearly written (especially in the case of scientific and technical terms), and in a form ready to be placed in the hands of the printer. It is a great advantage for MSS. to be typed, double spaced. If the paper be illustrated, the illustrations, maps, etc., must be supplied in a form ready for reproduction. Where reduction is required, detail and lettering must be proportionally enlarged. It may be necessary to return MSS. to authors for typing. In returning proofs to the Editor, the original copy should be included.

2. Uniformity must be preserved throughout in the use of capital letters, italics, abbreviations, punctuation, etc.

3. All generic and specific names must be underlined (denoting italics). Other scientific nomenclature must be in roman. Generic names must begin with a capital letter, and specific and varietal names (even where a proper name is used) must begin with non-capitals, as, for example, *Lovenia forbesi* T. Woods. (An exception to this rule is made in the case of botanical names, where the usage is to retain the capital letter in proper names.)

4. Diphthongs are not allowed; each vowel must be written separately, as, for example, Archaeocyathinae.

5. In the case of original descriptions the following abbreviations should be used: n. gen., n. sp., n. var.

6. Authors and authorities, following a name in roman, must be in italics; following a name in italics, to be in roman; when the species is transferred to another genus the name of the original author to be enclosed in parentheses. (No comma shall appear between the specific name and the name of the author.)

7. The names of Australian States are to be written in full in the text, but in the footnotes and synonymy are to be abbreviated as follow:—Australia, Aust.; New South Wales, N.S.W.; Victoria, Vict.; Tasmania, Tasm.; South Australia, S. Aust.; Western Australia, W. Aust.; Queensland, Qld.; North Australia, N. Aust.; Central Australia, C. Aust.; New Guinea, N. Guin.; New Zealand, N.Z.; Federal Capital Territory, F.C.T. Aust.

8. Symbols or abbreviations used to save trouble in writing, but not intended to appear as such in the printed text, are not allowable.

9. The maximum size of illustrations (maps excepted) to be $7\frac{1}{2}$ inches x 5 inches for plates, and $7\frac{3}{4}$ inches x 5 inches for text figures.

10. Papers submitted to the Society for reading must be lodged at the Society's rooms at least a week before the meeting of Council, which is held on the fourth Thursday in each month, from March to November, inclusive.

Note regarding Abstracts.—The author is requested to supply two brief abstracts of his paper—one for local use, and another, not exceeding 50 words, to be sent to publications which cannot grant more space.

LIST OF FELLOWS, MEMBERS, ETC.

AS EXISTING ON SEPTEMBER 30, 1930.

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.

Any change in address or any other changes should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrear.

Date of Election.

HONORARY FELLOWS.

1910. *BRAGG, SIR W. H., K.B.E., M.A., D.Sc., F.R.S., Director of the Royal Institution, Albemarle Street, London (Fellow 1886).
1926. *CHAPMAN, F., A.L.S., National Museum. Melbourne.
1897. *DAVID, SIR T. W. EDGEWORTH, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S.. F.G.S., Emeritus Professor of Geology, University of Sydney, Coringah, Sherbroke Road, Hornsby, N.S.W.
1898. *MEYRICK, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1894. *WILSON, J. T., M.D., Ch.M., Professor of Anatomy, Cambridge University, England.

FELLOWS.

1926. ABEL, L. M. Chapman Camp, British Columbia.
1925. ADEY, W. J., 32 High Street, Burnside, S.A.
1927. *ALDERMAN, A. R., M.Sc., F.G.S., West Terrace, Kensington Gardens, S.A.
1929. ANGEL FRANK M., Box 1327G, G.P.O., Adelaide.
1895. †*ASHBY, EDWIN, F.L.S., M.B.O.U., Blackwood, S.A.—**Council,** 1900-19; **Vice-President,** 1919-21.
1917. BAILEY, J. F., Director Botanic Gardens, S.A.—**Council,** 1928-.
1902. *BAKER, W. H., King's Park, S.A.
1926. BECK, B. B., 127 Fullarton Road, Myrtle Bank, S.A.
1928. BEST, R. J., M.Sc., A.A.C.I., Waite Agricultural Research Institute, Glen Osmond.
1928. *BEST, Mrs. R. J., B.Sc., 23 Ailsa Street, Fullarton Estate.
1930. BIRKS, W. R., B.Sc., Principal, Roseworthy Agricultural College.
1907. *BLACK, J. M., 82 Brougham Place, North Adelaide—**Sir Joseph Verco Medal,** 1930; **Council,** 1927-.
1924. BROWNE, J. W., B.Ch., 169 North Terrace, Adelaide.
1916. *BULL, LIONEL B., D.V.Sc., Laboratory, Adelaide Hospital.
1923. BURDON, ROY S., B.Sc., University of Adelaide.
1921. BURTON, R. J., Belair.
1922. *CAMPBELL, T. D., D.D.Sc., Dental Dept., Adelaide Hospital, Frome Road, Adelaide—**Council,** 1928-.
1924. CAVENAGH-MAINWARING, W. R., M.B., B.S., 207 North Terrace.
1907. *CHAPMAN, R. W., C.M.G., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University, Adelaide—**Council,** 1914-22.
1904. CHRISTIE, W., c/o Griffiths Bros., Hindmarsh Square, Adelaide.
1929. CHRISTIE, W., M.B., B.S., Education Department, Flinders Street, Adelaide.
1895. *CLELAND, JOHN B., M.D., Professor of Pathology, University, Adelaide—**Council,** 1921-26; **President,** 1927-28; **Vice-President,** 1926-27.
1930. COLLINS, F. V., B.V.Sc., Green Road, Woodville.
1930. COLQUHOUN, T. T., M.Sc., University, Adelaide.
1907. *COOKE, W. T., D.Sc., Lecturer, University of Adelaide.
1929. COTTON, BERNARD C., S.A. Museum, Adelaide.
1924. DE CRESPIGNY, C. T. C., D.S.O., M.D., 219 North Terrace, Adelaide.
1916. DARLING, H. G., Franklin Street, Adelaide.
1929. DAVIDSON, JAMES, D.Sc., Waite Agricultural Research Institute, Glen Osmond.
1928. DAVIES, J. G., B.Sc., Ph. D., Waite Agricultural Research Institute, Glen Osmond.
1927. *DAVIES, Prof. E. HAROLD, Mus.Doc., The University, Adelaide.
1927. DAWSON, BERNARD, M.D., F.R.C.S., 8 King William Street, Adelaide.
1930. DIX, E. V., Glynde Road, Firle.
1915. *DODD, ALAN P., Prickly Pear Laboratory, Sherwood, Brisbane.
1921. DUTTON, G. H., B.Sc., Agricultural High School. Murray Bridge.
1911. DUTTON, H. H., M.A. (Oxon.), Anlaby.
1902. *EDQUIST, A. G., 19 Farrell Street, Glenelg.
1918. *ELSTON, A. H., F.E.S.. "Llandyssil," Aldgate.
1925. ENGLAND, H. N., B.Sc., Commonwealth Research Station, Griffith, N.S.W.

Date of Election.

1917. *FENNER, CHAS. A. E., D.Sc., 42 Alexander Avenue, Rose Park—**Rep.-Governor,** 1929-; **Council,** 1925-28; **President,** 1930-; **Vice-President,** 1928-30; **Secretary,** 1924-25
1927. *FINLAYSON, H. H., The University of Adelaide.
1929. FRENEY, M. RAPHAEL, 14 Holden Street, Kensington Park.
1929. FRENEY, M. RICHARD, 14 Holden Street, Kensington Park.
1929. FRICKE, EVERARD F. S., B.Ag.Sc., Waite Agricultural Research Institute, Glen Osmond.
1923. *FRY, H. K., D.S.O., M.B., B.S., B.Sc., Glen Osmond Road, Parkside.
1930. GARRETT, S. D., B.A., Waite Agricultural Research Institute, Glen Osmond.
1919. †GLASTONBURY, O. A., Adelaide Cement Co., Brookman Buildings, Grenfell Street.
1923. GLOVER, C. J. R., Stanley Street, North Adelaide.
1927. GODFREY, F. K., Robert Street, Payneham, S.A.
1904. GORDON, DAVID, 72 Third Avenue, St. Peters.
1925. †GOSSE, J. H., 31 Grenfell Street, Adelaide.
1880. *GOYDER, GEORGE, A.M., B.Sc., F.G.S., 232 East Terrace, Adelaide.
1910. *GRANT, KERR, M.Sc., Professor of Physics, University, Adelaide—**Council,** 1912-15.
1904. GRIFFITH, H., Hove, Brighton.
1916. HACKETT, W. CHAMPION, 35 Dequetteville Terrace, Kent Town.
1927. *HACKETT, Dr. C. J., 196 Prospect Road, Prospect, S.A.
1922. *HALE, H. M., The Curator, S.A. Museum, Adelaide.
1930. HALL, F. J., Adelaide Electric Supply Coy., Ltd., Adelaide.
1922. *HAM, WILLIAM, F.R.E.S., Teachers' College, Kintore Avenue, Adelaide.
1916. †HANCOCK, H. LIPSON, A.M.I.C.E., M.I.M.M., A.Am.I.M.E., Bewdley, 66 Beresford Road, Bellevue Hill, Rose Bay, Sydney.
1924. HAWKER, Captain C. A. S., M.H.R., M.A., North Bungaree, via Yacka, South Australia.
1896. HAWKER, E. W., M.A., LL.B., F.C.S., East Bungaree, Clare.
1928. HAWKER, M. S., Adelaide Club, North Terrace.
1923. HILL, FLORENCE MCCOY M., B.S., M.D., University of Adelaide.
1927. HOLDEN, E. W., B.Sc., Dequetteville Terrace, Kent Town, S.A.
1929. HOSKING, JOHN W., 77 Sydenham Road, Norwood.
1930. HOSKING, J. S., B.Sc., Waite Agricultural Research Institute, Glen Osmond.
1924. *HOSSFELD, PAUL S., M.Sc., Rabaul, Territory of New Guinea.
1883. *HOWCHIN, PROFESSOR WALTER, F.G.S., "Stonycroft," Goodwood East—**Sir Joseph Verco Medal,** 1929; **Rep.-Governor,** 1901-22; **Council,** 1883-84, 1887-89, 1890-94, 1902-; **President,** 1894-96; **Vice-President,** 1884-87, 1889-90, 1896-1902; **Editor,** 1883-88, 1893-94, 1895-96, 1901-.
1928. HURCOMBE, Miss J. C., 95 Unley Road, New Parkside.
1928. IFOULD, PERCY, Kurralta, Burnside.
1918. *ISING, ERNEST H., c/o Superintendent's Office, S.A. Railways, Adelaide.
1912. *JACK, R. L., B.E., D.Sc., F.G.S., Assistant Government Geologist, Adelaide.
1893. JAMES, THOMAS, M.R.C.S., 9 Watson Avenue, Rose Park.
1918. *JENNISON, Rev. J. C., 7 Frew Street, Fullarton Estate.
1910. *JOHNSON, E. A., M.D., M.R.C.S., Town Hall, Adelaide.
1921. *JOHNSTON, PROFESSOR T. HARVEY, M.A., D.Sc., University, Adelaide—**Rep.-Governor,** 1927-29; ; **Council,** 1926-28; **Vice-President,** 1928-.
1929. JOHNSTON, W. C., Government Agricultural Inspector, Riverton.
1920. *JONES, PROFESSOR F. WOOD, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S., University, Melbourne—**Rep.-Governor,** 1922 27; **Council,** 1921-25; **President,** 1926-27; **Vice-President,** 1925-26.
1926. JULIUS, EDWARD, Conservator of Forests, Adelaide.
1918. KIMBER, W. J., 28 Second Avenue, Joslin.
1929. LAUBMAN, C. W., 75 Rundle Street, Adelaide.
1915. *LAURIE, D. F., Agricultural Department, Victoria Square.
1897. *LEA, A. M., F.E.S., S.A. Museum, Adelaide—**Council,** 1923-24, 1925-.
1884. LENDON, A. A., M.D., M.R.C.S., 66 Brougham Place, North Adelaide.
1922. LENDON, GUY A., M.B., B.S., M.R.C.P., North Terrace.
1925. LEWIS, A., M.B., B.S., Adelaide Hospital.
1930. LOUWYCK, REV. N. H., The Rectory, Yankalilla.
1922. *MADIGAN, C. T., M.A., B.Sc., F.G.S., University of Adelaide—**Council,** 1930-.
1923. MARSHALL, J. C., Darrock, Payneham.
1928. MAEGRAITH, B. J., The University, Adelaide.
1929. MARTIN, F. C., B.A., Technical High School, Thebarton.
1905. *MAWSON, SIR DOUGLAS, D.Sc., B.E., F.R.S., Professor of Geology, University, Adelaide —**President,** 1924-25; **Vice-President,** 1923-24, 1925-26.
1919. MAYO, HELEN M., M.D., 47 Melbourne Street, North Adelaide.
1920. MAYO, HERBERT, K.C., LL.B., Brookman Buildings, Grenfell Street.
1930. MCFADYEN, MISS A. L., B.Sc., Walford House School, Unley.

Date of Election.

1929. McLaughlin, Eugene, M.B., B.S., M.R.C.P., Adelaide Hospital.
1907. Melrose, Robert T., Mount Pleasant.
1928. Melville, L. G., B.Ec., F.I.A., Professor of Economics, University of Adelaide, Adelaide.
1924. Messent, P. S., M.B., B.S., 192 North Terrace.
1925. †Mitchell, Professor Sir William, K.C.M.G., M.A., D.Sc., The University, Adelaide.
1930. Mitchell, Miss U. H., B.Sc., Presbyterian Girls' College, Glen Osmond.
1926. Moore, A. P. R., D.D.Sc., 193 North Terrace, Adelaide.
1897. *Morgan, A. M., M.B., Ch.B., 215 Brougham Place, North Adelaide.
1924. Morison, A. J., Deputy Town Clerk, Town Hall, Adelaide.
1930. Morris, L. G., Beehive Buildings, King William Street, Adelaide.
1926. *Mountford, C. P., Postal Workshops, Adelaide.
1921. Moulden, Owen M., M.B., B.S., Unley Road, Unley.
1925. †Murray, Hon. Sir George, K.C.M.G., B.A., LL.M., Magill, S.A.
1925. North, Rev. Wm. O., Methodist Manse, Netherby.
1930. Ockenden, G. P., 11 Ailsa Street, Fullarton Estate.
1913. *Osborn, T. G. B., D.Sc., Professor of Botany, University, Sydney—**Council**, 1915-20, 1922-24; **President**, 1925-26; **Vice-President**, 1924-25, 1926-27.
1927. Paltridge, T. B., B.Sc., Koonamore, via Waukaringa, S.A
1929. Pank, Harold G., 75 Rundle Street, Adelaide.
1929. Paull, Alec. G., B.A., B.Sc., 10 Milton Avenue, Fullarton Estate.
1924. Pearce, C., 33 Capper Street, Kent Town.
1927. Pennycuick, S. W., D.Sc., The University of Adelaide.
1924. Perkins, A. J., Director of Agriculture, Victoria Square.
1928. Phipps, Ivan F., Ph.D., Waite Agricultural Research Institute, Glen Osmond.
1926. *Piper, C. S., M.Sc., Waite Agricultural Research Institute, Glen Osmond.
1925. *Prescott, Professor J. A., M.Sc., A.I.C., Waite Agricultural Research Institute, Glen Osmond—**Council**, 1927-30; **Vice-President**, 1930-.
1926. Price, A. Grenfell, M.A., F.R.G.S., St. Mark's College, North Adelaide.
1907. †*Pulleine, Robert H., M.B., Ch.M., North Terrace, Adelaide—**Council**, 1914-19; **President**, 1922-24; **Vice-President**, 1912-14, 1919-22, 1924-25; **Secretary**, 1909-12, 1925-30.
1925. Richardson, Professor A. E. V., M.A., D.Sc., "Urrbrae," Glen Osmond, S.A.
1926. *Riddell, P. D., Technical College, Newcastle, N.S.W.
1911. Roach, B. S., Education Department, Flinders Street, Adelaide—**Treasurer**, 1920-.
1924. Roeger, Miss M. T. P., c/o Central School, Goodwood.
1925. Rogers, L. S., B.D.Sc., 192 North Terrace.
1905. *Rogers, R. S., M.A., M.D., 52 Hutt Street, Adelaide—**Council**, 1907-14, 1919-21; **President**, 1921-22; **Vice-President**, 1914-19, 1922-24.
1922. *Samuel, Geoffrey, M.Sc., University of Adelaide.
1928. Scott, A. E., B.Sc., 143 Rundle Street, Kent Town.
1924. *Segnit, Ralph W., M.A., B.Sc., Architect-in-Chief's Department, Victoria Square, Adelaide—**Secretary**, 1930-.
1891. Selway, W. H., 14 Frederick Street, Gilberton—**Council**, 1893-1909.
1926. *Sheard, Harold, Nuriootpa.
1928. Showell, H., 27 Dutton Terrace, Medindie.
1920. Simpson, A. A., C.M.G., C.B.E., F.R.G.S., Lockwood Road, Burnside.
1924. Simpson, Fred. N., Dequetteville Terrace, Kent Town.
1925. †Smith, T. E. Barr, B.A., 25 Currie Street, Adelaide.
1927. Stapleton, P. S., Henley Beach, South Australia.
1922. Sutton, J., Fullarton Road, Netherby.
1925. Symons, Ivor G., Church Street, Highgate.
1929. Taylor, John K., Waite Agricultural Research Institute, Glen Osmond.
1928. Taylor, Miss Violet, 40 Eton Street, Malvern.
1929. Tee, Sidney F., Adelaide Hospital.
1923. Thomas, J. F., Tenterfield, N.S.W.
1923. *Thomas, R. G., B.Sc., 5 Trinity Street, St. Peters, S.A.
1923. *Tindale, N. B., South Australian Museum, Adelaide.
1894. *Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1925. Turner, Dudley C., National Chambers, King William Street, Adelaide.
1878. *Verco, Sir Joseph C., M.D., F.R.C.S., North Terrace, Adelaide—**Council**, 1924-; **President**, 1903-21; **Vice-President**, 1921-23.
1926. Wainwright, J. W., B.A., 32 Florence Street, Fullarton Estate.
1924. Walker, W. D., M.B., B.S., B.Sc., c/o National Bank, King William Street.
1929. Walters, Lance S., 157 Buxton Street, North Adelaide.
1912. *Ward, L. Keith, B.A., B.E., D.Sc., Govt. Geologist, Flinders Street, Adelaide—**Council**, 1924-27; **President**, 1928-30; **Vice-President**, 1927-28.

Date of Election.	
1920.	WEIDENBACH, W. W., A.S.A.S.M., Geological Department, Adelaide.
1904.	WHITBREAD, HOWARD, c/o A. M. Bickford & Sons, Currie Street.
1930.	WHITELAW, A. J., Norwood High School, Kensington.
1930.	WILKINSON, PROFESSOR H. J., B.A., Ch.M., M.D., University, Adelaide.
1920.	*WILTON, Professor J. R., D.Sc., University of Adelaide.
1923.	*WOOD, J. G., M.Sc., University of Adelaide.
1927.	WOODLANDS, HAROLD, Box 989 H, G.P.O.
1927.	*WOOLLARD, Professor H. H., M.D., University of Adelaide.

ASSOCIATE.

1929.	CLELAND, W. PATON, 31 Wattle Street, Fullarton.

PAST AND PRESENT OFFICERS OF THE SOCIETY.

PRESIDENTS.

1877-79	PROF. RALPH TATE, F.G.S., F.L.S.
1879-81	CHIEF JUSTICE [SIR] S. J. WAY.
1881-82	[SIR] CHARLES TODD, C.M.G., F.R.A.S
1882-83	H. T. WHITTELL, M.A., M.D., F.R.M.S.
1883-84	PROF. H. LAMB, M.A., F.R.S.
1884-85	H. E. MAIS, M.I.C.E.
1885-88	PROF. E. H. RENNIE, M.A., D.Sc., F.C.S.
1888-89	[SIR] EDWARD C. STIRLING, C.M.G., M.A., M.D. (Cantab.), F.R.C.S., F.R.S.
1889-91	REV. THOMAS BLACKBURN, B.A.
1891-94	PROF. RALPH TATE, F.G.S., F.L.S.
1894-96	PROF. WALTER HOWCHIN, F.G.S.
1896-99	W. L. CLELAND, M.B.
1899-03	PROF. E. H. RENNIE, M.A., D.Sc., F.C.S.
1903-21	SIR JOSEPH C. VERCO, M.D., F.R.C.S.
1921-22	R. S. ROGERS, M.A., M.D.
1922-24	R. H. PULLEINE, M.B., Ch.M.
1924-25	SIR DOUGLAS MAWSON, D.Sc., B.E., F.R.S.
1925-26	PROF. T. G. B. OSBORN, D.Sc.
1926-27	PROF. F. WOOD JONES, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S.
1927-28	PROF. JOHN B. CLELAND, M.D.
1928-30	L. KEITH WARD, B.A., B.E., D.Sc., F.G.S.A.
1930-	C. A. E. FENNER, D.Sc.

SECRETARIES.

1877	W. C. M. FINNISS.
1877-81	WALTER RUTT, C.E.
1881-92	W. L. CLELAND, M.B.
1892-93	W. C. GRASBY.
1893-94	W. B. POOLE.
1894-95	W. L. CLELAND, M.B.; W. B. POOLE.
1895-96	W. L. CLELAND, M.B.
1896-09	G. G. MAYO, C.E.
1909-12	R. H. PULLEINE, M.B., Ch.M.
1912-24	WALTER RUTT, C.E.
1924-25	CHAS. FENNER, D.Sc.
1925-30	R. H. PULLEINE, M.B., Ch.M.
1930-	RALPH W. SEGNIT, M.A., B.Sc.

TREASURERS.

1877	J. S. LLOYD.
1877-83	THOMAS H. SMEATON.
1883-92	WALTER RUTT, C.E.
1892-94	W. L. CLELAND, M.B.
1894-09	WALTER RUTT, C.E.
1909-20	W. B. POOLE.
1920	B. S. ROACH.

EDITORS.

1877-83	PROF. RALPH TATE, F.G.S., F.L.S.
1883-88	PROF. WALTER HOWCHIN, F.G.S.
1888-93	PROF. RALPH TATE, F.G.S., F.L.S.
1893-94	PROF. WALTER HOWCHIN, F.G.S.; PROF. RALPH TATE, F.G.S., F.L.S.
1894-95	PROF. RALPH TATE, F.G.S., F.L.S.
1895-96	PROF. WALTER HOWCHIN, F.G.S.
1901-	PROF. WALTER HOWCHIN, F.G.S.

REPRESENTATIVE GOVERNORS.

1877-83	[SIR] CHARLES TODD, C.M.G., F.R.A.S.
1883-87	H. T. WHITTELL, M.A., M.D., F.R.M.S.
1887-01	PROF. RALPH TATE, F.G.S., F.L.S.
1901-22	PROF. WALTER HOWCHIN, F.G.S.
1922-27	PROF. F. WOOD JONES, M.B., etc.
1927-29	PROF. T. H. JOHNSTON, M.A., D.Sc.
1929-	CHAS. FENNER, D.Sc.

THE SIR JOSEPH VERCO MEDAL.

AWARDS.

1929	PROF. WALTER HOWCHIN, F.G.S.
1930	JOHN McC. BLACK *(In absentia)*

APPENDIX.

FIELD NATURALISTS' SECTION

OF THE

Royal Society of South Australia (Incorporated).

FORTY-SEVENTH ANNUAL REPORT OF THE COMMITTEE

FOR THE YEAR ENDED AUGUST 31, 1930.

MEMBERSHIP.—Last year's membership was 150, of which total 110 were financial. This year's total membership remains about the same, taking into account the losses by resignations and the new members elected.

EXCURSIONS.—Various trips were undertaken during the year to places of interest, and visits were made to the Botanic Gardens and Museum. The Committee also reluctantly decided to abandon the motor trips, on account of the losses involved through not being sufficiently patronised to justify a continuance of these excursions at present.

LECTURES.—We have been favoured with an interesting series of lantern lectures during the period under review, as follows:—"The Stellar Universe," by Professor R. W. Chapman, C.M.G., M.A., B.C.E., F.R.A.S.; "The Architecture of India," by Rev. J. H. Allen, B.Sc.; "Honolulu, California and Arizona," by Dr. R. H. Pulleine, M.B., Ch.M.; "A Trip to Cairns," by Mr. A. J. Morison; "The Phenomena of the Atmosphere," by Mr. A. G. Edquist; "The Association of Insects with Plants," by Dr. James Davidson, D.Sc. Others who have assisted with lecturettes were:—Mr. A. M. Lea, F.E.S., on "Some New Guinea Insects"; Professor J. B. Cleland, on "A Trip to the MacDonnell Ranges"; Mr. J. G. Wood, on "Wallace's Line"; Mr. E. S. Thomas, on "Native Timbers"; and Dr. C. Fenner, F.G.S., on "Some Australian Fossils."

EXHIBITS.—Several members have contributed to this portion of our programme, and we are at all times pleased to have members bring exhibits.

"THE SOUTH AUSTRALIAN NATURALIST."—Our Journal has been published regularly each quarter, under the editorship of Mr. Ham. The part to be issued this month will complete volume II.

WILD FLOWER SHOW.—The 1929 Annual Show was held on October 10 and 11 in the Adelaide Town Hall, which was made available by the kindness of the Lord Mayor. The standard of past shows was well maintained, and resulted in a successful function. The balance-sheet showed a profit of £39 8s. 4d., which was between £5 and £6 in advance of last year.

HERBARIUM.—The work in the Herbarium has been continued, several meetings have been held, and the arranging and mounting of specimens have been proceeded with.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISBANE, MAY-JUNE, 1930.—At these meetings the F.N.S. was represented by Messrs. J. Bailey and A. G. Edquist.

RESIGNATION OF SECRETARY.—During the year the Section sustained a great loss, when Mr. E. H. Ising tendered his resignation as Honorary Secretary, after 12 years devoted service, dating from December 31, 1930. At a later date an opportunity was taken of making a presentation to Mr. E. H. Ising in recognition of his services. We have, however, been fortunate in securing his services as

Show Secretary for this year, as his past experiences in Show work will make his help in this capacity a very valuable contribution to the success of our 1930 Show.

New Secretary.—Following Mr. Ising's resignation, nominations were called for through "The South Australian Naturalist" for the position of Hon. Secretary, without response. At a meeting of the Committee, held on January 15, the undersigned consented to take the position of Acting Hon. Secretary, and has continued to act in that capacity.

H. Woodlands, *Acting Hon. Secretary.*

August 19, 1930.

ANNUAL REPORT OF SHELL COLLECTORS' CLUB

FOR THE YEAR ENDED AUGUST 31, 1930.

There were 21 meetings during the year, with an average attendance of 12.

Gastropods have been under review, and the following families have been dealt with, *viz.*:—Pleurotomariidae, Fiasurellidae, Haliotidae, Stomatidae, Thochidae, Turbinidae, Liotiidae, Neritidae, Acmaeidae.

Members of the Club invite those who have an interest in shells to join with them on the first and third Mondays in each month.

(Signed) W. J. Kimber, *Chairman.*
F. K. Godfrey, *Secretary.*

ANNUAL REPORT OF THE MICROSCOPE COMMITTEE.

The activities of the Microscope Committee of the Field Naturalists' Section extended throughout the year 1930, and the meetings maintained the usual regular attendance.

Early in the year the Committee was approached by the President of the Legacy Club with a view to interesting the boys in microscopic matters. Mr. Harding, assisted by divers members, arranged a number of lectures that were well attended. As a result of these efforts it was felt by members of the Committee that it would be fitting if the ordinary meetings of the Committee were thrown open to any of the lads who were interested, with the result that a large number, in charge of Mr. Shepherd, attended regularly.

The Committee was fortunate in obtaining the services of Mrs. Best, of the University staff. On one occasion a highly instructive lecturette was delivered on "Parasitology," and on another occasion the subject was "Single-celled Animalculae." Both lectures were amply illustrated with slides and specimens. On the occasion of the latter lecture the Committee joined with the Aquarium Society, and a very large gathering was present.

Mr. Machell, of the Education Department, was also kind enough to give an evening on "Aquarium Life," which was highly appreciated. An outline of Natural History, as taught in the schools of the State, was also given.

The thanks of the Committee are due to the Vice-President, Mr. W. A. Harding, who so kindly placed his microscopic projector at the disposal of the Committee. The instrument enabled large images of remarkable accuracy to be thrown on a screen, thus greatly facilitating the observation of the slides by the members.

(Signed) Frank B. Collins,
Hon. Secretary Microscope Committee.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Statement of Receipts and Expenditure for the Year ended August 31, 1930.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
To Balance from Last Year	24	8	0	By Postages, etc.	6	15	0
„ Subscriptions	33	15	0	„ Printing and Stationery	26	13	6
„ Bank Interest	2	5	2	„ Advertising	3	6	0
„ Flower Show	39	8	4	„ Hire of Hall and Lantern	6	18	11
„ "S.A. Naturalist" Sales	0	6	8	„ Badges	4	0	0
„ Badges	2	12	6	„ Flora and Fauna Collection for Flinders Chase	1	2	0
„ Collection, Flinders Chase	1	2	0	„ Library Books	0	19	0
				„ Travelling Expenses	1	12	7
				„ Royal Society	33	15	0
				„ Excursion Account Loss	0	12	9
				„ Bank Balance	18	2	11
	£103	17	8		£103	17	8

Audited and found correct,

(Signed) WALTER D. REED,
Chartered Accountant (Aus.)
WILLIAM H. BROADBENT, } Auditors.

Adelaide, August 19, 1930.

(Signed) E. V. DIX, Hon. Treasurer.

EXCURSION ACCOUNT.

Profits.	£	s.	d.	Losses.	£	s.	d.
1929—Nov. 30.				1929—Sept. 7.			
To Basket Range Trip	1	0	0	Trip to Mr. Coulls'	0	13	6
„ Excess of Loss over Profit	0	12	9	1930—Feb. 15.			
				Launch Trip	0	19	3
	£1	12	9		£1	12	9

(Signed) E. V. DIX, Hon. Treasurer.

GENERAL INDEX.

[Generic and specific names in italics indicate that the forms described are new to science.]

Fig. 1.

Fig. 2.

Photo by H. H. Finlayson. Gillingham & Co. Limited, Printers.

Fig. 1.

Fig. 2.

Photo by H. H. Finlayson. Gillingham & Co. Limited, Printers.

Fig. 1.

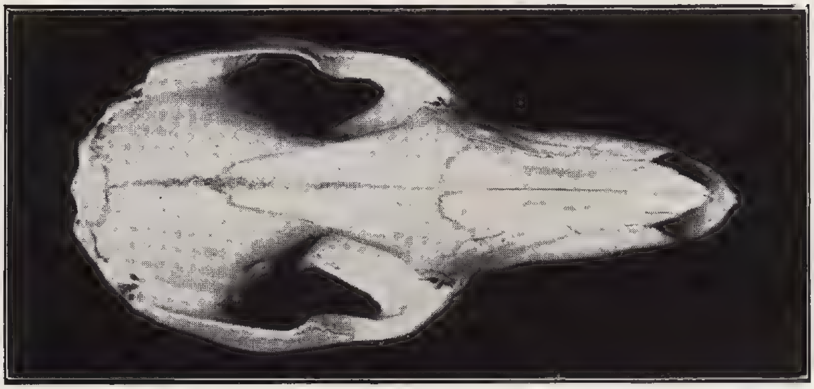


Fig. 2.

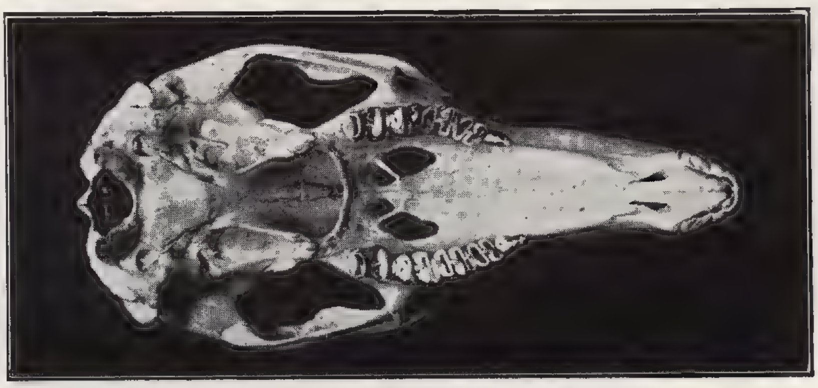
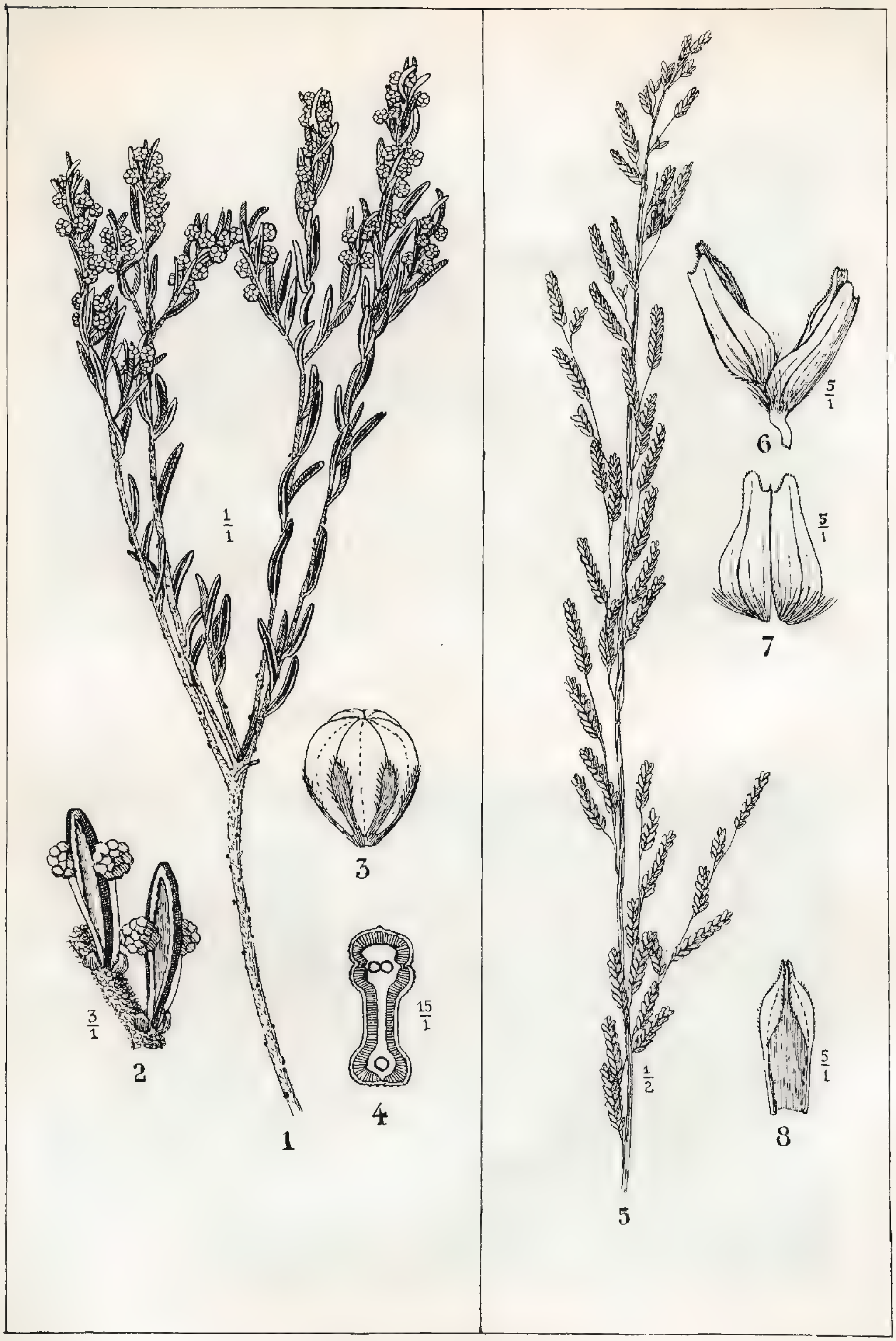


Fig. 3.

Photo by K. Crane. Gillingham & Co. Limited, Printers.



1-4, *Acacia lineata.* 5-8, *Triodia longiceps.*

Gillingham & Co. Limited, Printers.

Fig. 2

Fig. 1

Gillingham & Co. Limited, Printers.

Fig. 2.

Fig. 1.

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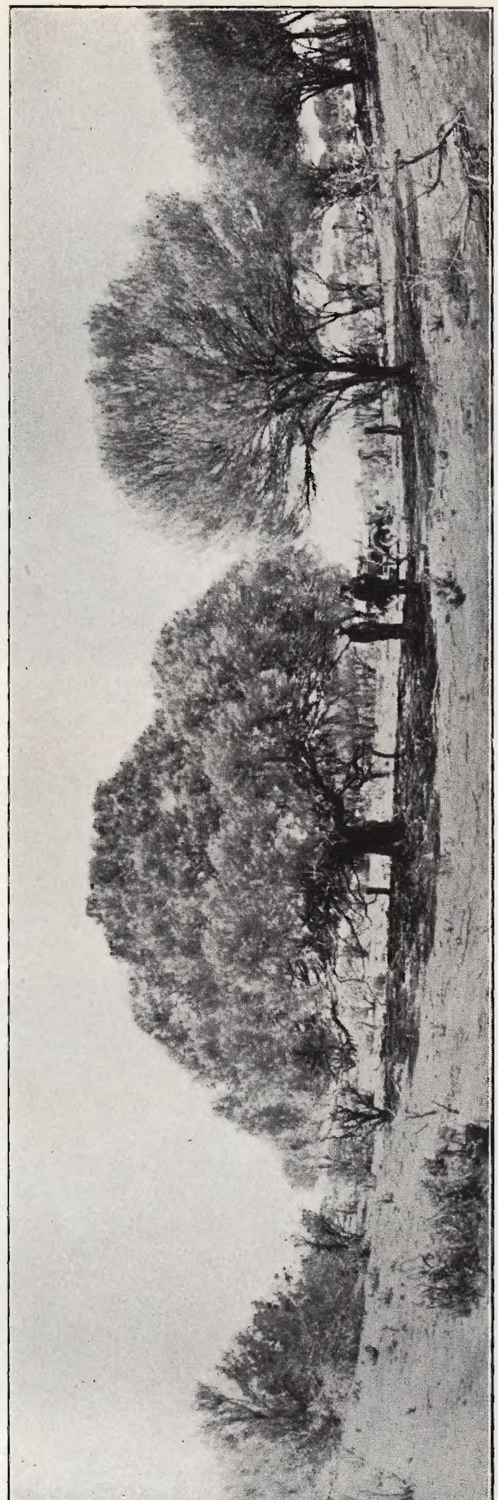

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Fig. 1. North Face of Depôt Hill and Faulted Block in the foreground.
The whole view is Tillite, except the clear edge on which the camera stood.

Fig. 2. Depôt Range, 5 miles—with Faulted Block in foreground.
The whole consists of Tillite, except the clear edge on which the camera stood.

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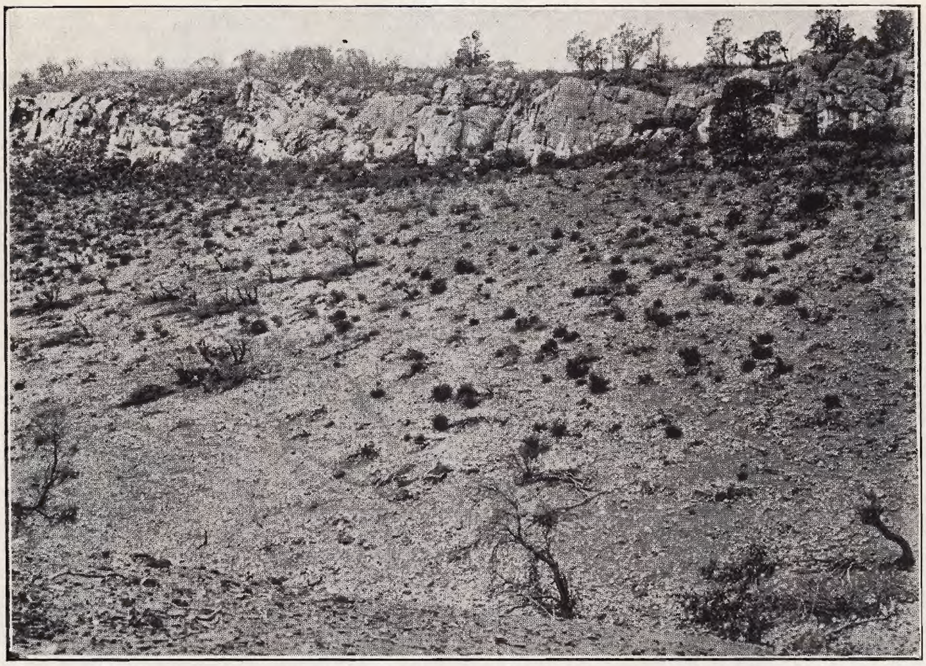

Fig. 1. Crest of "Granite Top," showing Glen Osmond Quartzite resting on Glen Osmond Lower Slates.

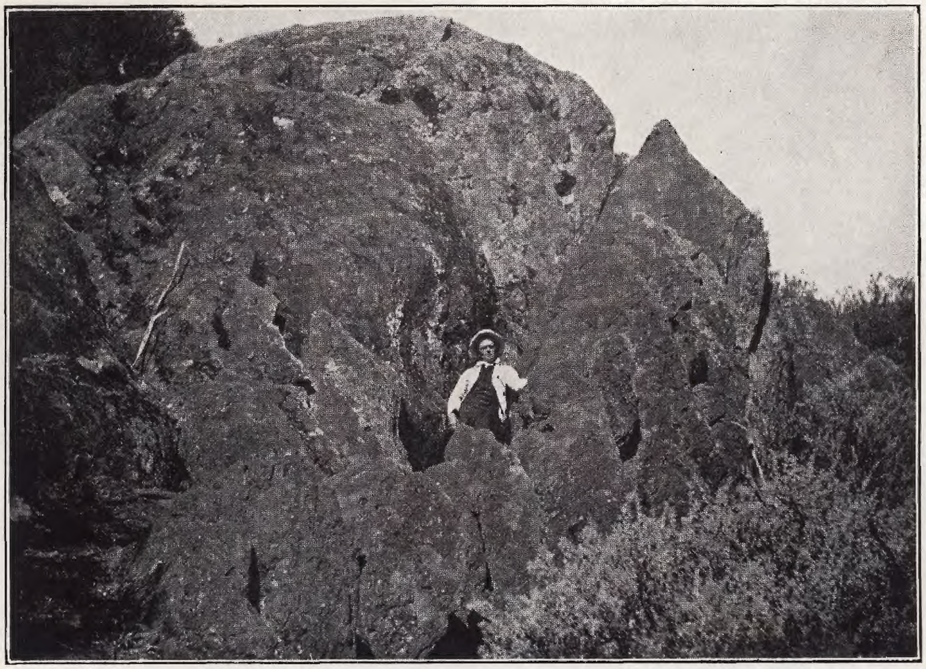

Fig. 2. "Peaked Hill." Viewof portion of the Tillite Outcrop.

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