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David Scott Mitchell.

JOURNAL

OF THE

HORN SCIENTIFIC EXPLORING EXPEDITION, 1894,

By C. WINNECKE, F.R.G.S.,

TOGETHER WITH

MAPS AND PLANS;

AND

REPORT OF THE PHYSICAL GEOGRAPHY
OF CENTRAL AUSTRALIA,

By Professor R. TATE and J. A. WATT, B.Sc.



South Australia :

C. E. BRISTOW, GOVERNMENT PRINTER, NORTH-TERRACE, ADELAIDE.

1897.

MEMBERS OF THE HORN EXPEDITION.

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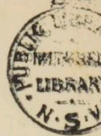
[Surveyor-General's Office, Adelaide—A. Vaughan, Photolithographer.

1. DR. E. C. STIRLING (ANTHROPOLOGY.) 2. G. A. KEARTLAND (NATURALIST.) 3. C. WINNECKE (LEADER.) 4. PROF. W. BALDWIN SPENCER (BIOLOGY.)
5. W. A. HORN (PROMOTER.) 6. J. A. WAIT (GEOLOGY.) 7. F. W. BELT (NATURALIST.) 8. PROF. RALPH TATE (BOTANY.)

THE HORN SCIENTIFIC EXPLORING EXPEDITION.

IN giving to the public the journal and maps kept and compiled by me as leader of the Horn Scientific Exploring Expedition of 1894 some explanation is due both to the public and myself respecting the form in which they are presented. In the natural order of things these should have been published in connection with the scientific and other records of the Horn Expedition, as both supplementary and complementary to them; but Mr. W. A. Horn, the organizer of the venture, for reasons not given, having first requested and arranged for their being forwarded to London for perusal, has declined to incur the expense necessary to such publication, and has also declined to refund the outlay incurred by me in their preparation. For general information I have included in Appendix B the valuable and interesting report of Professor Tate and J. A. Watt, B.Sc., on the physical geography of the country traversed by this Expedition, which forms a portion of the "Report on the Work of the Horn Scientific Expedition to Central Australia, Part III., Geology, &c." Delay in publication has been incurred through the journal and maps having been forwarded to London, whence, after nine months of waiting, they have been at length received in Adelaide. It having thus become necessary to look in some other direction for publication, I have pleasure in stating that the South Australian Branch of the Royal Geographical Society of Australasia has extended its patronage, and, in conjunction with the Department of the Minister for the Northern Territory and the Survey Department, the journal and maps appear under the Society's auspices.

The information contained is pronounced by competent critics in Adelaide to be accurate, valuable, and interesting.



The compilation had to be subordinated to my other pressing duties as leader. Natural features hitherto unmapped have been located by triangulation, and are now shown in their true position. The whole has involved extra travel, anxiety, and labor, and is cheerfully presented to those whose desire it is to have "filled up" the map of Australia. My grateful thanks I hereby tender to those scientific members of the party who aided me in our hurried ramble through the yet unmastered wilds of Central Australia.

CHAS. WINNECKE.

[*Copy of letter to Mr. Horn.*]

Adelaide, March 6th, 1895.

Dear Sir--In compliance with your request I send you, together with maps, my journal and other records of the scientific expedition equipped by you. As defined by yourself, the objects of the expedition were:—

1. The scientific examination of the country from Oodnadatta to the Macdonnell Ranges and the collection of specimens illustrative of the fauna, flora, and geological structure and mineralogical resources of that region, and the illustration by photography of any remarkable natural features of the country traversed.
2. The securing of photographs of the aborigines in their primitive state; the collection of information as to their manners, customs, and language; and the reproduction by photography of their mural paintings in caves and on rocks, &c., &c.

You will notice that these aims were kept well in view throughout the journey. For facility of reference I have appended to my journal a summary, reviewing in the briefest possible form the work performed by the party.

I am, &c.,

CHAS. WINNECKE.

W. A. Horn, Esq., Adelaide.

JOURNAL.

In order to facilitate the start of the expedition from Oodnadatta, I left Adelaide for that place on Monday, the 30th of April, accompanied by two camel-men (H. Edgar and R. Taylor) and the cook (C. Laycock). I reached my immediate destination late on Wednesday night, the 2nd of May. At the journey's end I was met by the Afghan Moosha, who had arrived from Farina the same evening with the camels. We all proceeded to his camp, about one mile west of the township. On the two following days I was engaged in transporting the stores from the railway station, purchasing additional rations, arranging the camel loads, making boxes, and attending to a variety of other matters, apparently minor, yet little less important. These affairs included the testing of the astronomical instruments kindly lent to the expedition by Sir Charles Todd and Sir Thomas Elder, and observing for magnetic variation and dip. On the evening of the 4th of May Mr. W. A. Horn, with Professors Tate and Spencer, Dr. Stirling, and Messrs. Watt, Keartland, and Belt, reached Oodnadatta by special train.

Saturday, May 5th.—Bar. 29·90in.; ther. 57°, wind S.; lat. 27° 33' 10" S., long. 135° 28' 0" E. Began at an early hour preparations for our departure northward, but, this being the first time the camels were packed, a start was not effected until 11·40 a.m. Our equipment comprises four horses, a camel-buggy, and twenty-three camels—twelve of which are pack camels heavily loaded with stores and a heterogeneous collection of boxes containing scientific instruments and collectors' instruments, and nine riding camels. To-day I employed a second Afghan and a black boy (whom I have known for many years) to go with the expedition.

The party now comprehends the following members:—W. A. Horn (organizer and promoter); C. Winnecke, F.R.G.S., leader (meteorology, surveying, and exploring); E. C. Stirling, C.M.G., F.R.S., M.D. (anthropology and ethnology); R. Tate, F.L.S., F.R.G.S. (palæontology and botany); W. Baldwin Spencer, M.A. (biology); J. A. Watt, M.A. (field geology and petrology); F. W. Belt and G. A. Keartland, naturalists and collectors; H. Edgar and R. Taylor, camel-drivers; C. Laycock, cook; C. Pritchard and

W. Russell, Government prospectors; Trooper Williams, of the mounted police; Moosha and Guzzie Boolooh, Afghan camel-drivers; and Harry, a black tracker of the native mounted police. The usual delays incidental to a first day's journey with heavily-packed camels occurred. I therefore decided to make a short stage. At 3:30 p.m. we camped on a small gum creek without water, having travelled seven miles. The camels, with but one or two exceptions, are not, I find, suited for an exploring trip such as we have before us. Several of them are lame and unfit to carry any load, while all the others are in very poor condition, unable to travel more than two miles an hour, and not strong enough to carry weighty burdens. I have determined that Trooper Williams and two horses shall return to Oodnadatta in the morning, as their services are not now required.

Sunday, May 6th.—Camp No. 1; bar. 29·80in., ther. 32°, wind S.E. Carried out my decision with regard to Trooper Williams and the two horses. A few interesting botanical and biological specimens were obtained here by Professors Tate and Spencer. We commenced packing the camels at 7 a.m., but did not resume our journey till two hours afterwards. Excepting a short midday halt at Storm Creek, we travelled all day at the highest speed the camels were capable of. At 6:30 p.m., having covered a distance of twenty-one miles, we camped near a dry swamp. The country traversed was dreary and desolate in the extreme, utterly destitute of grass, and without any traces of water.

Monday, May 7th.—Camp No. 2; bar. 29·84in., ther. 33°, wind S.E. This morning we were upon the road somewhat earlier than usual. For eight miles to the Macumba river there was no change in the character of the country from the stony arid plains which made travelling yesterday so monotonous and unpromising. Following then the course of the Stevenson Creek for ten miles we came to a large rain water hole, called Metrilligan by the natives. Here we camped, and found in the neighborhood a few semi-civilised examples of the aboriginals—the first seen. The camels' defects are more evident than ever to-day, and it is questionable whether I can complete the trip with them, except at a distressingly slow pace.

Tuesday, May 8th.—Camp No. 3; bar. 29·76in., ther. 35°, wind S.E. The usual routine of travel was adhered to. The track we wished to follow leaves the Stevenson about two miles on, turning more to the eastward. This course we followed, and at 4 p.m., having completed sixteen and a half miles, we camped amongst the sandhills, where grass and other herbage for the first time were fairly abundant.

Wednesday, May 9th.—Camp No. 4; bar. 29·75in., ther. 41°, wind E. At dawn this morning the thermometer registered 28°. The day's journeying was begun at 8·30 a.m. Travelled continuously throughout the day, except for an hour's halt at Dalhousie Springs to enable the geologist to complete an examination of this, the most desolate locality imaginable. Camped at 5·30 p.m. on Red Mulga Creek, having made good twenty miles. The name of the creek is derived from a peculiar and rare species of mulga, supposed to be *Acacia cyperophylla*, which we first beheld here, and which is possibly confined to this region. The tree differs from other kinds of mulga in its characteristic bark, which inclines downwards in shaving-like curls and is of a distinctive reddish color. A few aboriginals—uninteresting even to the anthropologist—were seen at Dalhousie Springs.

Thursday, May 10th.—Camp No. 5; bar. 29·84in., ther. 32°. Nearly two hours were occupied in arranging the camels' loads. The greater part of to-day's journey was across uninteresting stony plains. The last few miles, over red sandhills almost destitute of vegetation, were equally unattractive. At ten miles we passed the Opossum Waterhole, and at twenty-two miles we camped at Hughes Waterhole, a long narrow cavity of no great depth, containing rain water strongly impregnated with clay and vegetable matter, which gives the liquid a milky appearance. The country in the vicinity at present has almost all the attributes of a dreary desert. Of grass there is none, and nearly all the bushes have been destroyed by stock watering here; consequently the camels and horses will fare badly to-night. Additions to the ornithological, botanical, biological, and geological collections have been made, not only at this point, but at every camp and on every possible opportunity during the journey.

Friday, May 11th.—Camp No. 6; bar. 29·57in., ther. 37°. The Afghans reported that a strange camel had joined the mob during the night. I found the animal to be in a crippled condition, having large holes in the soles of its feet, due to the stony nature of the country; it was bleeding profusely, and could barely limp into camp. An early departure was made from this wretched place. At five miles we arrived at Blood's Creek store. Here I purchased a riding saddle to replace an old one supplied at Oodnadatta. At 3·30 p.m. we camped near a large rain water hole in the Adminga Creek, called Indiakata, having travelled seventeen miles.

Saturday, May 12th.—Camp No. 7; bar. 29·44in., ther. 35°. Mr. Horn and Professor Spencer obtained this morning several group photographs of the members of the party in suitable

localities near the camp. The taking of these delayed our start till 9·30 a.m. Throughout the rest of the day we were travelling across stony plains, camping at sundown about a mile north of Charlotte Waters telegraph station, near a large waterhole in the Coglin Creek. Here a disappointment awaited us. We had expected to be able to obtain additional camels to carry a portion of our equipment, and thus relieve the overburdened train. But our expectation has not been realised. We shall be compelled in consequence to continue our journey under existing disadvantageous circumstances. This will necessarily greatly retard our progress. Telegraphed to Mr. Gillen, at Alice Springs, to send some camels to Henbury Station with the two Government prospectors. Our intention being to leave the overland telegraph line at the Goyder river, special preparations were necessary; these duties occupied us till late at night.

Sunday, May 13th.—Camp No. 7; bar. 29·45in., ther. 41°. Returned with Mr. Horn to the telegraph station to bid final farewell to distant friends, and also to obtain a few necessaries for the expedition. Mr. P. M. Byrne, the stationmaster, kindly allowed me the use of his only camel, which I have therefore added to our caravan. Although injured and unfitted to carry any very heavy load, this animal will enable me to mount another man. And here I must avail myself of the opportunity to record my indebtedness to Mr. Byrne for frequent favors. Setting out with the whole caravan at 10·45 a.m., we continued northward, following the overland telegraph line across low red porcupine sandhills, timbered with mulga (*Acacia aneura*) and myall (*Acacia homalophylla*). At 4·15 p.m., after having travelled fourteen miles, we camped on a patch of good grass and amongst edible bushes. To both camels and horses the feed here was most welcome, they having lately suffered much from the scarcity of vegetation.

Monday, May 14th.—Camp No. 9; bar. 29·44in., ther. 34°. Having directed the main party to proceed by the track to the Goyder river, Mr. Horn, Mr. Watt, and myself started at 8·30 a.m., on a bearing of 282° 35', direct for Mount Daniel. Passing over one and three-quarter miles of well-grassed plains, we entered low undulating and very stony country, lightly wooded with myall, mulga, and low cassia bushes. This continued to Mount Daniel, which was reached in eight miles. The view from this hill is very extensive—detached table-top ranges, some very distant, are visible in all directions. I obtained a number of bearings and ascertained the height of the hill to be 987ft. above sea level. Its formation is desert sandstone. Mr. Watt having made a geological exami-

nation of this locality, we continued on a bearing of 339° for five and a half miles across well-grassed flats sparsely timbered with mulga, and occasional slight stony undulations until we reached the Goyder river at the road crossing. The main party arrived shortly afterwards, and as it is our intention to stay here to-morrow a temporary camp was formed. The river does not appear to have been in flood for many years past, and our prospects of finding, as we had hoped to do, well-watered country to the westward are not encouraging. Just at this point water is obtained from a large hole scooped in the sand of the creek bed, and from a well some 12ft. deep sunk in the creek. That procured from the latter, though only a sand soakage, is of excellent quality. A special kind of water frog was obtained by the black boys to-day on Boggy Flat, a few miles S.E. of the Goyder.

Tuesday, May 15th.—Camp No. 10, Goyder river; bar. 29.39in., ther. 39° ; lat. $25^{\circ} 38' 50''$ S., long. $134^{\circ} 39'$ E.; height 677ft. above sea level. Mr. Horn to-day formally transferred the leadership and supreme control of the expedition to myself. I was engaged throughout the day in preparing for a visit to Ayers Range, Professor Spencer, Dr. Stirling, and Mr. Watt volunteering to accompany me. In the evening Mr. Ross, a veteran explorer 77 years of age, arrived at our camp. In consequence of information obtained from him our original plans for visiting Ayers Range by the way of the Goyder were somewhat altered. It was decided that the main party should travel to Crown Point, and thence to a waterhole in the Lilla Creek described as Ross Camp. I determined, with Mr. Horn's approval, to carry out part of the first scheme and traverse the Goyder some distance westward, then cross on to the Lilla Creek, and finally join the main party at Ross Camp on Friday next. Mr. Watt volunteered to accompany me on this trip. Several black cockatoos were obtained to-day for the ornithological collection. Magpies were seen for the first time.

Wednesday, May 16th.—Camp No. 10; bar. 29.15in., ther. 41° . I set out at 8.45 a.m. accompanied by Mr. Watt and Harry the black boy, taking three camels and one horse, together with, we imagined, three days' rations and 15galls. of water, the main party having been instructed to proceed to Crown Point later in the day. We started on a bearing of $295^{\circ} 10'$; crossing to the northern side of the Goyder we passed over sandy soil with an occasional outcrop of desert sandstone clothed with porcupine grass and mulga. At two and a half miles we ascended a small stony rise and altered our bearing to $265^{\circ} 10'$. At one and a half miles from this point we crossed to the south side of the Goyder river and entered some high red sandridges running 15° east of

north. Two miles and we gained the top of a sandridge. Now we changed our course to $272^{\circ} 10'$ in the direction of one of two low stony rises, crossing on the way some porcupine sandridges, which here are about 200yds. apart, and mulga flats, until we reached the Goyder in two and three-quarter miles. Athwart the river, which at this spot has a width of about 250yds., we entered a well-grassed mulga scrub. At five and a half miles we altered our bearing to $245^{\circ} 10'$ in the direction of a very prominent hill. At one and a half, three and a half, four and a half, five and a half, and at nine and a half miles we crossed some small gum creeks trending southward and eventually joining the Goyder. With eleven and a half miles covered we changed our bearing to $181^{\circ} 40'$ for two miles to the river, which we then followed upon a course of $216^{\circ} 10'$ for three miles. It being now two hours after sundown we decided to camp without water, having travelled in all twenty-seven miles. Since we last crossed the Goyder river the country passed over has consisted of a loose red loam timbered with mulga and abundantly grassed. The river at our camp has a well-defined channel filled with white sand, and is over 400yds. wide. Stunted river gums appear all over the river bed and along the banks. From appearances I should judge that this river has not been in flood for many years; yet there are indications of the occurrence of high floods, and in such seasons the river must contain an immense volume of water. On examining our supply of food I find that we have barely two days' supply; sugar and salt have been entirely forgotten.

Thursday, May 17th.—Camp No. 11, Goyder river; bar 28.95 in., ther. 33° . A start was made at 7:30 a.m., on a bearing of $290^{\circ} 30'$, in the direction of the high hill towards which we travelled yesterday. Our course at the beginning was through well-grassed open mulga scrub, similar to that already mentioned. Three miles on, however, the country changed to porcupine sandridges timbered with native poplar, low grevillia, and cassia bushes. This continued to the foot of the hill, which we reached after travelling for five miles. The elevation, which I have named Mount Peterswald, after W. J. Peterswald, Esq., Commissioner of Police, consists of ferruginous sandstone with a capping of cherty shale. From its summit an extensive view was obtained; numerous detached masses of table top ranges and hills, some of considerable height, were visible towards the west. To the south the large gums of the Goyder river could be distinctly traced to a point ten miles S.S.W. Table ranges then intervened; also six miles distant, bearing $203^{\circ} 10'$, a peculiar escarped round hill resembling Crown Point; two rugged, isolated, and very prominent high

hills, distant seven and a half miles, bearing $290^{\circ} 20'$ and $295^{\circ} 51'$ respectively. I have named the northern and most conspicuous of the latter Mount Gordon, after the Hon. J. H. Gordon, M.L.C., Chief Secretary of South Australia. These hills are of very considerable elevation, and are surrounded by dense scrubs; Mount Musgrave bears $2^{\circ} 10'$, Crown Point $30^{\circ} 10'$, Mount Townsend $66^{\circ} 50'$, Mount Daniel $85^{\circ} 45'$, and Mount Beddome $110^{\circ} 40'$. After Mr. Watt had completed his geological examinations we resumed our journey on a bearing of $268^{\circ} 10'$ towards a high table top bluff. At the end of a mile's travelling we passed a large claypan with quantities of ironstone nodules. Further on we left both to the south and north numerous detached hills. At eleven miles, having rode over sandridges covered with porcupine, and mulga flats with patches of grass, we arrived at the Bluff, which I named Jenkins Bluff, after the Hon. J. G. Jenkins, Commissioner of Public Works. It proved to be of greater elevation than any hill we have yet ascended. Our view to the southward from its crown was intercepted by high mulga scrub, with which these ranges are densely overgrown. Towards the west we observed the table ranges continued as far as the eye could reach. A very high table top hill, looming considerably above the surrounding table ranges, and apparently the only remaining record of an earlier and more elevated tableland formation, bears $251^{\circ} 10'$, and is twelve and a half miles distant. I have named this important geological feature Mount Falconer, after His Excellency the Earl of Kintore, Governor of South Australia. Another very high hill, round in form and probably of granitic formation, bears 248° and is seventeen and a half miles off. I have designated it Mount Hopetoun, in compliment to His Excellency the Earl of Hopetoun, Governor of Victoria. Other high but less prominent hills are visible westward. A tent-shaped rise, which is twenty-nine and a half miles distant, bears $339^{\circ} 20'$. These table ranges collectively are a geographical feature of some note. They range over country some fifty miles in extent in an easterly and westerly direction, attaining an elevation of over 600ft. above the surrounding plains, and 1,500ft. above sea level, and they indicate the termination of the cretaceous formation towards this point. I have named them the Newland Ranges, after Simpson Newland, Esq., President of the Royal Geographical Society of Australasia, South Australian Branch. Towards the north-west the timber of a large creek is visible, a creek which I judge to be a tributary of the Lilla river. The Goyder river, owing to its trending so much to the southward, is rendered impracticable for our purposes. This fact, combined with the limited time at my disposal, induced me

to abandon the intention of following its channel to its source, important as it appeared when last seen. Our horse is now very much in need of water. I am unable to spare him much from the limited quantity in our casks, and, as my arrangements with Mr. Horn and the main party are to meet them to-morrow (Friday) evening at Ross Camp on the Lilla, thirty-eight miles west from Crown Point, I changed our course to $324^{\circ} 50'$. This will eventually bring us to the river. Journeying on during the evening, over sandhills covered with porcupine and dense cassia bushes for three miles, we reached firmer soil with patches of limestone rubble. At four and a half miles we crossed a small gum creek, which soon joined a larger one amongst small stony slopes overgrown with mallee (*Eucalyptus oliosa*). When five and a half miles had been completed we fortunately discovered a little grass. Upon this we camped, having travelled twenty-two and a half miles. A great deal of time was absorbed to-day in ascending and examining various hills.

Friday, May 18th.—Camp No. 12; bar. 28·83in., ther. 28° . An exceedingly cold and uncomfortable camp induced an early start. Continued on yesterday's bearing. At one and a quarter miles crossed a large gum creek having a well-defined channel some 60yds. in width, showing signs of heavy floods at some remote period. The timber (*Eucalyptus gorillolocalix*) growing on the banks of this creek is both larger and more abundant than that found in the Finke or Goyder rivers. I have named this stream the Way, after S. J. Way, Esq., the Lieutenant-Governor and Chief Justice of South Australia. Proceeding for three miles on our previous course, we crossed hard stony ground, densely overgrown with mulga and cassia bushes, through which the camels could only with the greatest difficulty force their way. Then we came in sight of another large gum creek, about one mile to the northward. Changing our bearing to $263^{\circ} 30'$ for half a mile, we reached a slight stony rise, from which an extensive view was obtained—Mount Humphries bearing $59^{\circ} 20'$, Mount Gordon 101° , and Jenkins Bluff $136^{\circ} 35'$. The junction of the Way and Lilla bears 51° . and is five and a half miles distant. Here we erected a large cairn of stones, and immediately afterwards resumed our travelling on a bearing of $259^{\circ} 40'$ across a stony and well-grassed plain. Numerous patches of salt, cotton, and blue bush were first noticed in this locality, which is by far the best pastoral country we have yet seen. At two and a half miles we crossed the Lilla, which has a well-defined and broad sandy channel. The flood marks, however, extend on either side beyond the river bed. I now directed the black boy to follow the creek, and to make a

smoke if he found water. Mr. Watt and I continued on the original bearing, $259^{\circ} 40'$. At four miles a large gum creek from the south-west junctions with the Lilla. At five and a quarter miles, having travelled over some splendidly-grassed cotton-bush and saltbush flats, we ascended a small sandstone mount, whence red sandhills were observable to the north. Changing our bearing to $274^{\circ} 5'$ for a mile, then to $260^{\circ} 10'$ for a mile to the junction of another gum creek from the west with the Lilla, we next altered our course to 180° for three-quarters of a mile, crossing some sandy river channels to the south side of the main channel of the Lilla. Then, observing smoke evidently raised by Harry, we travelled towards it on a bearing of $138^{\circ} 40'$, through well-grassed mulga scrub and dense patches of cassia bushes. At three and three-quarter miles we struck the southern branch of the Lilla, at a native well called Coolalie. The water here is about 6ft. below the surface in the sandy channel of the creek. Being led to believe that we should obtain the fluid more easily at Ross Camp, we continued up the creek on a bearing of 209° , through well-grassed mulga scrub, passing over several small saltbush and cotton-bush plains. With two and a half miles traversed we crossed the creek, which apparently comes from some table ranges to the south, and followed a small branch creek containing granitic sand. Three miles and a quarter had been covered, and we were at Ross Camp, indicated by the remains of numerous old and recent encampments. A diligent search confirmed my first impression of this place. The creek was perfectly waterless. From this point Mount Hopetoun bears 209° , and is distant seven miles. A very prominent hill in a range bearing 270° and thirteen miles off I have named Mount Magarey, after A. T. Magarey, Esq. There being nothing to detain us here, we retraced our tracks to Coolalie Well, arriving there at 6:30 p.m., having travelled twenty-two miles in all. We at once began to dig out sufficient sand to enable us to water the horse, and, if possible, the camels, who are now desperately thirsty. I found Mr. Watt and Harry both expert and willing workers with the shovel, and very soon, by the light of a small lamp, we excavated a large hole, into which the water slowly drained. At 9:30 p.m. all the stock had been watered out of my oilskin sheet. They drank an enormous quantity, but the supply in the well, though greatly diminished, was equal to the demand made on it. After partly refilling our casks we had ample time to consider our position. Mr. Horn and the main party not being here according to agreement, we were obliged to conclude that more reliable information obtained at Crown Point Station than any previously available had necessitated a further change of route.

I therefore decided to return some distance down the creek to-morrow, and, in the event of not meeting them in the next ten or fifteen miles, to send Harry to Crown Point with the information of our whereabouts, and to proceed with Mr. Watt direct to Engoordina, and intercept the party there. Numerous kangaroos were seen to-day for the first time, and dingoes announced their presence at night. Birds, however, appear to be singularly scarce in this region.

Saturday, May 19th.—Camp No. 13, Coolalie; bar. 28·74in., ther. 31°. An early start was made down the creek on a bearing of 29°. At three and a half miles we altered our course to 359° in the direction of a very prominent tent-shaped hill, crossing the creek near its junction with the main channel of the Lilla. Harry continued down the latter, and I have no doubt that he will to-night reach Crown Point Station, thirty miles hence. At one mile across well-grassed flats Mr. Watt and I again entered sandridges densely over-grown with porcupine and having a direction of N. 15° E. These continued throughout the day. In places where recent fires had burnt the porcupine large quantities of parakylia, herbage, and good grass were met with, and a few clumps of mulga were occasionally seen on the flats between the ridges. After nine miles had been accomplished we passed some very large desert oak (*Casuarina decaisneana*) with enormously large seedpods, a quantity of which I gathered, with other shrubs, for the botanical collection. Late at night, after having travelled twenty-three miles on the last bearing, we reached the foot of the hill and camped, thoroughly tired out with our twenty-seven miles ride on rough camels. The tracks of several emus and of numerous dingoes were seen to-day.

Sunday, May 20th.—Camp No. 14, Mount Watt; bar. 28·74in., ther. 34°; height of camp above sea level, 1,056ft. At dawn I set about getting the camels in readiness for the day's journey. A frugal breakfast, dictated by necessity, as we are now almost destitute of food, was disposed of before sunrise, and after packing up we ascended the hill at 7 a.m. There Mr. Watt soon discovered numerous (Lower Silurian) fossils, and urgently requested sufficient time to enable him to make a thorough examination of this important hill, which is composed of quartzite, and from which I obtained an extensive and far-reaching view. Mount Falconer, thirty-two miles away, bears 183° 45', and Mount Hopetoun, which bears 189° 30', is thirty-six miles off. A very high and prominent hill, bearing 252° 20' and eighteen miles away, forming part of a conspicuous range of detached hills, I have styled Mount Kingston, after the Hon. C. C. Kingston, Premier of South Australia. Another very



Crown Point and Finke River.

(H. Y. L. Brown.)



Crown Point (two miles distant).

high mount in the Johnstone Range, distant thirty-five miles and bearing $315^{\circ} 10'$, I have christened Mount Duff, after His Excellency Sir R. W. Duff, K.C.M.G., Governor of New South Wales. Numerous detached table-top hills, some eighteen miles off, are visible from N.N.W. round to N.N.E. Whilst Mr. Watt was engaged in collecting fossils I made a complete contour survey of this hill, which I have named Mount Watt, after my companion. At noon we departed on a bearing of $49^{\circ} 30'$ towards a distant peak. Our course now compelled us to cross the sandridges, which were both steep and high, the eastern side being invariably more abrupt than the western. The camels labored terribly, and appeared altogether unused to this sort of travelling, repeatedly falling in descending the eastern side of the ridges. It was only by exercising the greatest care that we averted serious accidents to ourselves and the animals; the latter also suffered severely from the porcupine grass, and towards evening were in agony. The direction of the sandridges appear to be N. 15° E. The rises are covered with thick porcupine grass and low cassia bushes. The intervening flats contain a few mulga. Occasionally small patches of stones (limestone nodules) are met with between the ridges, and here generally a little grass is found. At various distances I observed bearings to surrounding hills. At sixteen and a half miles we emerged from the sandhills and entered low broken tablelands. Our further progress towards the Round Peak, now about one and a half miles distant, was barred by very steep and exceedingly rough gullies. Eventually, however, we succeeded in getting the camels down into a hollow traversed by numerous intricate creeks. We were then compelled to lead them on foot several miles down the bed of sinuous creeks, frequently forcing a way through dense vegetation. After travelling in this fashion for a considerable time we finally got clear of the hollow at sundown, having, however, made good in a direct line only one and a quarter miles on a bearing of 9° . The Finke river was now discernible, and the range of detached table hills observed from Mount Watt appeared to the north. Altering our course to 29° , at one mile we struck a faint track, which we followed on a bearing of 102° , passing to the east of several round and flat topped hills. At five and a half miles we crossed to the northern side of the Finke river, and at 9 p.m., having travelled an additional nine and a half miles, we arrived at the Horse Shoe Bend Station, Engoordina, where I expected to find the main party camped; but we only found several deserted and dilapidated huts, no sign of any encampment whatever being present. It was, therefore, necessary to continue our journey in the hope of joining the main party at the mail station. At 1 a.m.,

after having travelled another ten miles in various directions, we arrived at our destination, and ascertained from some aboriginals that our party had not yet turned up. Here we camped, having travelled thirty-nine miles.

Monday, May 21st.—Camp No. 15; bar. 29·27in., ther. 31°. Decided to await the arrival of the main party here. At 9·30 a.m., while I was purchasing some food at the mail station, Mr. Horn and Harry arrived at the camp. I then learned that the main party had left the Goyder river on Wednesday shortly after my departure, camping that night and for the succeeding two days near Crown Point Station. The camel buggy was left here, and two camel pack saddles for the buggy camels were made by the Afghans. On Saturday the main party travelled from Crown Point towards the junction of the Lilla and Finke rivers, camping on the Lilla, twelve miles from Crown Point and twenty-six miles from Ross Camp. Harry, the black boy, arrived at this camp towards evening of the day on which I dispatched him to Crown Point, and delivered my letters to Mr. Horn. In consequence of the receipt of these Mr. Horn on Sunday travelled the main party northward by the old track towards Engoordina Station, camping some two miles south of the mail station. With my companions I rejoined the main party in one and a half miles at the deserted cattle station, and the whole expedition then proceeded westward towards Idracowra, I mapping the country on the way. At eighteen and a half miles we camped on Sullivan's Creek.

Tuesday, May 22nd.—Camp No. 16; bar. 29·03in., ther. 34°. Professor Spencer photographed the caravan this morning. The track now traverses the detached table-top range previously mentioned. Numerous isolated hills are visible in every direction. Owing to this fact I was occupied all day in mapping. At nineteen miles we camped at Idracowra old station, on the Finke river. Several long reaches of water were observed in the river about a mile south of our camp. The caravan will remain here to-morrow for the purpose of enabling photographs of Chambers Pillar to be obtained.

Wednesday, May 23rd.—Camp No. 17, Idracowra; bar. 29in., ther. 32°. I was occupied all day with the expedition plans and in working out the results of astronomical observations. Professor Spencer, Dr. Stirling, Mr. Watt, Mr. Belt, and Harry started for Chambers Pillar, which is about ten miles to the northward, in the morning, returning about 7 p.m. From rough measurements taken by Mr. Watt in following out my directions I computed the height of the pillar from its base to be 167ft. Professor Spencer obtained several photographs of this peculiar monument, which



Chambers Pillar.

has been fully described by its discoverer, J. M. Stuart. At 3 p.m. Mr. Horn departed on his return journey to Adelaide. A number of natives were camped near the station, several of whom I commissioned to procure specimens of natural history for the biological collection. In the evening they brought me a large snake, a *Moloch horridus*, and several other lizards. The camel-men also obtained a number of fish from the waterholes, amongst which no fewer than five varieties occurred. A large catfish—the only one caught—was unfortunately lost before it could be brought into camp. Mr. Keartland, the ornithologist, has been very busy with the birds near this camp, and the collection of skins is already assuming large proportions.

Thursday, May 24th, Her Majesty's Birthday.—Camp No. 17; bar. 29·06in., ther. 33°. Idracowra is the native name of Chambers Pillar, and Udrat-namma for the old station near our camp. I proceeded with Professor Spencer and Dr. Stirling to the waterhole, one mile south of the camp, in order to examine a large net which I had ordered to be placed there last night. We were fortunate enough to secure a catfish for the collection. Breaking up the camp we continued on the northern side of the river. At three and a half miles, over red sand and porcupine grass, we passed Idracowra new station (Boomdooma), now deserted. The track terminates here, and I shall for the future have to select a road for the caravan. A few natives were camped near the station. Examined a well on the north side of the river, about 20ft. deep, with apparently an unlimited supply of good water. The station consists of eight well-constructed log huts, which are enclosed by a wire fence. At nine and a half miles and twelve miles we passed several waterholes in the Finke, and at thirteen miles we camped at a long waterhole called Altalwey-nimma by the natives. A stockyard has been constructed about half a mile to the west of this waterhole, at which I met Fred. Warman, a member of one of my former exploring expeditions. He informed me that he was camped at a large waterhole about three miles W.S.W. from here, near the Johnstone Range. The latter we purpose visiting to-morrow, in order to examine certain peculiar waterlines mentioned by Mr. E. Giles. From a high sandhill about one mile north of our present camp I obtained an extensive round of bearings to numerous hills. Mount Duff, I found, bears W.S.W., and is nine and a half miles distant. The country on both sides of the Finke river consists of high, steep, red sandridges, overgrown with porcupine grass and a few cassia bushes. Occasionally the overflow from the river forms a narrow flat, and here the vegetation is both abundant and of excellent quality.

Friday, May 25th.—Camp No. 18, Finke river; bar. 29·04in., ther. 42°. No fish were found in the large net set overnight. Early this morning F. Warman led us across a cane grass flat to his camp. Here both salt and fresh waterholes exist, near which about a dozen aboriginals were encamped. We obtained a new kind of lizard and various articles of native workmanship for the collection. I also engaged another black boy, Tommy, who professed to know all the ranges we contemplate visiting. Tommy was perfectly nude, and soon prepared himself for his journey by merely fixing a leather strap round his waist. I mounted him on the Charlotte Waters camel, and then continued the journey up the Finke, crossing it six times in twenty miles. The flats on both sides of the river vary in width, but never exceed half a mile. They are generally well grassed, with an abundant growth of cotton-bush and saltbush. Beyond the flats high red sandridges covered with porcupine grass and low bushes extend for some distance. At 7 p.m., having travelled twenty-one and a half miles in a general W.N.W. direction, we camped on the Finke river, near a water-hole designated Ampire.

Saturday, May 26th.—Camp No. 19, Finke river; bar. 28·94in., ther. 48°; height above sea level 944ft. Started early, consequent upon my intention to make Henbury Station to-night. Crossing the Finke immediately after leaving our camp, on a bearing of 327°, across red sandridges covered with porcupine, we reached the junction of Palmer and Finke rivers at two and three-quarter miles. A fair sized and rather deep waterhole marks the confluence of these rivers. We continued, on a bearing of 343°, over red sandridges and river flats, the latter being fairly well grassed. When one mile and a half had been completed, and again at the end of three and three-quarter miles, we crossed the Finke river. At four and three-quarter miles we altered our course to 315° for two and a quarter miles, and to 313° 30' for the subsequent two and a quarter miles, across porcupine sandhills, to a low stony rise. From this ascent I obtained an extensive view of the valley of the Finke river, and could trace the tortuous course which this stream here pursues. Low hills are observable in all directions. Resuming then our journey on a bearing of 318° 20' across a level and splendidly-grassed plain, on which a few patches of stones occur at intervals, we, at three and a half miles, four and a half miles, and four and three-quarter miles, crossed the three small gum creeks. At five and a half miles we met Mr. E. W. Parke, who, after welcoming the party very kindly, offered us the use of his head station. At sundown, having travelled eight and a quarter miles on the last bearing, we camped on the Finke river, near Henbury Station, having made, in

all, a stage of twenty and a half miles, the last three miles having been a repetition of sandhills and porcupine. I was employed until midnight with my astronomical observations.

Sunday, May 27th.—Camp No. 20, Henbury Station; bar. 28.75in., ther. 40°; lat. 24° 33' 20" S., long. 133° 15' 27" E.; height 1,259ft. above sea level. There being ample work here for the whole party, I decided to give the camels a day's rest, which they greatly needed. Mr. Walter Parke, of Henbury Station, kindly offered me the use of as many horses as I should require. Dr. Stirling and Mr. Watt visited (about twelve miles to the eastward, in Chandler's Range) a remarkable rock, called Antiarra, used by the aborigines in their periodical ceremonies. Mr. Parke undertook to pilot Mr. Watt, and furnished a black boy to do the same for Dr. Stirling. Professor Spencer, besides attending to his especial work, obtained, on my furnishing him with the means from our stores, various articles for the ethnological collection from the natives, a number of whom were camped near by. Professor Tate, as usual, devoted his time to botanising. I started at an early hour on a bearing of 85° 10' over high porcupine sandhills, crossing the Finke at one and a half miles and four and a quarter miles. The river at these points is a network of waterholes and extremely boggy channels. At three and a half miles I passed, about half a mile to the south of Christopher's Pinnacle, a low hill with an outcrop of quartzite in the form of a broken column in Chandler's Range. It is by no means conspicuous, and is overshadowed by the higher ranges immediately to the north. With six and a quarter miles completed, I ascended a high mass of quartzite rock about half a mile south of the range. To the S. and S.E. red sandhills appear as far as the vision extends. I continued on a bearing of 73° for three-quarters of a mile, 24° for a further three-quarters of a mile, and 37° 20' for one mile, passing through an opening in the centre of Chandler's Range, having now Antiarra water and rock about three miles to the east. Proceeding on a bearing of 20° for one and a quarter miles, I reached a post erected by me in 1878. Here ended my immediate journey, and, in stopping, I was enabled to check my present traverse. Returning afterwards to camp, I met Dr. Stirling and a black boy about six miles from Henbury on their way to Antiarra. In the afternoon and evening I was engaged on the expedition plans and in calculating and booking up meteorological observations. The two Government prospectors (C. Pritchard and W. Russell) engaged by Mr. Gillen at Alice Springs arrived at Henbury yesterday with two camels, and reported themselves to me to-day. I instructed them with respect to their duties in connection with the expedition. The party now

consists of twelve white men, two Afghans, and two black boys, together with twenty-six camels and two horses.

Monday, May 28th. — Camp No. 20, Henbury Station; bar. 28·72in., ther. 26°. Last night was the coldest we have yet experienced. The thermometer descended to 12° below freezing point, and all the water in the bags became solid masses of ice. Obtained a supply of beef and other necessaries from the station, and, after wishing farewell to Mr. Parke and Mr. Gill, whose kindness to us exceeds all praise, we continued our course up the Finke. Crossed the river near our camp, and travelled for two miles on a bearing of 315° through a sandy cane grass flat, then at 303° 20' over porcupine sandridges for four miles, again crossing the Finke at one and a quarter miles and also at two and a half miles. Changed the course to 297° for two and a half miles, then 337° for three-quarters of a mile, once more crossing the Finke, this time near some large sheets of water. Continued across a flat on a bearing of 305° 45' for one mile, and then yet again across the Finke. These repeated crossings are a great trial to the heavily-loaded camels, and greatly retard the progress of the caravan. At one and a quarter miles we camped in the sandhills on the eastern side of the river near a clump of desert oak.

Tuesday, May 29th.—Camp No. 21; bar. 28·54in., ther. 29°; height above sea level, 1,324ft. An early departure was made. Continued on the previous bearing 324° 20' for one and three-quarter miles over porcupine sandhills to a low stony sandstone rise, from which an extensive section of a high scrubby range is visible a few miles to the northward; this is, no doubt, a continuation of the James Range, of Stuart. A gum creek issuing from these ranges joins the Finke about half a mile to the westward. The river then takes a decided bend to the westward, in which direction the sandhills appear unusually high. The prominent hill towards which we have been travelling, distant three miles from here, is of considerable altitude, probably over 1,000ft. above the plain; it appears to be very rugged, and is entirely enveloped in mulga scrub. I have named it Mount Holder, after the Hon. F. W. Holder, Treasurer of South Australia and Minister Controlling the Northern Territory. Altered our course to 314° 20' for two and three-quarter miles through dense mulga scrub to a gap in the James Range; advantage has been taken of the precipitous rocks on either side to construct a horseyard by fencing across the gap in two places. Continued on a bearing of 295° 20' across a magnificently-grassed plain, on which the Mitchell grass of Queensland is fairly abundant; cotton-bush and saltbush also prevail. High rough ranges enclose the plain on the north

and south. At one mile we met a war party consisting of fourteen olackfellows, whose destination was Henbury. All these warriors were elaborately painted with red and yellow ochre and plentifully armed with spears and boomerangs. I learnt that they had come from the mission station with the intention of fighting the Henbury natives in order to avenge the death of one of their comrades. At two miles we crossed a fair-sized gum creek trending S.W. Sandhills covered with mulga scrub were now seen. At two and three-quarter miles I ascended some very rough quartzite rocks to obtain a round of bearings. Continued through low broken porcupine and scrubby hills for three and a half miles on various bearings to the western side of the Finke, and camped at Parke's Running Water. Professor Tate having remained, unknown to me, some miles back, I sent Harry out to show him the road to the camp. The elevation of this camp, I find by repeated hypsometer observations, to be 1,588ft. above sea level. High scrubby ranges surround the camp, and what in Central Australia is a novelty, namely a running stream, is to be seen here. At present the water is only 3in. or 4in. deep and about 6ft. wide. Our stage to-day totalled fourteen miles. I camped early, so that a thorough examination of this important locality could be made. The water-holes were dragged with the large net with but partial success, no new kinds of fish being obtained.

Wednesday, May 30th.—Camp No. 22, Parke's Running Water; lat. $24^{\circ} 18' 21''$ S.; height 1,588ft.; bar. 28.39in., ther. 31° . Continued on last night's bearing 230° for one mile to a point of the range, then changed the course to $235^{\circ} 10'$ for two and a quarter miles across sandy flats, splendidly grassed in places and timbered with mallee, bloodwood, and mulga, to a porcupine hill. The range to the north, about two and a half miles distant, continues westward in an apparently unbroken line. Altered our course to $272^{\circ} 5'$, crossing a few porcupine sandhills and well-grassed mulga flats. Five distinct varieties of the eucalypti apparently occur somewhat plentifully in this region. At two and a half miles we crossed a large gum creek issuing from the ranges to the northward, and at four miles I ascended a rough quartzite rise in order to obtain a round of bearings. Professor Tate and Mr. Watt, with whom I sent Harry the black boy as guide, here made a divergence, in accordance with previous arrangements, to the north for the purpose of examining the geological structure of the main range, in which fossils are said to occur, rejoining the party at Illamurta. As for the main party its course was changed to $279^{\circ} 40'$ for two and three-quarter miles through mulga scrub to the foot of the range, which is densely overgrown with porcupine.

We then altered our bearing to 334° for one and a half miles to a gap, through which Ilpilla, or McMinn's, Creek emerges. I now directed the main party to proceed to Illamurta, which was in sight, and following Ilpilla Creek for two miles into the ranges, at one and a half miles I found a nice little waterhole with an abundance of fish. On the hillside opposite the waterhole numerous caverns have been created by the decomposition of the rock. I had no time to examine these rude caves, which are said to contain specimens of native art. After mapping various portions of the ranges, I returned to the entrance of the gap, and from there followed the direction taken by the main party, one mile on a bearing of 235° and half a mile on a bearing of $297^{\circ} 40'$ to the Police Camp at Illamurta Spring, at which we camped. This spring is situated in a small creek, and is easily found from its proximity to a huge and imposing pile of rocks, which form a striking feature in the range. The water appears only for a few chains in the creek and is of excellent quality. High ranges of quartzite and sandstone surround this spot to the south, west, and north. Mr. T. Dare hospitably entertained us at his station during the evening. Professor Tate and Mr. Watt desiring, if possible, to examine further the geological structure of these ranges, and Professor Spencer being anxious to avail himself of the opportunity afforded by the soil and humidity of the spring to perfect the biological collection, I have decided to remain in camp here to-morrow. We experienced a disagreeably close night, the only one yet experienced; the thermometer at 10 p.m. registered 69° . Our elevation here is 1,674ft. above sea level.

Thursday, May 31st.—Camp No. 23, Illamurta; bar. 28.22in., ther. 53° . A few drops of rain fell during the night, not sufficient to do either good or harm. This morning Mr. Watt, with whom I have dispatched Harry the black boy, started for a day's excursion on foot into the ranges. Professor Spencer examined the soil in the vicinity of the spring for earthworms, &c. Professor Tate attended to his botanical collections, and Mr. Keartland, as usual, employed the whole of his time with the ornithological specimens, being highly delighted at having obtained a number of rare and very beautiful finches at this place. Mr. Belt made an extended examination of the precipitous ranges surrounding the camp and secured some very valuable botanical specimens from the summit of the highest hills. I was engaged all day upon the topographical map and in working out my observations. I also arranged with Mr. T. Dare, who kindly undertook to supply a number of horses, to instruct Mr. C. E. Cowle on his return from Erldunda, where he had gone with the expectation of meeting the party, to overtake me

on the Petermann Creek. The object of this arrangement is that Mr. Cowle may lead a detachment of the party to Ayers Rock, which it is desirable to photograph and which he recently visited.

H. E. E.

Marked a tree about four chains south of the spring C. W., this being our twenty-third camp. 23

Friday, June 1st.—Camp No. 23, Illamurta; bar. 28·14in., ther. 18°; height 1,674ft. At dawn this morning the thermometer registered 14° below freezing point. This is a variation of just 50° in temperature since the preceding night. The water in the bags and in the receptacles was frozen into a solid mass of ice. Farewell having been said to Mr. T. Dare, a start was made westward along the south side of the James Range. This remarkable and extensive range has an unbroken and almost due east and west direction, extending from the Todd river in longitude 135° E. to the westward, a distance of 250 miles. Our course was 233° 20' for one mile to the top of a low rocky hill; thence 259° 30' for three and three-quarter miles through open and splendidly-grassed mulga scrub, changed to 272° 20' for one and a half miles and 254° for eight and a quarter miles to a rugged mass of bare rocks, at which my horse took fright. The girths and reins both giving way, I received a nasty fall. The expedition continued on a bearing of 274° for one and a half miles and 265° for four miles over sandhills and well-grassed flats to the Palmer river, a broad sandy stream lined with gum saplings and containing plenty of water, which was still running at the time of our crossing. About one and a half miles north a large waterhole, Ilarra, some two and a half miles long, occurs in the river. Saving a few miles of sand and porcupine near the Palmer, the whole of our journey to-day has been over splendidly-grassed saltbush country. Professor Spencer, Dr. Stirling, and Mr. Watt visited the large waterhole in the Palmer, just mentioned, their main object being to inspect in its neighborhood some caves and mural paintings of the natives. I walked to a hill south of the camp to obtain bearings to surrounding hills and ranges. Ilarra Rock bears 23°, and is about two miles distant; it is a huge outcrop of quartzite on the summit of the middle tier of the James Range. Our stage to-day has been twenty-two miles.

Saturday, June 2nd.—Camp No. 24, Palmer river; bar. 28·14in., ther. 17°; height 1,738ft. Crossing the Palmer river we continued on a bearing of 230° for one mile. Then Professors Spencer and Tate, with Dr. Stirling, made for Tempe Downs Station, nine miles distant, the main party proceeding, on a bearing of 188° 45', across sandhills towards what looked like a gap in the southern ridge of

the James Range. At one and a half miles we crossed the Walker Creek, a gum creek having a sandy channel, equal in size to that of the Palmer. At two and a half miles we reached the break in the range, which I found very rough yet passable for the camels. At three and a half miles we altered our course to $258^{\circ} 20'$, across splendidly-grassed saltbush and cotton-bush flats, lightly timbered with gums and acacias. At one and a half miles we passed some high sandstone rocks, and at five miles arrived at the Petermann Creek. After prolonged search a difficult crossing was found. Further vexatious delays occurred through the loads shifting. Finally, however, we managed to get the pack camels across this creek, which is about 40yds. wide with high precipitous banks; its gum timber is similar to that on the Palmer, being mostly young saplings. At five and a half miles we crossed a gum creek, Undia, coming from the ranges to the south. At seven and a half miles a spur of the Levi Range approached the Petermann Creek; and at eight and a quarter miles I found a shallow waterhole about 300yds. long and 15yds. wide, at which I decided to camp. The country passed over to-day is most magnificently grassed, and good saltbush and cotton-bush are everywhere abundant. This camp, which is 1,888ft. above sea level, will be the scene of our first depôt. I have, therefore, had the tents erected and arrangements made for a prolonged stay. The Levi Range, a sandstone formation of about the same elevation as the James Range, is about half a mile to the south of our camp, and now has an abrupt and wall-like appearance, assuming the character of an amphitheatre.

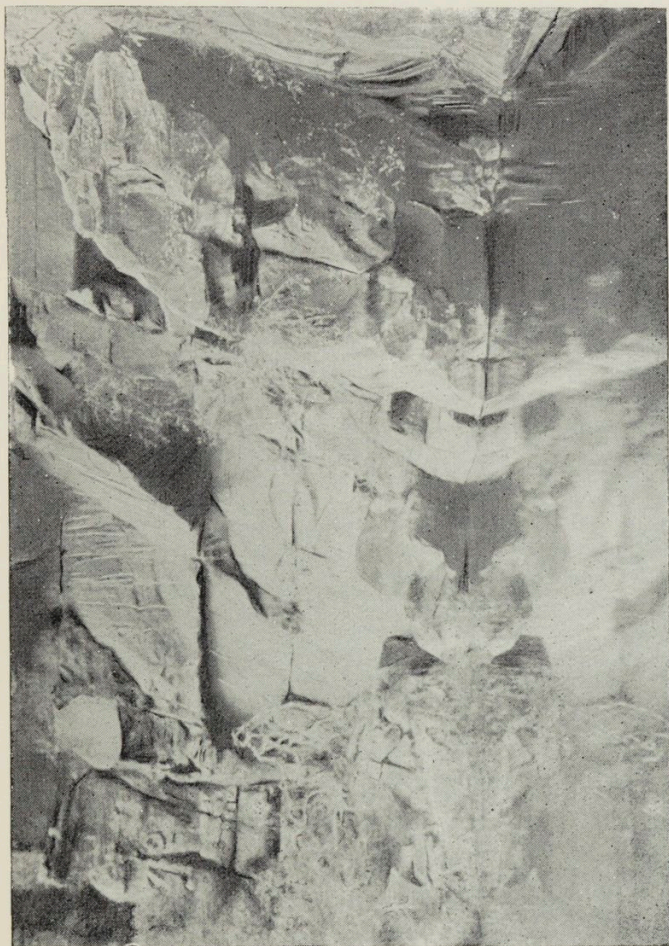
Sunday, June 3rd.—Camp No. 25, Petermann Creek; bar. 28.06in., ther. 30° ; height 1,888ft. Mr. Watt being desirous of examining the geological structure of Levi's Range, I ordered Tommy, one of the black boys, to accompany him thither. Both returned at dusk. A general overhaul and re-arrangement of the loading were made with the view of reducing the burdens as much as possible, as we have to take a fresh supply of rations from here. These stores are now overdue—they ought to have come to hand two days ago. Mr. Kearthland and Mr. Belt were busy all day preserving and skinning birds for the ornithological collection. I was engaged in bringing my work up to date and in obtaining various meteorological observations. Some natives approached Levi's Range to-day, but they ran away as soon as they found themselves observed. Towards evening the sky became overcast, presenting every appearance of coming rain. This prevented me from verifying the position of the camp, although I waited till long past midnight in the hope of obtaining satisfactory observations.

Monday, June 4th.—Camp No. 25; bar. 23.16in., ther. 56° .

Mr. Watt set out to examine the James Ranges to the north of the camp, and, as he anticipated reaching Tempe Downs Station early in the day, he declined the services of a black boy. Accompanied by Mr. Belt and Tommy the black boy, and leaving the camp in charge of Mr. Keartland, I returned on our tracks, mapping the country to the Walker Creek north of Petermann Gap. Thence I travelled to Tempe Downs Station. Starting on a bearing of 307° in the direction of Mount Lewis, a high prominent point in an elevated scrubby range, I crossed the Walker Creek in one and a half miles; at three and a half miles over red sandridges covered with porcupine grass and casuarina (desert oak) forest, I altered the course to 272° in the direction of a spur in the southern range. At half a mile we again crossed the Walker, and at two and three-quarter miles entered the Walker Gorge on a bearing of $229^{\circ} 30'$. This gorge is formed by the Walker Creek flowing through three ridges of the James Range. High precipitous rocks abut on the watercourse. An abundance of water is always running amid the reeds and rushes here. Emerging from the gorge in three-quarters of a mile, we entered the Tempe Downs Plain on a bearing of $71^{\circ} 20'$, and after twice crossing the Walker Creek in one and a quarter miles we arrived at the station. All this region consists of high, scrubby, rocky, and impassable ridges, trending in parallel lines east and west, with plains between varying considerably in extent. These expanses of flat country are generally well grassed and fairly timbered; but red sandhills are often encountered, with their inevitable porcupine grass. Mr. Thornton, the owner of Tempe Downs, with the utmost generosity, insisted on all the members of the party partaking of his hospitality. I found Professors Spencer, Tate, and Dr. Stirling, who arrived here on Saturday evening, all well pleased at the extended time allowed them and anxious for a further stay, the fauna, flora, and formation of the locality proving to be of especial interest; but the limited time at our disposal will not permit me to prolong the visit here. In the evening Mr. Thornton arranged for our edification a corroboree by the natives, of whom a large number are camped in the vicinity of the station. An intensely cold night somewhat chilled the ardor of the native performers. Nevertheless the anthropologist will, I doubt not, fully describe this ceremony, which was not without interest despite the circumstances militating against it. Our second instalment of stores obtained from Mr. F. Raggett, of Alice Springs, arrived at Tempe Downs to-day. Mr. Thornton having kindly placed a trustworthy black boy at my disposal, I sent instructions to Mr. Keartland to dispatch eight pack camels to Petermann Gap to-morrow.

Tuesday, June 5th.—Camp No. 26, Tempe Downs Station; bar. 28.26in., ther. 49°; height 1,791ft. Mr. Watt, who attempted to cross the ranges from the camp to Tempe Downs Station yesterday, was unable to do so and was out by himself all night; he returned safely early this morning. Assisted by Mr. Belt, I examined and re-sorted the stores just arrived, and arranged to have them taken back to Petermann Gap. I also paid off Tommy the black boy, who has not been of much assistance, and engaged a local native called Arabi Bey. Professor Spencer meanwhile photographed several groups of natives in their corroboree costume. At noon, accompanied by Mr. Thornton, we all started for Petermann Gap, arriving there at 3 p.m. The pack camels and men from the Petermann Dépôt arrived at 4:30 p.m. Previous to this Mr. Thornton had selected and yarded for us a fine fat bullock from his herd. In the evening we killed and cut up the beast, which will serve us as our meat supply for the next three weeks. Mr. Thornton generously refused all consideration for this munificent present, thus adding to our obligations to him. I must also mention that I received a letter from Mr. C. E. Cowle advising me of his arrival at the dépôt with nine horses and a black boy.

Wednesday, June 6th.—Camp No. 27, Petermann Gap; bar. 28.30in., ther. 27°. Mr. Thornton still further increased my indebtedness to him by providing horses for Professor Tate and Dr. Stirling, and by undertaking to accompany the professors to the Palmer river, north of Illara Waterhole, for the purpose of pointing out the locality in which a species of grass tree grows. Wishing our late kind host farewell, I directed the men with the pack camels to return in charge of Mr. Belt to the Dépôt Camp. Then, with the view of making the utmost use of the little time at my command, I continued mapping the country in detail in a south-easterly direction. Starting from Petermann Gap, on a bearing of 120°, across well-grassed salt and cotton bush country, at one and a half miles I passed a dry polygonum grass and box swamp, due to the overflow of Petermann Creek. At three miles I ascended a rocky rise, with the object of obtaining bearings to the surrounding hills. The Petermann Creek has now resolved itself into extensive gum flats, which surround this and other neighboring mounts. Here I noticed for the first time two of those rare birds the Princess Alexandra parakeet (*Polyteles Alexandra*). Continued on a bearing of 123°, passing through flooded gum flats for three and a quarter miles to a rocky sandstone ridge embedded in high red sandridges. At four and a half miles I found myself on the Palmer river. This I followed on the previous bearing, and at five miles I arrived at Mr. E. Giles's "permanent



Reedy Creek, Gill's Range.

water" (Middleton's Fish Ponds), now, however, quite dry. Altered my course to $177^{\circ} 50'$ for two miles to a stockyard and well on the Petermann Creek, near the eastern termination of the Levi Range. This well appears to be about 60ft. deep, and at present contains about 30ft. of water. Several small clay waterholes near the stockyard do not now contain any water. Petermann Creek joins the Palmer river a few miles to the eastward. Once more altered course, now so as to strike Undia Creek near its junction with the Petermann. At twelve and a half miles, over well-grassed country, I crossed Undia Creek, and at fifteen and a half miles I reached the Dépôt Camp, No. 25, having travelled altogether twenty-eight miles. Mr. Belt, with the pack camels, had previously arrived. Professor Spencer and Dr. Stirling came in towards evening, under the guidance of my black boy, whom I sent back at sundown for Professor Tate. Both the professor and his guide returned to camp in about an hour's time. Mr. C. E. Cowle reported himself to me on my arrival. From his knowledge of this country, and his experience with the aboriginals of this region, he will be a valuable addition to the party. The expedition now consists of eighteen members, with twenty-six camels and eleven horses.

Thursday, June 7th.—Camp No. 25, bar. 28.16in., ther. 52° . A somewhat late start was made with the pack camels. Mr. Watt and Professor Tate, having been provided with horses, proceeded with Mr. Cowle to Gill's Range, for the purpose of examining certain fossil deposits recorded by Mr. H. Y. L. Brown, the Government Geologist, as existing in that neighborhood. I then set out on a bearing of 265° , following the course of the Petermann Creek. With three miles completed I found myself at the foot of Mount Levi, and the termination of the Levi Range. Accordingly I altered my course to 257° , crossing the Petermann in one mile. At two miles I passed several rain water holes in the creek, and then changed the course to $257^{\circ} 10'$, in the direction of Gill's Range. With one mile covered on this line I passed Mr. E. Giles's "permanent waterhole" and marked tree. I do not regard the waterhole capable of affording a perpetual supply. The indications of permanency described by Mr. Giles are only saline deposits from the rocks, due to evaporation. A quarter of a mile further on I struck the junction of Petermann and Trickett's Creeks. From here a fine open plain, splendidly grassed, with an abundance of salt and cotton bush, extends to the foot of Gill's Range. At three and a half miles I arrived at the south-eastern point of this range. Here I awaited the coming of the main party, and then camped half a mile to the south, on Trickett's Creek. In the afternoon I proceeded with Professor Tate and Mr. Watt to

the northern side of the range, near the Petermann Creek, in order to examine the fossil beds which occur there. In the evening I made extensive astronomical and meteorological observations.

Friday, June 8th.—Camp No. 28, Trickett's Creek; bar. 28·00in., ther. 57°; height 1,963ft.; lat. 24°-27' 48" S., long. 132° 3' 30" E. An unpleasant sultry night was followed by a real summer's day, the thermometer rising to 97° in the shade during the afternoon. After instructing Mr. Cowle to proceed with Mr. Watt to Bagot's Creek by the northern side of Gill's Range, for the purpose of determining the fossiliferous beds in that locality, I directed the main party along the southern side through well-grassed mulga scrub and across luxuriantly-grassed open flats. With fifteen and a half miles covered we arrived at a small creek issuing from a gorge in the range. The ridge maintains a uniform altitude of between 500ft. and 600ft., and has a slight indeterminable escarpment both on its northern and southern aspect, while the creek contains numerous large gum trees and was named by Mr. E. Giles Bagot's Creek. We camped near a small reedy and permanent waterhole at the entrance of the gorge.

Saturday, June 9th.—Camp No. 29, Bagot's Creek; bar. 27·92in., ther. 47°; height 2,088ft. Sufficient rain fell during the night to wet our blankets. All the members of the party were engaged throughout the day exploring the range, gorge, and creek to the northward. Numerous birds were obtained, and six young emus were captured alive by the black boys and handed over to the ornithologist for his collection. I was occupied all day and until late at night in bringing my work up to date. Marked a tree on

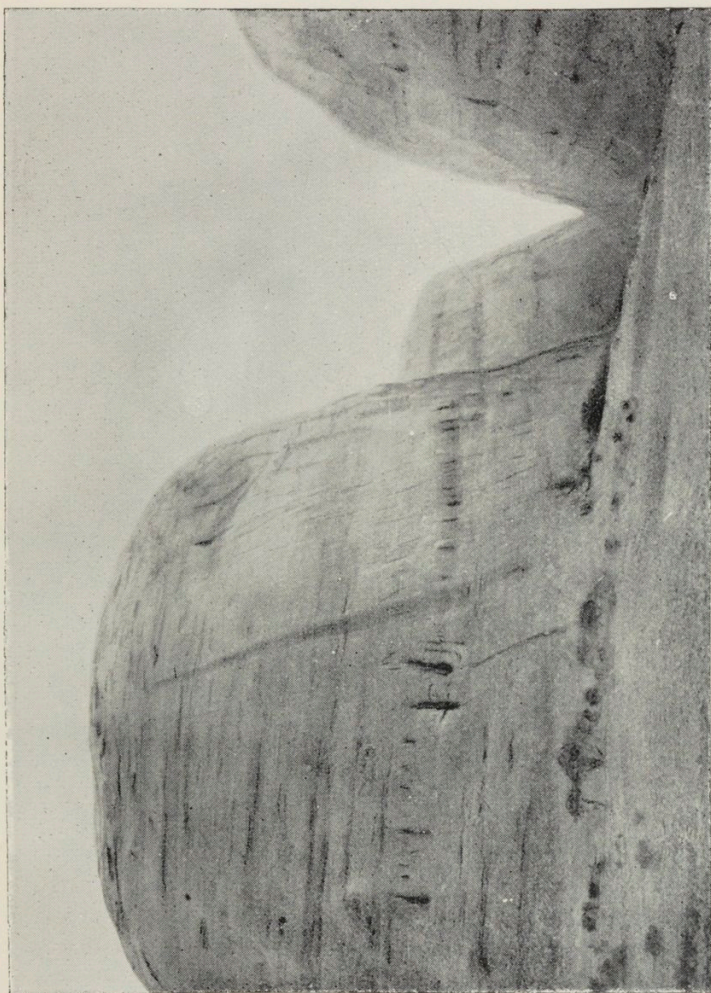
H. E. E.

the eastern side of the creek adjacent to the waterhole C. W., this

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being our twenty-ninth camp since leaving Oodnadatta. In the evening the camp was prepared in the expectation of more rain falling, which seemed imminent.

Sunday, June 10th.—Camp No. 29, bar. 27·98in., ther. 31°. The rain clouds disappeared during the night and an early departure was made this morning. I arranged for Dr. Stirling to proceed with Mr. Cowle in advance for the purpose of enabling an inspection to be made of several small gorges in the range. The main party travelled near the range in a general westerly direction over sandy soil densely timbered with mulga, desert oak, and low cassia bushes. At two and a half miles we passed Stokes Creek, a rather large gum creek draining the central portions of Gill's Range. Five miles further on we crossed a small gum creek, the Kathleen, about half a mile south of the range. A permanent spring of water exists



Felix Spring, Mount Olga.

in a small gorge about three-quarters of a mile to the north of our track. The fatal poison plant *Gastrolobium grandiflorum* was obtained here for the first time. I did not expect to find it this side of King's Creek, and shall now take extra precautions against losing any of my camels. At thirteen and a half miles we arrived at Reedy Creek, which was followed, half a mile north, to the foot of some high, perpendicular, and bare rocks. We camped at a small reedy waterhole, into which the water runs from a large permanent pool immediately beneath the rocks. The creek forms a waterfall about 50ft. in height above the permanent pool. Other and smaller rockholes exist higher up the rock. A few acres of reeds and rushes surround the water near the camp. Fine large gums grow in profusion in and near the stream. Another spring, similar in every respect to that giving rise to Reedy Creek, exists in a branch creek a short distance to the eastward. Our camp is near Mr. E. Giles's and Dr. C. Chewings' marked trees. Several varieties of ferns were found growing in the interstices of the rocks near the permanent pool, which is about 20yds. in diameter. My astronomical observations occupied me until midnight.

Monday, June 11th.—Camp No. 30, Reedy Creek; bar. 27.99in., ther. 39°, lat. 24° 17' 49" S., long. 131° 38' 25" E.; height 1,903ft. This being one of the localities in which it was expected that valuable additions would be made to the zoological, botanical, and geological collections, I decided to camp here for two days. Accompanied by Mr. Cowle and two black boys I started in a westerly direction with the intention of connecting my route with Mr. W. C. Gosse's at King's Creek. Travelling over casuarina sandhills and spinifex for five miles to King's Creek we found Mr. Gosse's marked tree on the eastern bank of the creek. This gum tree (*Eucalyptus tessalaris*) has now been undermined by repeated floods and retains its erect position only by reason of its exceptionally large roots, which are fully exposed. In all probability before many more years elapse another flood will entirely obliterate this important mark. In order, therefore, to identify its position I have arranged with Mr. Cowle for the erection of a large cairn of stones 6ft. in height, with a centre pole, on a stony hill bearing exactly N.W. 45°, and distant nineteen chains from it. The following bearings and distances to surrounding hills will further establish the position of the tree, which was excellently marked on the south

7

side by Mr. E. Berry, Mr. Gosse's lieutenant, G O S:—Point of

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ridge near creek, distant thirty-six chains, 15° 20'; stony ridge Δ, distant nineteen chains 45°; mulga hill, about thirty chains distant,

309°; low hill, forty chains 334° 20'. From Mr. Gosse's No. 7 depôt we followed King's Creek northward. At one and three-quarter miles, in dense mulga scrub, we found a blackfellow's skull. This was secured for the anthropologist. At two and three-quarter miles the black boy, Arabi Bey, pointed out a small spring in the bed of the creek. The acacia scrub on either side of the creek near the spring is almost impenetrable. Gill's Range terminates a mile to the westward, apparently in two high bluffs. The northern of these, the most conspicuous and elevated, was named Carmichael's Crag by Mr. E. Giles. We now travelled eastward through closely grown mulga scrub. Passing Penny's Creek in about two miles we arrived at the camp in four miles. The members of the scientific staff have been employed all the day through in their special work, and are well satisfied with the results this place has yielded. Several natives surprised on the range vanished before we had a chance of conversing with them. In their desperate haste to get away they abandoned all their weapons, which were subsequently added to the ethnological collection.

Tuesday, June 12th.—Bar. 27.94in., ther. 32°. To-day final preparations were made for dispatching under Mr. Cowle's guidance a detachment of the party to Ayers Rock. With the assistance of the black boys, excursions into the ranges to the north and into the sandhills to the south resulted in the value and importance of the several scientific collections being materially increased. The rocks at Penny's Creek, two and a half miles to the westward, were examined. A new land snail and the cycad, locally called a palm, were obtained in this locality. Two natives from Tempe Downs arrived at the camp, bringing a rare lizard sent by Mr. Thornton. I observed the magnetic dip and variation, computed results of astronomical and other observations, completed the topographical map, and, by measurements, ascertained the height of the cliffs above the permanent pool to be 146ft.

Wednesday, June 13th.—Bar. 27.86in., ther. 36°. A long journey was before me to-day, and as I had many matters to attend to this morning we were astir earlier than usual. Mr. Cowle, with Professor Spencer and Messrs. Watt and Belt, who desired to participate in the trip, will leave the main party at this place and visit Ayers Rock and, if possible, Mount Olga, for the purpose of obtaining photographs of either or both of them. Dr. Stirling, who originally wished to go with this party, eventually preferred to accompany the main expedition. Having given Mr. Cowle final instructions and arranged to meet him at Glen Helen a fortnight hence—that is, on the 26th of this month—I led the main party westward, with the intention of visiting Laurie's Creek in order to



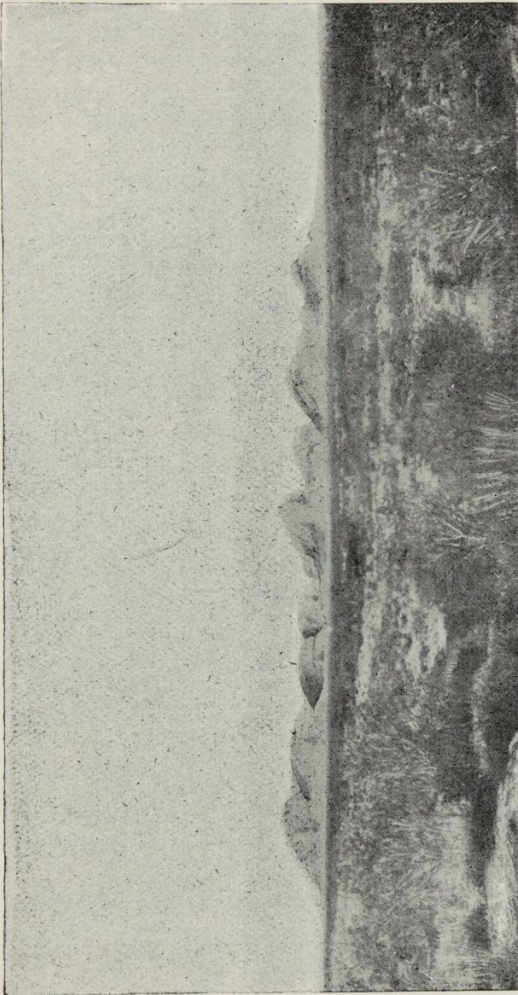
Ayers Rock (about two miles west).

examine numerous fossiliferous deposits discovered by Mr. Thornton in that neighborhood. Starting on a bearing of 315° along the foot of the range, we crossed King's Creek in three and a half miles. At four miles Gill's Range abruptly terminates in several high red bluffs, the most prominent of which is, as already stated, Carmichael's Crag. Altered our course to $320^{\circ} 40'$ over splendidly-grassed salt and cotton bush flats. This is by far the best pastoral country I have yet seen on this journey. Numerous large clay-pans were passed. At three-quarters of a mile, and again at three and a quarter miles, we crossed a small gum creek, both trending to the south. The country now changes to red sandhills and becomes more scrubby, large plots of porcupine grass occurring frequently. The James Range still continues in a westerly direction, some six miles to the north, and appears to be densely timbered with acacia. A low sandstone ridge runs parallel with our course to the south, from half a mile to two miles distant. At seven and three-quarter miles we crossed another small gum creek, this one flowing north. Now altered our course to $308^{\circ} 40'$, crossing a miniature gum creek in one and a half miles and another somewhat larger creek at four miles; the latter forms a gorge or gap in the sandstone ridges to the south. I have named this gap Morris Pass after M. Doswell, Esq., of the Crown Lands Department. Changed our course to 268° through Morris Pass; and at half a mile varied it to $287^{\circ} 5'$ for two and a half miles through very dense mulga scrub. Upon entering the pass, the sides of which are two parallel sandstone ridges, we became entangled in a network of deep rocky creeks with steep banks and a dense growth of acacia, through which we had the utmost difficulty in finding a path for the camels. At two and a half miles the scrub became more open and saltbush flats occurred. At five and a quarter miles we struck Laurie's Creek, which I followed southward for about three-quarters of a mile, to two small shallow rain water holes, near which I decided to camp. Leaving here Professor Tate and Dr. Stirling, with whom I had pushed on in advance, I returned after sunset some four miles towards the pass and brought the pack camels into camp, afterwards observing for latitude and magnetic variation. Our stage to-day has been twenty-three miles, though I myself have travelled thirty-one miles, over somewhat rough country and through dense scrub.

Thursday, June 14th. — Camp No. 31, Laurie's Creek; bar. 27.70in., ther. 29° ; height, 2,263ft.; lat. $24^{\circ} 7' 22''$ S.; variation $2^{\circ} 35'$ E. Several native signal smokes having been observed in the vicinity yesterday, I sent in quest of those who had raised them our two black boys and the blackfellow from Tempe Downs,

Mennamurta, who had elected to accompany the expedition. My object was to induce the aboriginals to visit our camp for the benefit of the anthropologist. But only one blackfellow and his family came in. Him I dispatched with the others to collect specimens of natural history. In the evening three lizards, a number of frogs, and some birds' eggs, together with a number of fossils (*Orthoceras* and *Lituities*) were brought to me. Professor Tate to-day examined the district for fossils and botanical specimens. A large number of rock pigeons were shot near the camp, sufficient for several meals for the whole party. I followed the creek southward for several miles to its junction with another gum creek from the westward and mapped the surrounding country. A prominent hill bearing 192° , distant nine and a half miles, I have named Mount Tucker, after C. Tucker, Esq., Mayor of Adelaide. In the evening I attended to the maps and computed results from various astronomical observations. By careful hypsometer measurements I found that this camp occupied the most elevated position we had yet attained, namely, a height of 2,263ft. above sea level. Obnoxious burrs, notably *salsola-kali*, infest the whole of the country in this neighborhood, as well as the other territory through which we have passed, supplying our chief source of inconvenience throughout the whole journey.

Friday, June 15th.—Camp No. 31; bar. 27.72in., ther. 28° . An earlier start than usual was made this morning, with the view of affording Professor Tate an opportunity to examine a fossiliferous deposit some two miles to the north. I sent Harry and another black boy to show him, and Dr. Stirling, who accompanied him, to the locality in question, giving Harry directions how to join the main party. Following Laurie's Creek, on a bearing of 24° , we passed in one mile through a rough gap in a low sandstone and quartzite ridge, and entered Mr. E. Giles's Vale of Tempe. This is merely a small well-grassed cotton and salt bush plain, five square miles in extent, intersected by Laurie's Creek and surrounded by low scrubby ridges. Altered our course to $318^\circ 50'$ along the main channel of Laurie's Creek, finding at the end of one mile that the creek receives numerous small tributaries from the surrounding stony undulations, which are exceptionally densely timbered with mulga (*Acacia aneura*). At one and a half miles we again entered sandridges, which now have a direction of $N. 73^\circ E.$ A change of bearing to $336^\circ 15'$ towards a low depression in the James Range, revealed to us that the sandridges, which are overgrown with porcupine grass and timbered with casuarina, alternate with mulga flats for five miles and then give place to salt and cotton bush plains. With six miles covered we arrived at a low sandstone



Mount Olga.

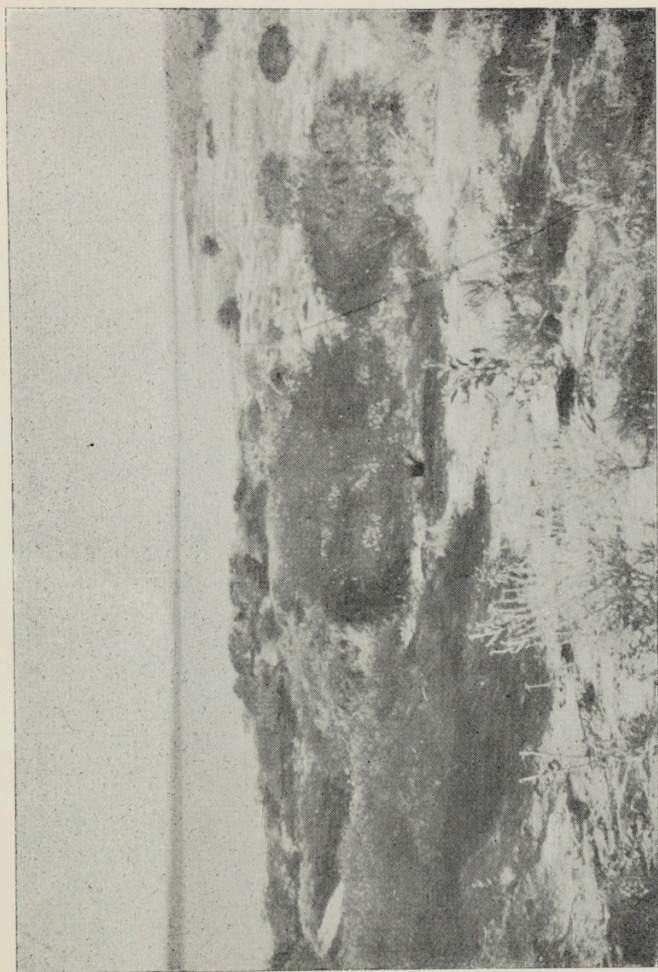
and quartzite ridge, which is, in reality, the western termination of the James Range. Professor Tate and Dr. Stirling, under Harry's guidance, here rejoined the main party. The professor had obtained from the black boy a perfect and complete specimen of a trilobite. Mr. Keartland during a short halt shot a dingo, whose skull now enriches the collection. Altered our course to 6° over porcupine ridges, timbered with casuarina and several varieties of eucalyptus. At four and a half miles we passed several grass trees (a species of *Xanthorrhoea*, probably *Anguillaria Australis*) and kurrajongs (*Brachychiton Gregorii*). Changing our course to $4^{\circ} 40'$ in the direction of a low hill near Glen Edith, we discovered that at five miles and twenty-one miles from the point from which we started to-day, taking the course we pursued, the sandhills cease and that sandstone rocks appear shortly afterwards. Arrived at Glen Edith; we camped, having travelled twenty-two miles. I found the Tarn of Auber, which is in a cleft from 6ft. to 10ft. wide in a low bare sandstone ridge, to be quite dry and full of sand and *debris*. By digging down some 4ft. I obtained sufficient water for the horses, who, however, would not touch it, the water emitting a strong odor of decayed vegetable and animal matter and proving unfit for consumption. Good surface water has always been obtained here by previous explorers, even in very dry seasons. I therefore anticipated being equally fortunate, and with the view of saving the camels from unnecessary labor I did not have the kegs filled at Laurie's Creek. The next known supply of water is an eight days' journey off. Mr. Gosse's marked tree, about eight chains west of the Tarn, has been partially burnt and the inscription effaced since Mr. Tietkins removed the overgrown bark in 1889. Dr. Chewings' marked tree, ^{C. C.} 1. 9. 85 is about two chains south, and

Mr. Tietkins' marked tree, ^T 5. 89, is about four chains west of the Tarn. A little grass occurs in the immediate neighborhood of Glen Edith. The hills are covered with porcupine. The native fig tree (*Ficus orbicularis*), cypress pine (*Callitris*), and bloodwood gum (*Eucalyptus terminalis*) grow in the interstices of the rocks near the water. Otherwise there is nothing specially noticeable at this camp, which is 12ft. lower than our last on Laurie's Creek. The native name of the Tarn of Auber is Toonker-boongia.

Saturday, June 16th.—Camp No. 32, Glen Edith; bar. 27.62in., ther. 34° ; lat. $23^{\circ} 50' 20''$ S.; height 2,251ft. Directing the party to follow round the low stony ridges to the eastward of the Tarn of Auber I ascended the highest point of the ridge bearing N.N.W., and one mile from the camp. From here I obtained an exten-

sive view. Numerous distant mountains of the Macdonnell Ranges are visible from W. 18° N., round by north to east. Mr. Giles's two pine-clad hills bear S.S.E. three-quarters of a mile off. Low hills, some being very distant, are visible from S.S.W. to west. After taking a complete round of bearings I continued on a line of $38^{\circ} 10'$ across high porcupine sandridges. At one and three-quarter miles, after rejoining the main party, changed the course to $17^{\circ} 40'$ for two and a quarter miles, and then to 40° at three miles. During the mid-day halt Mr. Keartland shot and secured for the ornithological collection fifteen specimens of that most rare bird the Princess Alexandra parakeet (*Polyteles Alexandræ*). When seven miles had been traversed the gum timber of Deering Creek came into view. By altering the course to 89° in the direction of some very large gums we passed at half a mile the bend of the creek, and at one mile crossed to the eastern side of the creek, where we camped, having travelled in all seventeen miles over somewhat steep sandridges, here and there fairly well grassed, and all thickly clad with desert oak. Several fine kurrajong trees were seen to-day, and the pituri bush (*Dubosia Hopwoodi*), which is fatal to camels, was gathered. In places the flats between the sandridges are densely timbered with mulga. Deering Creek has a well-defined channel some 20yds. wide, and is lined with luxuriant gums. The sand in the creek near our camp was quite moist, and we easily obtained sufficient water for all our purposes. A high and very prominent mountain, bearing $70^{\circ} 20'$, and distant eight and three-quarter miles, marks the commencement of the Macdonnell Ranges. A conspicuous mountain, bearing 39° , distant seven and a half miles, I have named Mount Stirling, after Dr. E. C. Stirling, C.M.G., the anthropologist and ethnologist of the expedition. The black boy, Mennawurta, procured a new species of tree lizard and two opossums. Several emus and dingoes were seen during to-day's journey.

Sunday, June 17th.—Camp No. 33, Deering Creek; bar. 27.63in., ther. 25° ; height 2,210ft. Leaving the caravan, with instructions to follow the creek in an easterly direction for some ten miles and then camp, Harry remaining as guide, I started with Professor Tate and Dr. Stirling for the high mountain bearing $70^{\circ} 20'$. Mr. Keartland will stay at this place with H. Edgar and a black boy until noon, to complete, if possible, the preservation of the whole of the specimens of the Princess Alexandra parakeet obtained yesterday, and then overtake the main party. After travelling five miles across sandridges overgrown with porcupine and patches of inferior grasses, and densely timbered with mulga, teatree (*Thyptomene maisonneuvii*), native poplar, peach tree (*Santalum acumina-*



Lake Amadeus.

tum), drooping acacia or ironbark (*Acacia salicina*), kurrajong, and mallee (*Eucalyptus pachyphylla*), we arrived at an open stony plain which extends to the base of the mountain. This height is composed of quartzite and sandstone, and has an abrupt escarpment facing westward and southward, appearing indeed from these directions to be inaccessible. It is of very considerable elevation, being some 1,533ft. above the surrounding plain and 3,884ft. above sea level. This important geographical feature not having previously received a name, I have called it Mount Tate, after Professor R. Tate, the palæontologist and botanist of the expedition, who will make a geological examination of the range to which it belongs, and which is called Babamamma by the natives. At five and a half miles, after having crossed several small gum creeks trending southward, I altered the course to $96^{\circ} 30'$, a small pine-clad hill, mentioned by previous explorers, bearing 122° . At two and three-quarter miles, across low but distressingly stony hills, we came to a small mallee creek, near which we decided to leave the camels, and continue the further exploration of the precipitous hills to the north on foot. Crossing several ridges we ascended a rugged stony creek confined between steep rocks until further progress was prevented at a considerable altitude by a steep outer escarpment of the parent hill. On our return Dr. Stirling and I noticed a number of white bats (*Megaderma gigas*) evidently dislodged from their retreat by the smoke and fire of several large plots of porcupine grass which we had ignited in the gorge. Frightened by us, they disappeared in a crevice near the summit of a hill some 350ft. above the creek bed. We at once ascended to this spot and discovered a small horizontal fissure some 4ft. in width and 2ft. in height. One of the special objects of the expedition being to obtain specimens of the interesting and rare animals referred to, Dr. Stirling ventured into the cave. Assuming a recumbent position he penetrated some 5yds. from the entrance. There, owing to the shape and size of the cavern, he could stand erect, and walked without hindrance for 20yds. further. Beyond that he could not go. Having exhausted all our stock of matches, and possessing no other materials for illumination, he was reluctantly compelled to return. Two ordinary grey bats only were driven by him from the cave. A large number of white bats and other animals, including dingoes, sought a retreat in the further recesses of the hill. A return to where the camels had been left was followed by our continuing on a bearing of $125^{\circ} 30'$ for three and a half miles to Deering Creek. Here we found the main party camped at a small rain water hole. The first two miles of our journey was over exceedingly rough stony ground; the last one

and a half miles through dense mulga and drooping acacia scrub, magnificently grassed. Mr. Keartland and Edgar, who were unable to complete their work this morning, rejoined the party after sundown. Mr. Keartland, who is a most enthusiastic ornithologist, continued as usual to work until midnight in order to preserve all the birds obtained yesterday and those procured to-day. Professor Tate was occupied for several hours in arranging and cataloguing the plants gathered during the day's travel.

Monday, June 18th.—Camp No. 34, Deering Creek; bar. 27.46in., ther. 41°; height 2,351ft. The camels had divided into several small mobs this morning; consequently a somewhat late start was made. I was disposed to return to the bat cave with additional means for procuring specimens of the *Megaderma*, but as it was represented that specimens of these animals could be obtained near Alice Springs I proceeded on a course of 110° 40' over porcupine sandhills timbered with casuarina, mulga, mallee, drooping acacia, and low cassia bushes. This description applies to the country for three and three-quarter miles, when we reached a sandstone ridge, which forms part of Gardiner's Range. The rocks here have a dip of 85° to the north. Altered our course to 53° 5' over similar sandridges. At two and a half miles we passed several clusters of large grass trees, and at three miles crossed the confluence of two gum creeks near a shallow rain water hole now about 300yds. in length. A brief halt was made here, and through the combined efforts of the party several interesting botanical specimens were obtained. Mr. E. Giles, through not following its erratic course, concluded that the Carmichael's Creek westward of this point was a separate geographical feature and named it Deering Creek. To obviate future misconception I have designated the eastern portion of the creek from this waterhole, near which a small creek junctions from the north, Carmichael's Creek. The northern creek will therefore be considered as forming the upper tributaries of the Deering. A high mountain in the northern range bears 18° and is five and a quarter miles distant; this was named Mount Musgrave by Mr. Giles. Mereenie Bluff, the termination of the southern range, is twelve and a half miles distant and bears 75° 5'; a peculiar chain of escarped mountains, forming the middle range, terminate in a series of abrupt bluffs, of which the western one is the most elevated and constitutes Mr. Giles's Haast's Bluff. After carefully perusing Mr. Giles's detailed description of this peculiar feature I am convinced that the position at present attributed to Haast's Bluff on existing charts is erroneous. [Subsequent conversation with Dr. Chewings, who explored this region in 1885, further tended to establish my conviction.] I have,

therefore, allotted Dr. Haast's name to the bluff it was originally intended for and eliminated it from the description of the mountains some twenty-two miles to the northward, to which it has hitherto been misapplied, judging it expedient that so palpable an error should not be perpetuated. Haast's Bluff from this waterhole bears 62° and is seven miles distant. Continuing our journey on a bearing of $75^{\circ} 5'$, in the direction of Mereenie Bluff, we passed through some almost impenetrable but well-grassed mulga scrub, crossing small gum creeks at one and a half miles, two and a half miles, five and three-quarter miles, six and a quarter miles, eight miles, and eight and a half miles, all trending southward, and all evidently tributaries of Carmichael's Creek. At from four miles to five and three-quarter miles a small well-grassed open plain occurs. At six miles low stony undulations commence; these are overgrown with porcupine grass and densely timbered with mulga and cassia bushes. At sundown we camped on the last-mentioned gum creek. The dense scrub greatly retarded our progress, and we only accomplished sixteen miles. Our present camp, which is 2,586ft. above sea level, occupies the most elevated position we have yet reached—in fact, it was the loftiest camp throughout the whole journey. A young emu, captured to-day by the black boy, has been added to the collection. Mr. Keartland has succeeded in domesticating three of the young emus obtained at Bagot's Creek and two rock pigeons winged at Laurie's Creek, although the birds are not yet quite resigned to their daily ride on camel-back. During the afternoon I sent the black boy Arabi Bey over to a "smoke," a few miles north of our track. I have observed it for the past three days, and on his return Arabi Bey reported that many natives were camped near a waterhole, engaged in a periodical ceremony of "making young men." In response to an invitation Arabi was instructed to give them, these blacks promised to visit our camp.

Tuesday, June 19th.—Camp No. 35, bar. 27.29in., ther. 23° ; height 2,586ft. Only three aboriginals made their appearance this morning; the rest apparently belong to the sandhill tribes from the westward and declined to come into contact with white men. They are assembled at the waterhole referred to, which is called Tooringoa, some ten miles to the north-west. With the view of visiting the encampment of these blacks I informed the anthropologist of these particulars, but it was considered that the limited time at our disposal would not permit of the idea being carried out. Accordingly the party moved on in an easterly direction through closely-grown mulga scrub and across stony undulations for two and a half miles to the foot of Mereenie Bluff. This range presents an abrupt and almost inaccessible front to the

westward and northward, an extensive escarpment in these directions of an intensely red color being its distinctive feature. The name "Mereenie" is derived from the natives. Altered our course to 21° , following Carmichael's Creek to its source amongst low porcupine rises. At two miles we entered a narrow valley scarcely a quarter of a mile in width, confined by Haast's Bluff Range on the north and the Mereenie Escarpment on the south side. [This remarkable valley was subsequently traced and mapped eastward in a direct line for more than 100 miles, and during the whole of this distance it retained its original characteristics.] I have named it Mereenie Valley. At three and a half miles we crossed the watershed and arrived at the source of the Darwent. The elevation of this, the western commencement of Mereenie Valley, I estimate to be about 2,800ft. above sea level. This in all probability is the loftiest watershed in Central Australia. The Darwent Creek trends eastward and occupies nearly the whole of Mereenie Valley, in which we discovered an extensive bed of fossiliferous limestone soon after crossing the watershed. Our course down the valley was on a bearing of 75° . The escarpment of the Mereenie Range continues in an unbroken line to the eastward, resembling an enormous wall, the range to the north apparently increasing in height. At seven miles we passed an enormous boulder of quartzite that had fallen from the cliffs forming the escarpment on the south range some 800ft. above the valley. The weight of this enormous block of stone had caused it to roll into the centre of the valley, and it now forms a most conspicuous landmark visible for miles on either side. With nine and a half miles covered we found that the creek takes a sharp turn and forms a narrow gorge or gap in the northern range. A small waterhole near the entrance of the gap afforded a convenient site as a camp. By its side we therefore halted. The native name of this place is Oolooroo. The Mereenie Escarpment and the northern range, we noticed, continued to the eastward as far as the eye can reach, while a very high mountain (Mount Heughlin) bears 80° . The bed of fossiliferous limestone previously mentioned proved very extensive, and continues along the valley to beyond our present camp. A small gorge in the northern range exists about three-quarters of a mile to the eastward. This has been named Stokes Pass; it contains a permanent supply of water.

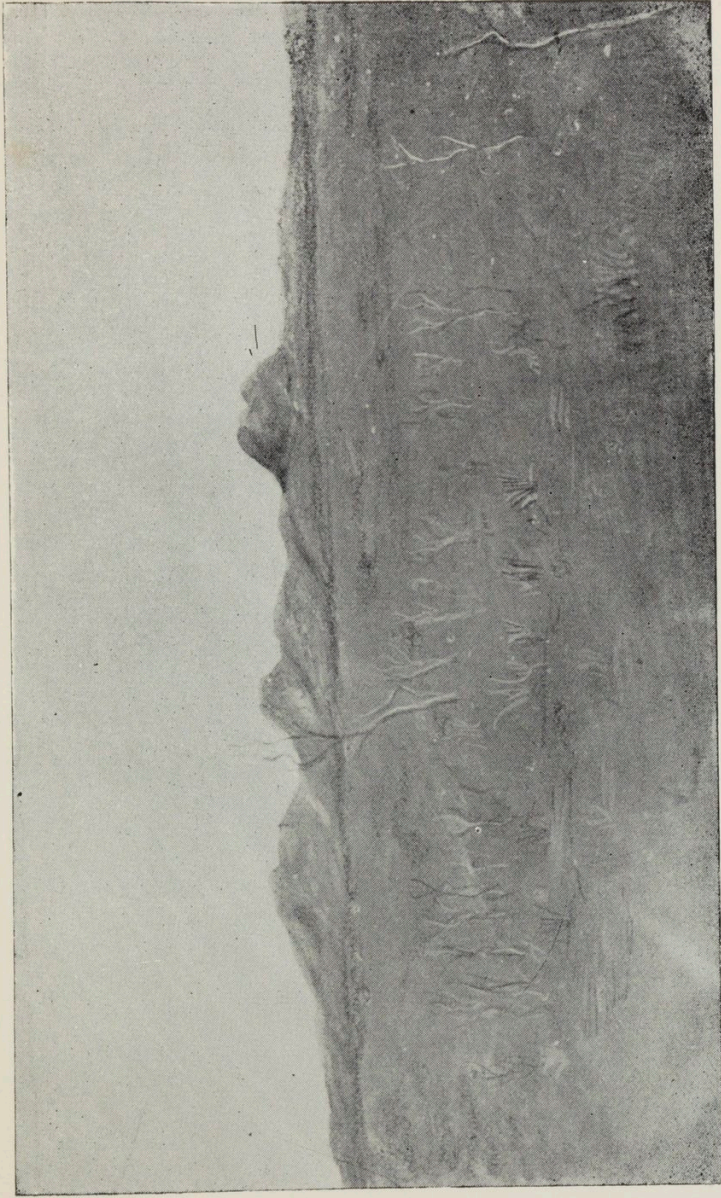
Wednesday, June 20th.—Camp No. 36, bar. 27·53in., ther. 27° ; height 2,256ft., lat. $23^{\circ} 34' 23''$ S. The expedition remained here to-day, in order to afford Professor Tate an opportunity of completing his geological examination of the Mereenie Range and to enable me to plot up the expedition map and compute results of

various observations. This part of my work, as I have no assistant, occupied me until midnight. In the afternoon heavy clouds appeared and thunder rumbled in the distance, but only a few drops of rain fell. Mr. Keartland was employed throughout the day in skinning and preserving birds, which have been fairly numerous during the last few days. A large number of rock pigeons were shot at this camp.

Thursday, June 21st.—Camp No. 36; bar. 29·69in., ther. 40°. During the early part of the night a few drops of rain came down. This morning I moved the camp some seven and a half miles down the creek in a northerly direction, and stopped at a large rain water hole, called Oondoomoola. The course at starting was 24° 30', through the gap, a narrow pass some three-quarters of a mile in length, and was then altered to 51° across a small plain. At one mile we passed through a second gap in a higher range, trending nearly east and west. The latter range is the continuation of that in which Mount Musgrave and Mount Tate are situated. All these ranges are of quartzite formation, and run in parallel ridges. Near the entrance of the second gap and at the confluence of two creeks permanent pools of water were found. Teatree, frequently an indication of permanent water, grows in profusion along the several channels of the creeks. Leaving the range, in another mile we entered on a well-grassed mulga plain, on which both saltbush and cotton-bush flourish. At two and three-quarter miles, on a bearing of 9°, I ascended a small ironstone rise, and obtained a fine view of the surrounding mountains. Now changed the course to 343° 50', travelling through well-grassed mulga scrub for two and three-quarter miles to Oondoomoola Waterhole. The camp having been formed, preparations for an extended trip to what has been erroneously termed Haast's Bluff were made. Professor Tate and I set out on horseback to examine some ranges bearing 72° 10' and four miles distant. Travelling over splendidly-grassed saltbush plains until near the ranges, we came to an exceedingly dense belt of mulga scrub. Here, for the first time during the entire trip, a few quartz reefs were discovered. We returned to camp at sundown.

Friday, June 22nd.—Camp No. 37, Oondoomoola Waterhole; bar. 27·82in., ther. 27°; height 1,969ft. Leaving the main camp at this waterhole in charge of Mr. Keartland, I proceeded, with Professor Tate, Dr. Stirling, the two Government prospectors (C. Pritchard and W. Russell), Taylor, and two black boys, taking nine camels and two horses, with four days' rations, towards the high mountains hitherto styled Haast's Bluff. Our course was 359° 20' for three-quarters of a mile to Annaldie, another large

rain water hole in the Darwent. Leaving the creek to the west we continued on a bearing of 318° in the direction of the eastern point of the eastern bluff. At half a mile we crossed a large gum creek which joins the Darwent half a mile to the N.W. After this a few outcropping rocks indicated a geological change, micaceous schists, epidote, and other granitoid rocks appearing. At two miles and four and a quarter miles we crossed some small quartz reefs. Then the course was changed to $323^{\circ} 35'$, still through richly-grassed mulga scrub, with saltbush and cotton-bush flats. At four and a quarter miles we reached the foot of some hills to the east of the high bluff, and camped. Professor Tate employed the rest of the day in examining the geological structure of this peculiar range, which here consists of three distinct and lofty mountains, the western one being the loftiest of them, and the second highest mountain, not only in the Macdonnell Ranges, but in the whole of South Australia. The eastern bluff has an immense capping of quartzite, which rests on metamorphic rocks. This quartzite presents a perpendicular face or escarpment to the southward, and is 357ft. in height. The altitude of the bluff itself is 1,535ft. above the surrounding plain, and 3,690ft. above sea level. The height of the middle gigantic hill is 4,009ft., whilst the western, and at the same time most massive of the rises, has an elevation of 4,646ft. The natives seem to have no particular name for these imposing geographical features. Throughout the journey I have endeavored to obtain the aboriginal appellations for all objects seen, but in this instance the words given by different natives are totally at variance, and seem to be descriptive for the occasion only. I have therefore styled these three important mountains Mount Edward, Mount William, and Mount Francis after the brothers, Messrs. Edward, William, and Francis Belt respectively, and the range to which they belong the Belt Range. Dr. Stirling and I, with the black boy Racehorse, proceeded to the northern side of the range, passing the Welcome and other springs, in search of two corroboree stones said to have been hidden here by the natives. Before we started I was not aware of the doctor's object in wishing to visit this spot. I accompanied him because I desired to sketch in the northern portions of the range and connect my present traverse with my previous work of 1878. Eventually, however, the information obtained by him from Mr. R. Coulthard, of Tempe Downs Station, relative to the stones was communicated to me. The directions for finding them were most explicit, and we followed them out to the letter, but a three hours' search among the innumerable outcrops of rocks proved unavailing, and we returned to the camp without



(H. Y. L. Brown.)

Mounts Edward, William, and Francis—Belt Range.



Mount Francis, Belt Range.

(H. Y. L. Brown.)

the longed-for curiosities. Our black boy, Racehorse, had deserted us meantime. Probably he guessed the nature of our quest, and, afraid of arousing the resentment of the other natives, he returned to camp. In the evening I questioned him, and, after a vast amount of evasion, elicited the information that a large number of corroboree stones were hidden in a cave in the ranges to the eastward. I obtained knowledge of the exact position of this cave, and as these rare and interesting stones are of especial interest and value to the ethnological department I have determined to visit this spot to-morrow. The two prospectors (Pritchard and Russell) returned to the camp in the evening and reported having tested not only all the localities indicated by me, but also others, without finding any trace of minerals. They are of the opinion that this part of the ranges is unsuitable for further prospecting. In this the geologist now concurs. I regret this all the more because the metalliferous rocks in this neighborhood were the first seen during our journey. Several natives were heard near the camp during the early part of the night, but otherwise they did not disturb us. A small spring is situated near the north-eastern point of Mount Francis, but the approach to it up a small gully is exceedingly rough. A mile to the westward, near the foot of the range, is the Welcome Spring, a small stream of the purest water flowing for about 100yds. amongst matted reeds and rushes along a small creek channel luxuriantly timbered with black wattle trees of large size, and making a pleasant change in this otherwise sterile region.

Saturday, June 23rd.—Camp No. 38; bar. 27·82in., ther. 28°; height 2,155ft. This morning I moved the camp about two miles to the south-west, and from here determined the exact heights of various points of the surrounding mountains. I measured an extensive baseline, being greatly assisted in this by Dr. Stirling and Professor Tate, and also by the prospectors and Taylor. At noon I directed the prospectors with Professor Tate to return to camp No. 37. Accompanied by Dr. Stirling, Taylor, and the two blacks I started in search of the corroboree stones. Racehorse now seemed loath to proceed in the direction of the hills where these treasures were hidden, and endeavored to persuade me not to go. But all his excuses and objections were futile, and fortunately the information I secured from him last night rendered his further assistance of little importance. Course 35° for half a mile, Mount Francis now bearing N.N.W. and half a mile distant; changed to 99° 40' for two and a half miles, through well-grassed and rather dense mulga and cassia scrub, to the Darwent Creek. A small soakage in the sand of the creek bed, called Ana-loorgoon by the

natives, was discovered, a ridge of micaceous schist, traceable in a direct line to Mount Francis, crossing the Darwent and forming a rocky bar, which acts as a dam and conserves the water. After refilling the now empty water kegs and watering the camels and horses I continued on a bearing of $93^{\circ} 5'$ for one and a half miles to a small stony rise. From here the hills in which the stones were deposited bear $78^{\circ} 20'$. Passing through splendidly-grassed mulga scrub we reached the ranges in five and a half miles. The cave for which we were bound is called Koondunga by the natives, and is situated on the south side and half way up the first ridge. The hills themselves are composed of micaceous schist, and have an altitude of about 150ft. above the surrounding plains. A high mountain discovered by me in 1878 bears 65° and is four miles distant. I have named it Mount Chewings, after Dr. C. Chewings, who explored this country in 1885. On ascending with Dr. Stirling to the spot I was seeking I found a small opening, some 4ft. in width and 3ft. in height, penetrating about 7ft. into the hill. The entrance to the cavern was partly filled up with loose fragments of rocks and the interior with gum and wattle boughs. On removing these an enormous number of wooden corroboree sticks, varying in size and shape, were first exposed. Some appeared to be very ancient, and exhibited signs of frequent use. [I have since ascertained that all the aboriginal tribes for many miles around use this cave as a depository for their tribal sticks, which no female is permitted to see.] Many expeditions have started in search of this cave, but hitherto all have failed to find it, as nothing would induce the local natives to betray its whereabouts. We first removed sixty wooden tablets (or so-called sticks), all being elaborately carved or marked on both sides with a number of concentric lines, which appeared to be perfectly intelligible to both our black boys. Underneath these we obtained fifteen stone tablets, carved in like manner. This latter discovery is the most important yet made of these rare specimens of native skill, and will materially enhance the value of the ethnological collection. Selecting some thirty-three wooden, opossum, emu, euro, sugar ant, and other corroboree sticks, and taking all the stone ones, I left a number of tomahawks, large knives, and other things in their place, sufficient commercially to make the transaction an equitable exchange. A special corroboree ground, used by the natives for generations past, is situated under a high black hill some miles to the eastward; but the limited time at our disposal prevented us from visiting this interesting place. After carefully packing our trophies on the camels we started at sundown, intending to return to the main camp if possible to-night. Course $227^{\circ} 30'$, across undulating stony country,

timbered with mulga and bloodwood gums. At five miles altered bearing to 180° for four and a half miles, through dense mulga scrub, and at 10 p.m. we arrived at our destination, having travelled twenty-two miles since noon.

Sunday, June 24th.—Camp No. 37; bar. 27.73in., ther. 35° . Last night the thermometer descended to 22° . I was employed throughout the day and until midnight in attending to my special

H. E. E.

work. Marked a tree on the eastern side of the waterhole C. W.

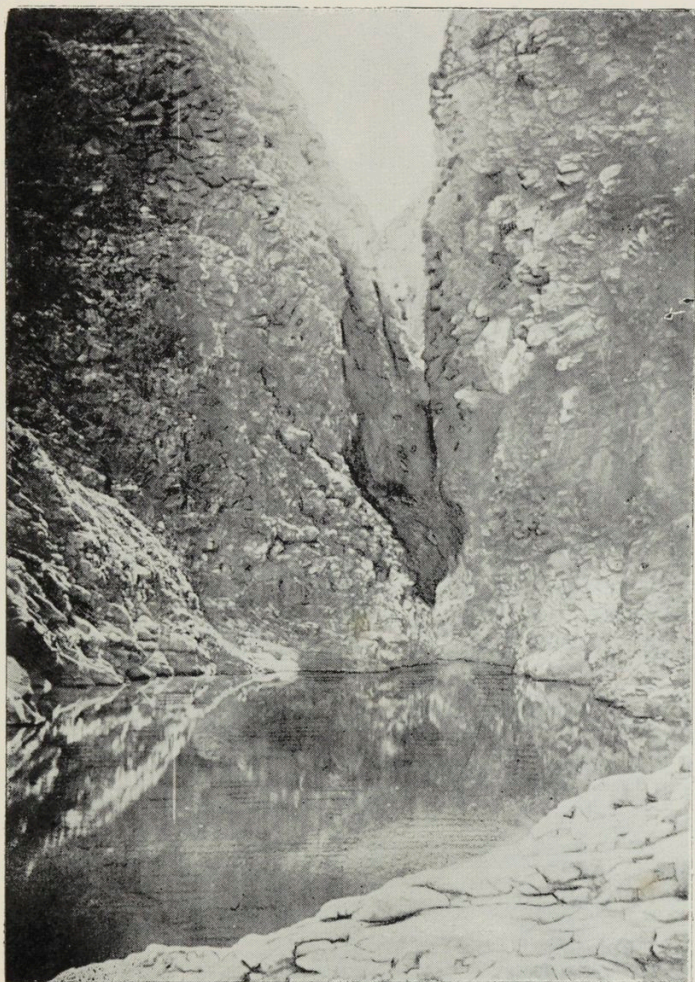
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Dr. Stirling obtained the various significations of the corroboree sticks from the black boys and superintended the repacking of those articles. Professor Tate was fully engaged in perfecting the geological and botanical collections; Mr. Keartland occupied himself throughout the day in preserving birds, of which a large number have been secured at this camp. In this locality the bronze-winged pigeon is fairly numerous, the small quail abounds, and a black cockatoo differing from the southern species was caught, being the second specimen that has fallen into our hands during the trip.

Monday, June 25th.—Camp No. 37; bar. 27.78in., ther. 39° . In consequence of our three days' stay at this waterhole the packs became somewhat disarranged; hence a late start. Course $107^\circ 30'$ for half a mile to the western point of a quartzite ridge near the junction of a large gum creek from the eastward with the Darwent. Altered bearing to $103^\circ 30'$ for three and three-quarter miles through dense mulga scrub to a stony spur; thence $168^\circ 10'$ for three-quarters of a mile to Arumbera Creek, and 118° for two and a half miles along the creek to a large rain water hole, the native name of which is Andantompantie. From here Mount Heughlin bears $51^\circ 50'$ distant fourteen and a half miles, Mount Zeil $86^\circ 30'$ distant fifteen miles, and Mount Sonder $95^\circ 30'$ distant twenty-four miles. The former two mountains have been transposed on several charts, and Mount Zeil has been locally renamed Mount Razorback; I cannot, however, adopt these erroneous alterations. A large stockyard has been constructed near this waterhole. Now altered course to $86^\circ 30'$; at one and a half miles passed another large rain water hole in the creek, and at two and a half miles changed the bearing to $78^\circ 30'$, crossing Arumbera Creek at one and a half miles and two and a half miles. At three and a half miles altered course to 115° for one and three-quarter miles along the northern side of the creek, which now comes from the direction of Mount Heughlin. We now travelled over admirably-grassed open plains on a bearing of 105° for two and a quarter miles, when

we found ourselves amongst low stony rises thickly covered with porcupine and densely timbered with mulga. Changing then the course to $92^{\circ} 20'$ we crossed numerous small gum creeks trending southward and eventually flowing into the Finke river. At one and three-quarter miles struck a bush track, which we followed on a bearing of $124^{\circ} 30'$ for two miles between two low porcupine ridges, and then, some two hours after sundown, we camped, having travelled twenty-two miles.

Tuesday, June 26th.—Camp No. 39, Mount Zeil; bar. 27.62in., ther. 26° ; height 2,249ft.; lat. $23^{\circ} 35'$ S. I had arranged with Mr. Cowle prior to his departure for Ayers Rock that the members of the expedition under his charge should rejoin me to-day at Glen Helen Station. I, therefore, sent the pack train in charge of Professor Tate with instructions to follow the track and camp at the station, distant one and a half miles from our camp. Half an hour after Professor Tate reached this place Mr. Cowle arrived there with Professor Spencer, Mr. Watt, and Mr. Belt, all well, having been absent just fourteen days. Professor Spencer reports that he has succeeded in obtaining photographs of both Ayers Rock and Mount Olga. Mr. Cowle is deserving of the greatest commendation for the able manner in which he has performed this journey. The party under his guidance were compelled to travel from dawn until sundown, covering a distance of between eighty-five miles and ninety miles over continuous porcupine sandridges. They were without water—a fact entailing additional anxiety—and Mr. Cowle's achievement in arriving at the rendezvous almost to the hour agreed upon cannot be allowed to pass without special record. Added to the voluntary assistance rendered by Mr. Cowle I may mention that several of the horses lent to the expedition for the journey are Mr. Dare's private property. Professor Tate, on making Glen Helen Station with the main party, found it such a desolate spot that he deemed it advisable to send to me for further instructions before camping; I thereupon advised him to proceed to Mount Sonder. Dr. Stirling remained with me and assisted in measuring an extensive baseline, which will enable me to determine the position and altitude of Mount Zeil and Mount Heughlin. The doctor, I may remark, has a natural aptitude for this kind of work, and it is due to his assistance on this and other occasions that I have been able to determine the exact heights of the several mountains in this part of the Macdonnell Ranges; we were thus engaged until noon. I then made a traverse to a rain water hole near Mount Sonder, at which the whole party afterwards camped. Starting on a bearing of 128° we crossed the Finke river, here called the Davenport, at half a mile, and arrived at Glen Helen



Redbank Gorge, MacDonnell Ranges.

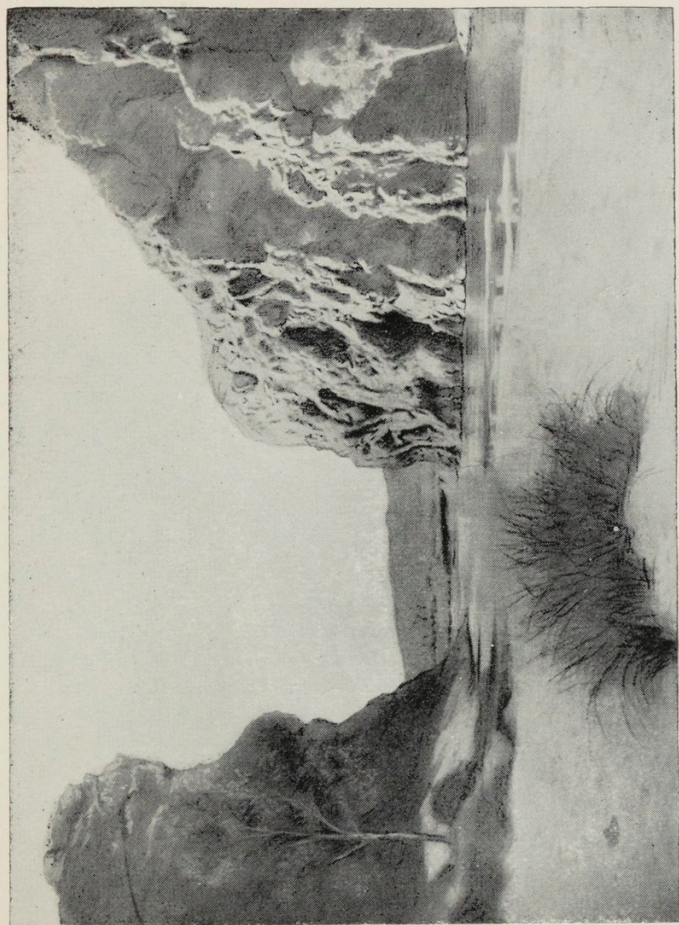
Station in one and a half miles. This station, which has now been abandoned, consists of three substantial stone and wood houses and a large stockyard, all in good order. The garden still contains a few vegetables. We secured a quantity of tomatoes, cabbages, and melons, and then continued on the previous bearing. At two and a quarter miles low hills form a gap, through which the creek takes its course. A small waterhole in the creek near the station is said to be a "permanent water." At four and a half miles altered the course to 86° for three and a quarter miles to a waterhole in the Finke river, near Mount Sonder, and camped. The Redbank Creek from the north and several gum creeks from the south unite with the Finke river near the camp. The country round about at present looks very dry and desolate. It is scarcely credible that 18in. of rain have fallen here within the last six months, yet such is the case.

Wednesday, June 27th.—Camp No. 40, Mount Sonder; bar. 27.48in., ther. 25° ; height 2,135ft.; lat. $23^{\circ} 36' 16''$ S., long. $132^{\circ} 30' 47''$ E. This being one of the localities requiring a thorough scientific examination I decided to remain encamped here for two days. Dr. Stirling, Mr. Belt, and Mr. Cowle essayed the ascent of Mount Sonder, but after climbing over rough ranges for many hours they were compelled to return to camp without having visited the highest point of the mountain. To-day Professor Tate was occupied with the botanical specimens collected on the Ayers Rock journey. Meanwhile Professor Spencer and Mr. Watt were engaged upon their especial work and Mr. Keartland was employed in making further valuable additions to the ornithological collection, which is now assuming large proportions. The collection of rock specimens and fossils is also beginning to be very bulky. Throughout the day and until midnight my attention was given to plotting in detail the position of the natural features of the country traversed.

Thursday, June 28th.—Bar. 27.50in., ther. 21° . Mr. Cowle, whose leave of absence has long since expired, now asked to be permitted to return to Illamurta that he might resume his official duties. I should like to have retained his valuable help to the end of the expedition, but this was impossible, and early this morning he reluctantly took his departure for the Finke Gorge, taking with him two of my black boys, Arabi Bey and Mennamurta, whose services I no longer need. In the afternoon Mr. Cowle returned and reported that the Finke Gorge was impassable. This knowledge will save me some thirty miles of useless travelling. Sent an Afghan with a camel and the large camera to a picturesque gorge in the Redbanks Creek in order to enable Professor Spencer to

photograph it. Harry the black boy I dispatched to the slopes of Mount Sonder to procure additional specimens of a new heather (*Epacris*), imperfect specimens of which were obtained yesterday by Messrs. Belt and Cowle. Received a report of the journey to Ayers Rock from the several members who accompanied Mr. Cowle and marked their route on the map. Computed the altitude of the various mountains in this neighborhood, which give the following results:— Mount Heughlin, probably the highest hill in Central Australia, 4,786ft. above sea level; Mount Zeil, 4,040ft.; and Mount Sonder, 4,496ft. in height. The prospectors assiduously tested several localities in the vicinity of this camp without obtaining the slightest indications of any minerals. An enormous carpet snake, fully 8ft. in length, was captured during their researches. The name of Mount Heughlin has been erroneously applied to a high hill west of the Mount Heughlin of Mr. E. Giles. I have, in properly rearranging the names of the several hills, expunged the name of Mount Razorback, which is Mr. Giles's Mount Zeil, and designated the high mountain west of Mount Heughlin, visited by me in 1878, Mount Chewings.

Friday, June 29th.—Bar. 27.61in., ther. 20°. Mr. Cowle, who had remained with us over night once more departed for Illamurta this morning. Directing the caravan to return on our former course some four miles, I started on a bearing of $138^{\circ} 10'$ through well-grassed mulga scrub with occasional low spinifex undulations (micaceous schist). At three and a quarter miles I ascended a tent-shaped hill (quartzite) for the purpose of obtaining the necessary bearings to surrounding hills and ranges. Continued on a bearing of $301^{\circ} 20'$ for one and three-quarter miles to a low hill, passing several small quartz reefs; then $295^{\circ} 40'$ for one and a quarter miles, and 268° for three and a half miles to a large tributary creek (the Davenport) of the Finke river. This was followed by the whole party on a bearing of 241° for one mile and $225^{\circ} 30'$ for two and a quarter miles to a gorge or pass in the northern range of Mereenie Valley. I have named this gorge Goyder's Pass, after G. W. Goyder, Esq., C.M.G., late Surveyor-General of South Australia. It furnishes the only possible approach to Glen Helen Station now that the Finke Gorge, twenty-one miles to the eastward, has become impassable. Continued due south through the Pass for half a mile; then altered our course to 102° along Mereenie Valley, which is here about a quarter of a mile in width and hemmed in on either side by high precipitous ridges. The bed of fossiliferous limestone previously noted in this valley again appears here. At one mile and two and a half miles we crossed two small gum creeks trending westward, and at four miles the



Finke Gorge, MacDonnell Ranges.

course was altered to 103° . After travelling an additional seven and a half miles along the valley we camped at sundown. The total distance covered to-day was twenty-seven miles.

Saturday, June 30th.—Camp No. 41; bar. 27.73in., ther. 25° ; height 1,889ft. Following upon an intensely cold and windy night, we started early on a bearing of $96^{\circ} 50'$ and at five miles arrived at the Finke river, which here forms three gorges, through the parallel ridges to the north and south. Camped on the eastern side of the river near the southern ridge. The water in the river is still running in a strong stream, and is so decidedly brackish that when boiled it becomes undrinkable. I sent two men to open up a small spring about half a mile down the river. They obtained a sufficient quantity of good water for our purposes. Teatree grows abundantly in the river bed near the camp. In the afternoon I visited the Finke Gorge with Professor Spencer, Dr. Stirling, and Mr. Belt. There are two immense and extremely steep ridges north of our present camp, through which the Finke river has forced its course. The gap in the first of these is only a quarter of a mile off. Numerous fossils were discovered here by Mr. Watt in the quartzite rocks. The second, or Finke Gorge, is one and a quarter miles north of the camp. A large and deep permanent waterhole completely fills up the space between the high perpendicular rocks constituting the sides of the gorge. I sent Harry to the north side of the range to obtain additional specimens of a new plant discovered by Mr. Cowle. Several charges of dynamite were exploded in the waterhole, and a quantity of small fish secured for Professor Spencer's collection. The waterhole, however, proved to be too large to render this method effective with the large fish.

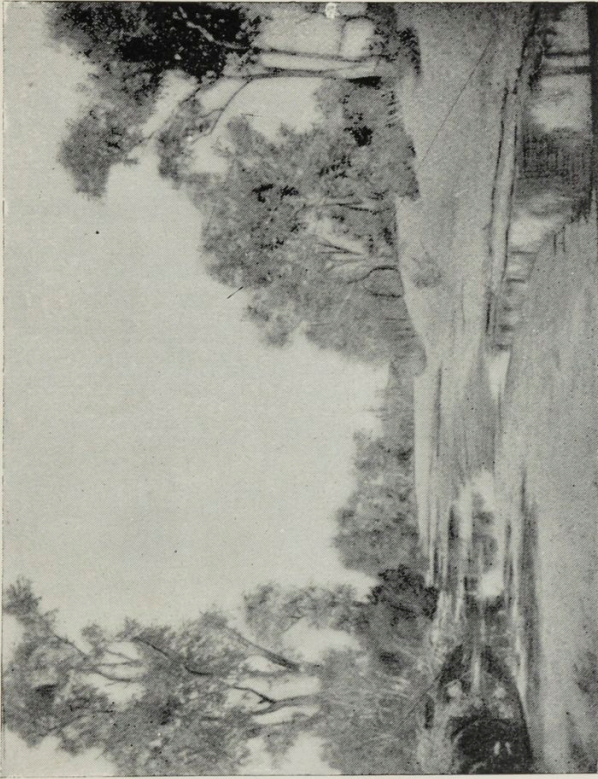
Sunday, July 1st.—Camp No. 42, Finke river; bar. 27.92in., ther. 29° ; height 1,739ft. Professors Spencer and Tate examined the river and Mr. Watt the ranges in the vicinity of the camp. I ascended a high range one and a half miles north of the camp, and obtained bearings to the mountains and hills previously noticed. In the afternoon I brought the expedition map, &c., up to date, computed the elevation and distance of various hills, and obtained an extensive series of magnetic (dip circle) and other observations. Several natives are camped in the creek, but no information or article of importance was acquired from them. Through an old native, sent by Mr. Cowle from the mission station, we received our first letters since leaving the overland telegraph line.

Monday, July 2nd.—Bar. 27.79in., ther. 25° . Our departure was somewhat delayed this morning owing to the camels having strayed. Once started, we followed the Finke southward, passing

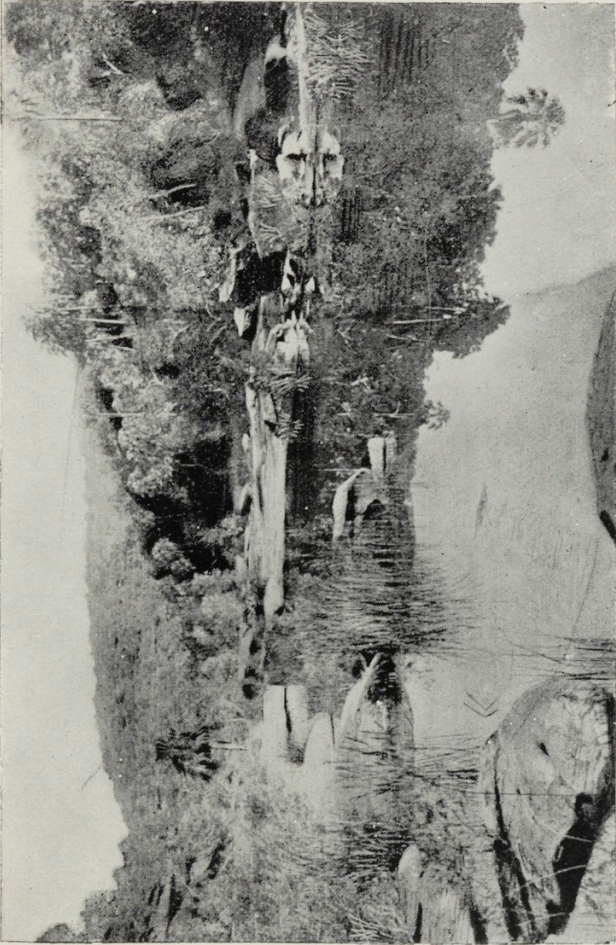
through the gap in the southernmost ridge of the Macdonnell Ranges, on a bearing of 153° . At one and a half miles the ranges, consisting at this point of conglomerates, terminate, and we entered the Missionaries Plain, which occupies the intervening space between the Macdonnell and Krichauff ranges. This plain has a width of from eight to twenty miles, and is about 150 miles in length, extending from long. $131^\circ 50'$ E. to $134^\circ 10'$ E. It consists of sandy well-grassed country, thickly timbered in places with mulga and low cassia bushes. With nineteen miles covered, we arrived at the Moravian Mission Station, Hermannsburg, on the northern side of the Finke river and about one mile north of the Krichauff Ranges. As a mission station it was recently abandoned, and all the missionaries have departed. Mr. Heidenreich, jun., who is now in charge, heartily welcomed us, and insisted on the whole party partaking of his hospitality.

Tuesday, July 3rd.—Camp No. 43, Hermannsburg Mission Station; bar. 27.93in., ther. 22° ; height 1,643ft.; lat. $23^\circ 56' 52''$ S., long. $132^\circ 45'$ E. This morning I sent the two prospectors, Pritchard and Russell, with a local black boy and three camels, to the Upper portions of Ellery's Creek, in the Macdonnell Ranges, a locality likely to prove metalliferous. Mr. Watt, the geologist, accompanied them, with directions to rejoin me at Alice Springs. I proceeded, with Professors Tate and Spencer and Mr. Belt, to the Glen of Palms, some nine miles to the south of the mission station. The Finke river enters the Krichauff Ranges one mile to the south of this station, and continues its sinuous course through these massive ranges for some distance to the south of our No. 22 camp. The palms (*Livistona Mariae*) in this glen reach a height of 60ft. to 100ft., and are exclusively confined to this one locality. The cycad (*Encephalartos Macdonnelli*) also grows abundantly in the Palm Creek, some four miles to the westward of camp No. 44. In the afternoon Dr. Stirling arrived at this camp, accompanied by Mr. Heidenreich. I returned to the main camp at the mission station in the evening, but was too ill to continue my astronomical observations.

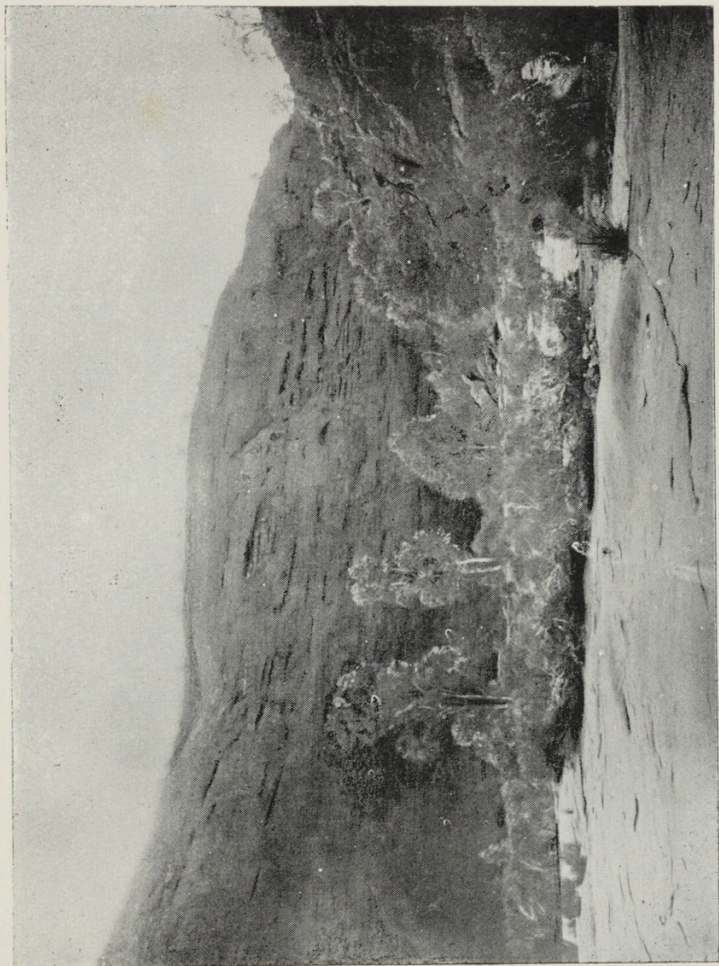
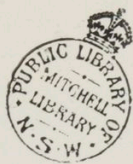
Wednesday, July 4th.—Bar. 27.97in., ther. 25° . Assisted by Edgar and the two Afghans I surveyed the mission station, which proved to be a very extensive place. It comprises three large well-built stone houses, one of nine rooms and two of seven rooms; two large two-roomed stores, built of sandstone; and numerous small huts, built of wood and clay—the whole forming a village more conspicuous than many of our northern townships. The garden—justly noted for its abundance of fine vegetables and fruit trees, among which numerous date palms, some bearing fruit,



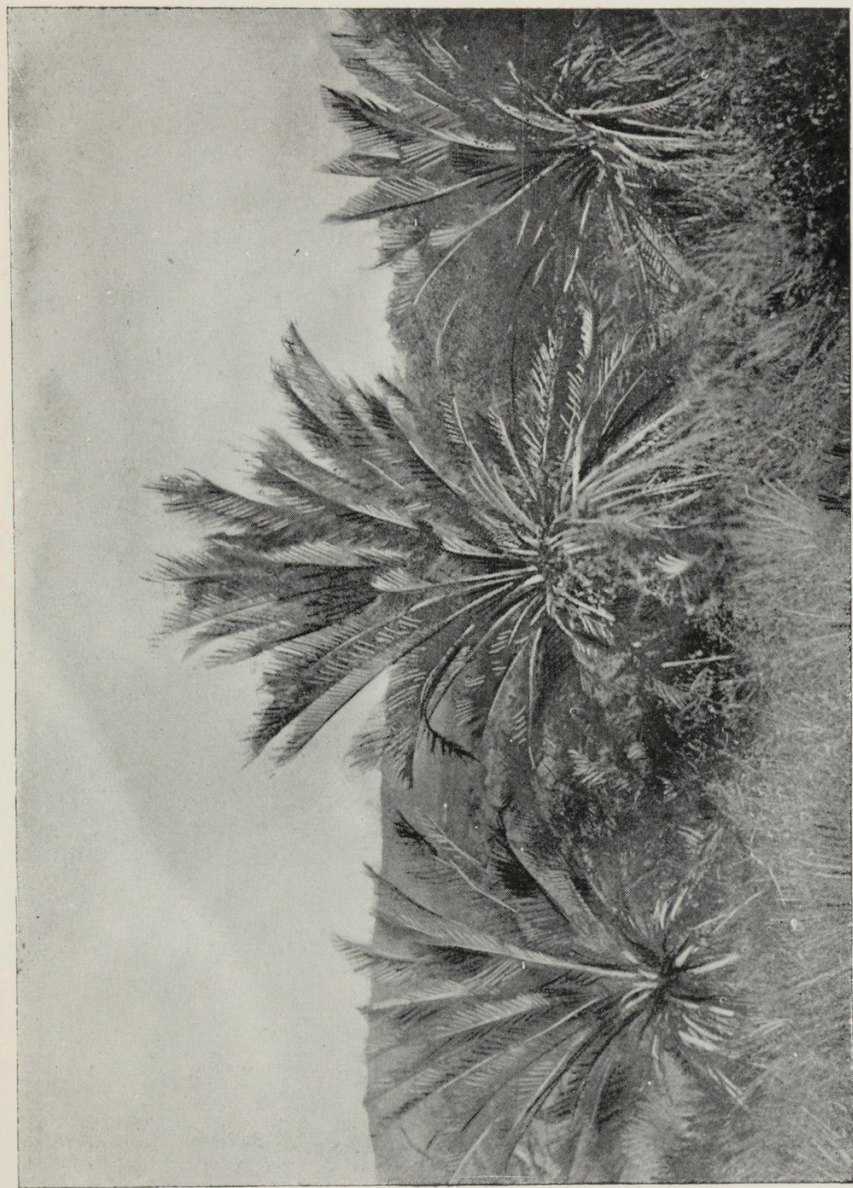
Ellery's Creek, Missionaries Plain.



Palm Creek, Krichauff Ranges.

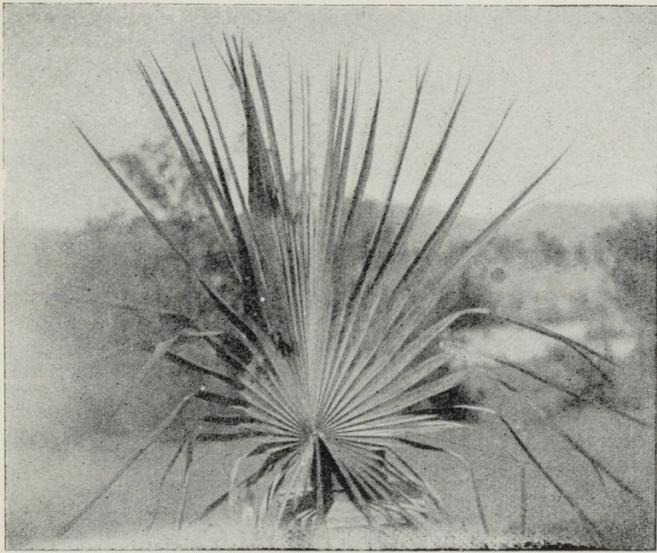


Cycad Gorge, Krichauff Ranges.



Cycads (*Eucephalartos MacDonnelli*).

(*F. F. Gillen.*)



Leaf of Palm Tree ("Livistona Marisæ").
(F. J. Gillen.)

are conspicuous—is on the northern bank of the river. A simple and effective system of irrigation from shallow wells of good water has been brought into requisition, and the whole of the extensive area can be watered in a very short time by the use of several pumps. The water in the Finke river, now running in a small stream, is of varying quality. In some places it is perfectly fresh; in other parts it is brackish, and even salt. Dr. Stirling, with Mr. Heidenreich, returned from a trip to the Glen of Palms this afternoon. Numerous natives, terribly dilapidated in appearance, are camped in the vicinity of the station. From these we have obtained a number of native implements for the ethnological collection. I was occupied with astronomical observations until midnight.

Thursday, July 5th.—Bar. 27·97in., ther. 25°. I was employed at my plans, magnetic and other observations, and computations until 10 p.m. Mr. Keartland has been constantly employed in preserving birds, of which a large variety has been obtained here.

Friday, July 6th.—Bar. 27·94in., ther. 32°. I have sent an additional supply of rations to Professors Spencer and Tate, who desired permission to prolong their stay at Palm Creek on account of the scientific productiveness of the locality. I was occupied until 10 p.m. with my calculations, plans, and other matters. I find that the altitude of Mount Giles, in the main tier of the Macdonnell Ranges east of Mount Sonder, is 4,260ft.

Saturday, July 7th.—Bar. 27·97in., ther. 31°. I proceeded to the ranges south of the camp to complete the topographical sketch of this country, and observed the magnetic dip. Mr. Belt returned to Palm Creek and reported that the other members of the party would come back to-morrow.

Sunday, July 8th.—Bar. 28·02in., ther. 39°. Accompanied by Mr. Belt I visited Bagot's Springs, four and a half miles west of our camp, mapping the natural features of the surrounding country. Mr. Belt obtained additional specimens of a new species of finch and of other birds at this spring and during the journey back to the camp. Professors Tate and Spencer returned from Palm Creek at 3·30 p.m., highly satisfied with the result of their stay there. The generosity and kindness of Mr. Heidenreich and Mr. Foster of Hermannsburg Station to the party exceed all praise; they most hospitably entertained us during our sojourn at the station, supplying us with whatever we desired.

Monday, July 9th.—Bar. 27·97in., ther. 34°. The caravan did not leave until 10 a.m. This late start was due to the disarrangement of the loads in consequence of our extended stop at this

camp. Mr. Heidenreich sent a blackfellow with the party to show me a large waterhole in Ellery's Creek, six and a half miles east of the station. An hour was spent here in making additions to Professor Spencer's collection. I then continued eastward for an additional fourteen miles, and camped at sundown in a dense mulga scrub. The country travelled over to-day turned out to be inferior to the other portions of the Missionaries Plain traversed by us, consisting of low sandhills and sandy flats covered with porcupine and patches of coarse grass, and timbered with drooping acacia, mulga, stunted mallee, and low cassia bushes. I have named a prominent round hill in the James Range, bearing 184° from this camp and eleven miles distant, Mount Keartland, after Mr. G. A. Keartland, the indefatigable ornithologist of the expedition. The western point of the Waterhouse Range bears due east and is four and a half miles away.

Tuesday, July 10th.—Camp No. 45, bar. 27.61in., ther. 37° ; height 2,009ft. The thermometer descended to 15° below freezing point last night. To complete the work allotted to the expedition it is necessary to visit Paisley's Bluff in the Macdonnell Ranges. I have therefore decided to send the main party with Dr. Stirling and Mr. Keartland on from here by the road to Owen Springs Station, and thence to Alice Springs. I myself, in executing Mr. Horn's final instructions, proceeded with Professors Tate and Spencer, Mr. Belt, two men, and six camels to the ranges. Started on a bearing of $44^{\circ} 50'$ in the direction of a high bluff east of Mount Conway. Our course was over sandy soil, covered with porcupine and densely timbered with mulga, drooping acacia, and mallee scrub. At two miles the country became undulating, and was covered with small stony pebbles, the scrub being denser than ever. We crossed the sources of numerous small creeks, all trending to the S.E. At eleven miles we got among some low but very rough and precipitous stony rises, terribly overgrown with porcupine grass. Sundown found us camped on a small teatree creek, near the base of the southern ridge of the Macdonnell Ranges, a stage of seventeen and a half miles having been made. I followed this creek into the range, and discovered a small spring about a quarter of a mile to the north of our camp. I have named the spring Edgar's Spring, after H. Edgar, a member of the expedition. Its water, which flows for about 30yds. and then disappears, emerges from a crevice in the conglomerate rocks; the latter extend from here to the Finke Gorge and to near Mereenie Bluff. To-day's journey has been most distressing to the camels and horses—the latter have now been for two days without a drink; for them, therefore, the finding of water has been a most opportune



discovery. With Mr. Belt I ascended the range in search of a road for the camels; a gully observed to the eastward will apparently meet our requirements.

Wednesday, July 11th.—Camp No. 46; bar. 27·69in., ther. 24°; height 2,086ft.; lat. 23° 49' 50" S. This morning Mr. Belt led the camels and horses to the gully discovered yesterday, about a quarter of a mile to the eastward of Edgar's Spring. Here the euros and wallabies have made a fair track over a depression to the northern side of the range. Professors Tate and Spencer and I walked from the camp to the summit of the range. To the north we discerned several parallel ridges of the Macdonnell Ranges. Mount Conway, I found, bears 53° 45', Brinkley's Bluff 32°, and Paisley's Bluff 90° 50'. Continuing on a bearing of 342° 40', we passed, at one mile and two and a half miles, through two gaps in quartzite ridges having an east and west direction. At the latter gap we crossed the confluence of two large gum creeks, tributaries of the Hugh river. Here occurs a very striking and interesting geological change, which will be fully recorded in the geological report of the expedition. I have named the several gaps through which we have travelled Gill's Pass, after T. Gill, Esq., Under Treasurer of South Australia. Altered course to 36° for one mile and 79° 20' for two and a half miles over grassy plains to the Hugh river, the trend of which is to the southward, through a break in a quartzite ridge about one mile to the south. Continued on the previous course for an additional two and a half miles to the foothills of Mount Conway, a prominent mountain on which I erected a trigonometrical station in 1877. On ascending the highest point of these secondary hills I at once became convinced of the impossibility of discovering a practicable road to Paisley's or Brinkley's bluff through the ranges to the north. I therefore returned with Mr. Belt to the Hugh river, and followed it on a bearing of 22°, the rest of my party following at a slower pace. Low, rugged, micaceous schist rises abut on the river, causing its channel to be exceedingly rough and rocky. We passed numerous waterholes, and at one mile altered our course to 351° in the direction of a gorge of singular appearance west of Paisley's Bluff. At two and a quarter miles a large gum creek joins the Hugh river from the westward. At two and a half miles we ascended a rough stony ridge, and obtained an extensive view of surrounding country. To the west, north, and east high massive ranges apparently render further progress in those directions out of the question. Changed course to 98° (direction of this ridge), finding, at three-quarters of a mile that the Hugh river passes through a gap, in which we found a large and, I think, permanent waterhole. After directing

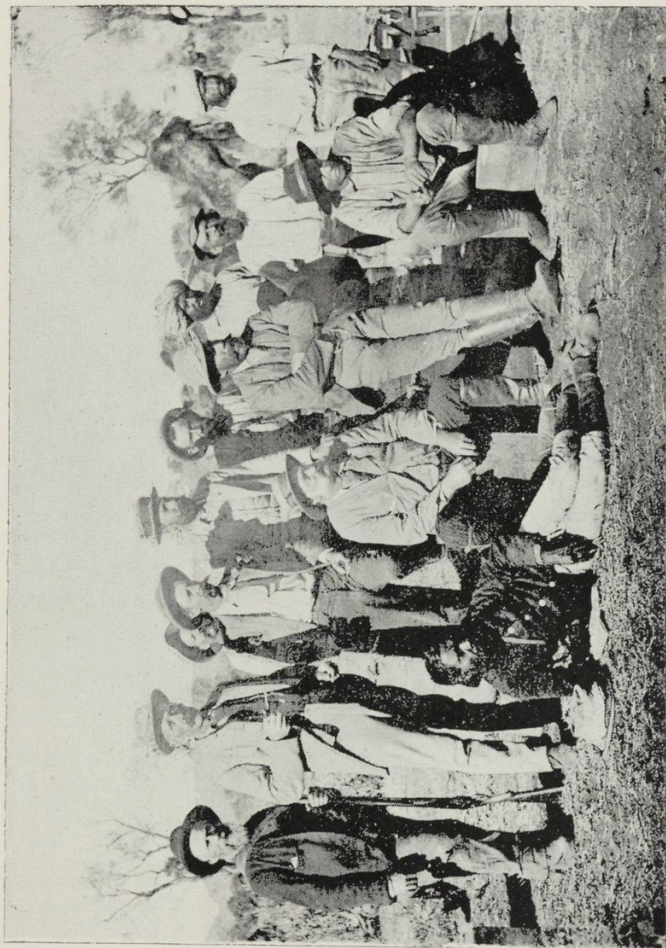
Mr. Belt to return and bring the rest of the party to this spot, which I selected as a camp, I continued, on a bearing of 304° , for one mile, through dense mulga scrub, to the entrance of the gorge near Paisley's Bluff. Leaving my horse here, I proceeded on foot up the creek issuing from the gorge on a bearing of 351° for one mile to the base of Paisley's Bluff. With the appearance of this locality I was disappointed, finding it very sterile. Disappointment also awaited me in meeting with but two small pools of stagnant water near the mouth of the gorge. Moreover, a strange solitude beset the place. Not the faintest sound was heard to indicate that any living thing existed here, and the sight of bare and massive quartzite and gneiss rocks rising perpendicularly to an immense height and displaying numerous fractures and dislocations completed in me a feeling of profound depression. Paisley's Bluff is probably 1,500ft. above the gorge, which is only about 20yds. wide, and is densely timbered with large pines, gums, and cycads (*Encephalartos Macdonnelli*). When I entered the gorge the sun had already set. I did not, therefore, venture far into the gloomy valley, which I have named Spencer's Gorge, after Professor W. Baldwin Spencer, of the Melbourne University, the biologist of the expedition. Having satisfied myself of the absurdity of attempting to take the camels this way, I returned to the waterhole, at which I found the rest of the party camped. Our stage to-day has been twenty miles over very rough country.

Thursday, July 12th.—Camp No. 47; bar. 27.74in., ther. 32° ; height 2,185ft. Professors Tate and Spencer desired to make an examination of this locality and the gorge visited yesterday. In order to gratify this wish the camp remained at the waterhole. I proceeded northward for the purpose of ascertaining whether a practicable road existed through the Macdonnell Ranges in this direction. Course 29° for half a mile to a gap in another high ridge which runs in a parallel line with Paisley's Bluff Range; thence $87^\circ 30'$ for one and three-quarter miles between high ranges, and $22^\circ 30'$ for half a mile to a gorge in the main range west of Brinkley's Bluff. The latter bluff is an immense mass of granitic rocks of great altitude, abrupt, and apparently inaccessible from the west. A large waterhole occupies the whole space between the perpendicular walls of the gorge, which is only about 25yds. in width. To-day the water near the eastern wall of rocks was fortunately of no great depth and I succeeded in getting through the gorge. Continued on a bearing of $14^\circ 40'$ for three-quarters of a mile to a granitic hill; thence $3^\circ 40'$ for three and a half miles to a small waterhole in a rocky gap of a low granite ridge. The creek is now densely overgrown with teatree, and con-

tains numerous small waterholes, some of which would probably last for twelve months after rain. The northern ridge of the Macdonnell Ranges is now four miles to the north and can be crossed without much difficulty. Having ascertained this fact I retraced my steps to the camp. The distance travelled to-day was fourteen miles. Two blackfellows arrived at the camp in the afternoon; we gave them five rock wallabies shot during the day by our black boy Harry. To-day Mr. Belt secured a species of owl and specimens of other birds for the collection. Several dingoes approached the camp in the afternoon and made us fully aware of their presence during the night, but all endeavors to capture them proved futile. Rock wallabies are very numerous in the ridges near the camp. I have called the several gorges and gaps through which the Hugh river takes its course in this part of the Macdonnell Ranges Stuart's Pass, after John McD. Stuart, the explorer, who crossed the ranges here on his memorable journeys across Australia.

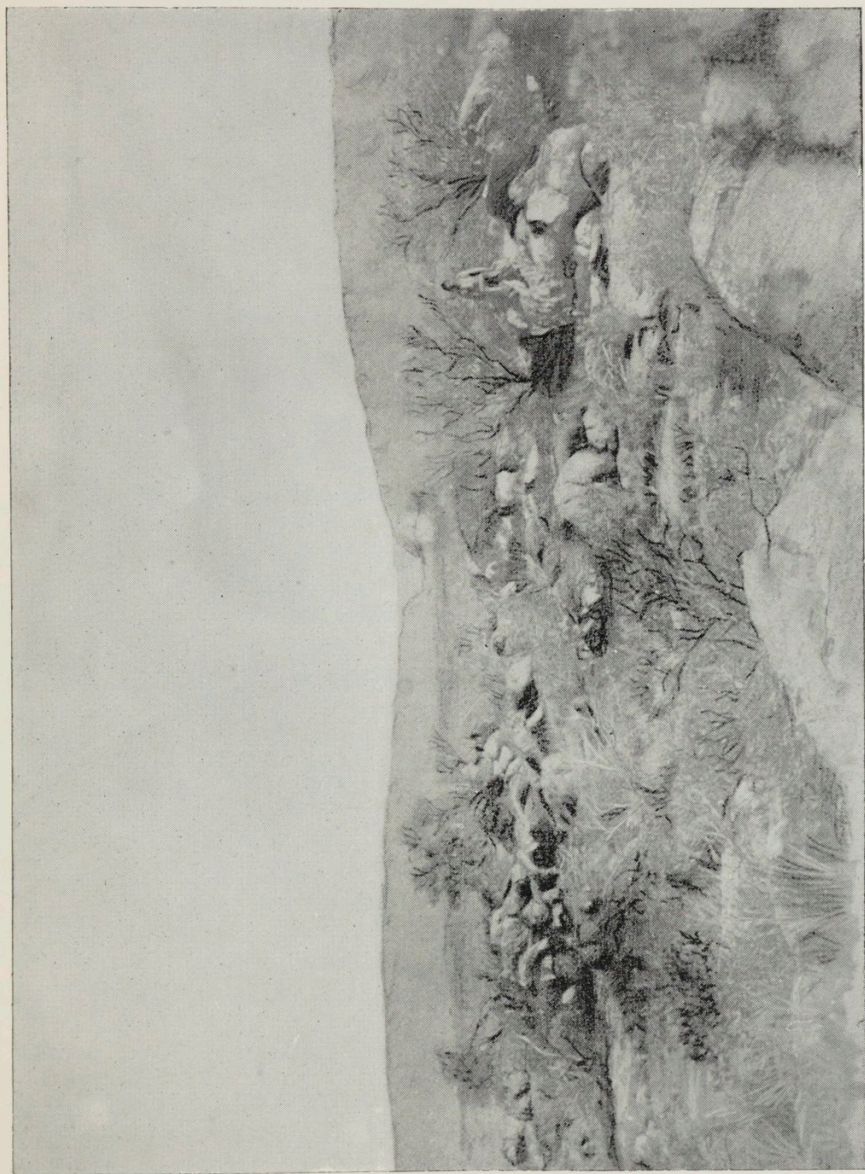
Friday, July 13th.—Bar. 27·80in., ther. 34°. I followed my yesterday's course to the small gap in the low granite ridge, seven miles distant. The rough road tried the camels severely. The two natives who had accompanied us professed to be able to show me a good track from here through the ranges to the Burt Plain. I therefore allowed them to lead the way. Starting in the direction of N. 65° E. they piloted us over very rugged steep hills for eight miles to the northern range. A small teatree creek (wherein a perfect bower-bird's nest was observed), which we followed for some miles, is rendered impassable by enormous masses of rocks, amongst which several fine rock waterholes occur. These, however, are inaccessible to stock, and I had no alternative but to cross the steep rocky range to the north, a rather hazardous undertaking with camels. The ascent was comparatively easy, but the descent had to be effected by continual zigzags, at the risk of breaking the camels' legs amongst the outcropping rocks. Nevertheless at sundown the Burt Plain was safely reached, and we camped in a small gum creek, about half a mile north of the Macdonnell Ranges. A noisy flock of some fifty or sixty black cockatoos were disturbed near the rock waterholes and Mr. Belt succeeded in securing three for the ornithological collection.

Saturday, July 14th.—Camp No. 48; bar. 27·64in., ther. 35°; height 2,168ft. Last night the thermometer descended to 25°. An early start was made this morning. Now, in country explored by me in 1878, I no longer felt compelled to keep a traverse. We followed the Macdonnell Ranges eastward, crossing splendidly-grassed open plains lightly timbered with mulga. At fourteen miles we arrived at the Painta Spring, discovered by me on my



Camp near Alice Springs.





Heavitree Gap, MacDonnell Ranges.

(F. J. Gillen.)

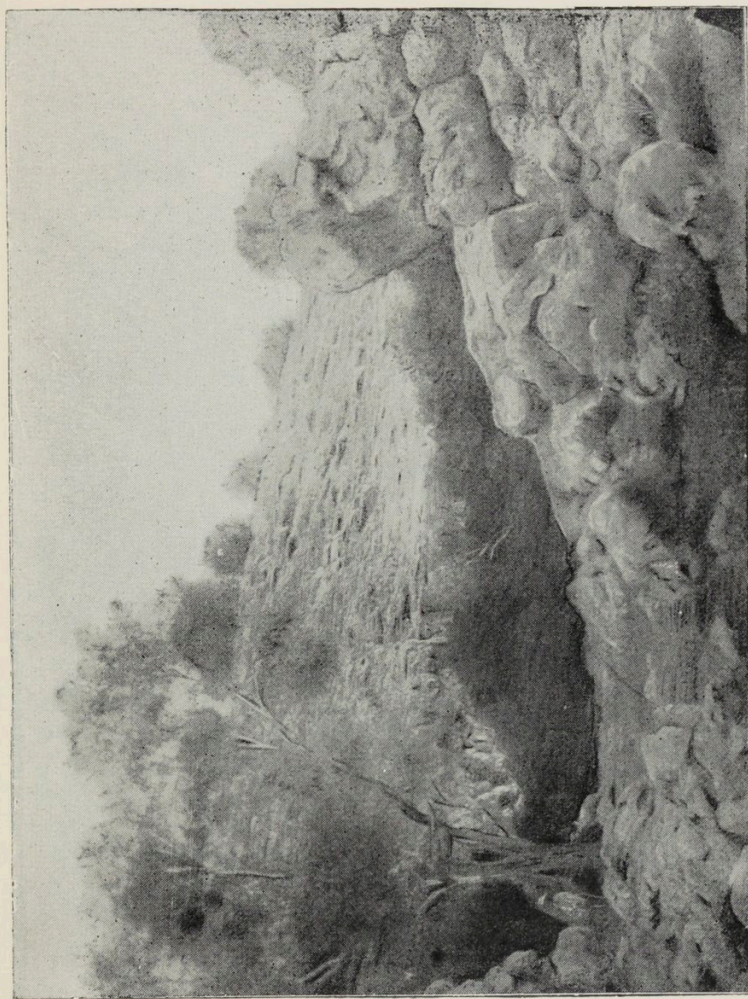
51' 55" E. I attended to various camp matters this morning, Mr. Belt assisting me by taking an inventory of our stores. In the afternoon he and I visited Mr. Ragget's store in the township, and purchased an additional supply of rations. After this we paid a social visit to the telegraph station, returning in the evening to the camp, so as to enable me to complete my work. Professors Tate and Spencer and Mr. Watt visited a fresh water lagoon south of our camp and Mr. Keartland certain caves in the same neighborhood from which the white bats given to us were obtained.

Tuesday, July 17th. — Bar. 28·06in., ther. 32°. Last night the thermometer descended to 17°. It was my intention to move southward to-day. Professors Tate and Spencer, however, desired permission to remain here another day. I fell in with this idea, more especially as the arrangement gave me the opportunity of completing my work and of obtaining additional magnetic observations. I now returned the camels obtained here for the two Government prospectors, Pritchard and Russell. The engagement of these two practical miners expires to-day, and in justice to them I must say that better men for the work allotted to them could not have been selected. True their search for auriferous areas has not met with success; but that fact has not been due in any way to want of skill or enthusiasm on their part. In the afternoon Professor Spencer suggested that he should remain at Alice Springs until the 4th of August, pointing out that by availing himself of the mail coach he could rejoin the party at Oodnadatta. His motive for wishing to stay here for this extended period is to obtain additional specimens of a new marsupial supplied to the expedition by Mr. South, and to study the habits of a peculiar sound-emitting spider obtained from Mr. Gillen. Feeling assured that Mr. Horn would approve of such a proceeding as tending to further the objects of the expedition, I readily agreed to the suggestion and furnished the professor with the necessary funds for carrying out his plan. Mr. Watt desired to make use of the opportunity to visit the auriferous area of the Eastern Macdonnell Ranges and the ruby fields. Mr. Horn, having expressed a wish that this should, if possible, be done by the party, I detached one of the prospectors, C. Pritchard, to accompany Mr. Watt on this journey, for which Mr. South generously offered to furnish the necessary horses. Mr. Gillen in the evening photographed the members of the expedition at our camp. Mr. Belt to-day ascended the high range near the camp—which I named during my trigonometrical and exploratory expedition of 1877-1881 Mount Gillen—in search of novelties for the several collections. After an arduous journey of many hours over rough ranges he returned to camp,

bringing amongst his collection a new and singularly beautiful flowering plant which attracted Professor Tate's attention. The occurrence of the plant on the Mount Gillen Range gave the professor the commendable idea of naming it after Mrs. Gillen as a slight acknowledgment of the hospitality accorded to the party by Mr. Gillen. This is not the only new plant discovered by Mr. Belt on this expedition. Professor Tate subsequently ascended the eastern extremity of the Mount Gillen Range for the purpose of obtaining additional specimens of the plant for his collection; in this he succeeded.

Wednesday, July 18th.—Bar. 27·98in., ther. 17°. Last night was exceedingly cold, the thermometer descending to 17°, but at 9 a.m. it registered 51°. Although we were astir at 5·30 a.m. a start was not effected until 10 a.m. I first attended to Mr. Watt's requirements, furnishing him with plans and instructions relating to the country which he is about to visit and which I explored some fifteen years ago. Mr. Gillen came down to the camp to wish us farewell. His generosity and extreme hospitality will not be readily forgotten by the several members of the expedition. Our course to-day was in a general S.S.E. direction over splendidly-grassed plains lightly timbered with drooping acacias and low cassia bushes. At nine miles we passed a bend of the Todd river, indicated by a dense and impenetrable forest of gum saplings. Two and three miles further on we crossed two gum creeks—probably the Roe and Laura Creeks—trending eastward and eventually joining the Todd river. The latter stream equals in many respects the Finke river, and once more I must regret that the time at our disposal does not permit me to explore this very important waterway. With twenty miles covered we camped at sundown on a small gum creek near the Ooraminna Range. One of the camels has eaten a poisonous plant, a species of *Swansonia*, a quantity of which we passed through to-day, but having been given care and attention it has suffered no serious results. Mr. Belt again obtained several rare and probably unknown birds, which will constitute a valuable addition to the ornithological collection.

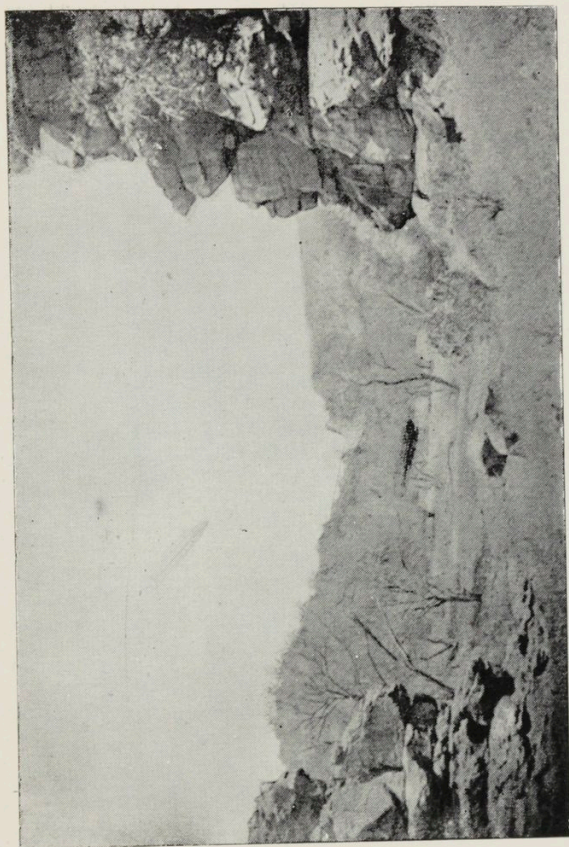
Thursday, July 19th.—Camp No. 51; bar. 28·35in., ther. 39°; height 1,522ft. The camels divided into several mobs during the night, and two of them could not be found until 10 o'clock. In consequence of this a start was not made till very late in the day—course 153°. At half a mile we passed through a small gap and at one and a quarter miles I ascended a sandstone rise. A high prominent dark hill, the most elevated in the Ooraminna Range, bears 131° 30' from here, and is five miles distant. I have named



Ooraminna Rock Waterhole—Ooraminna Range.

(F. J. Gillen.)





Hell's Gate, Ooraminna Ranges.



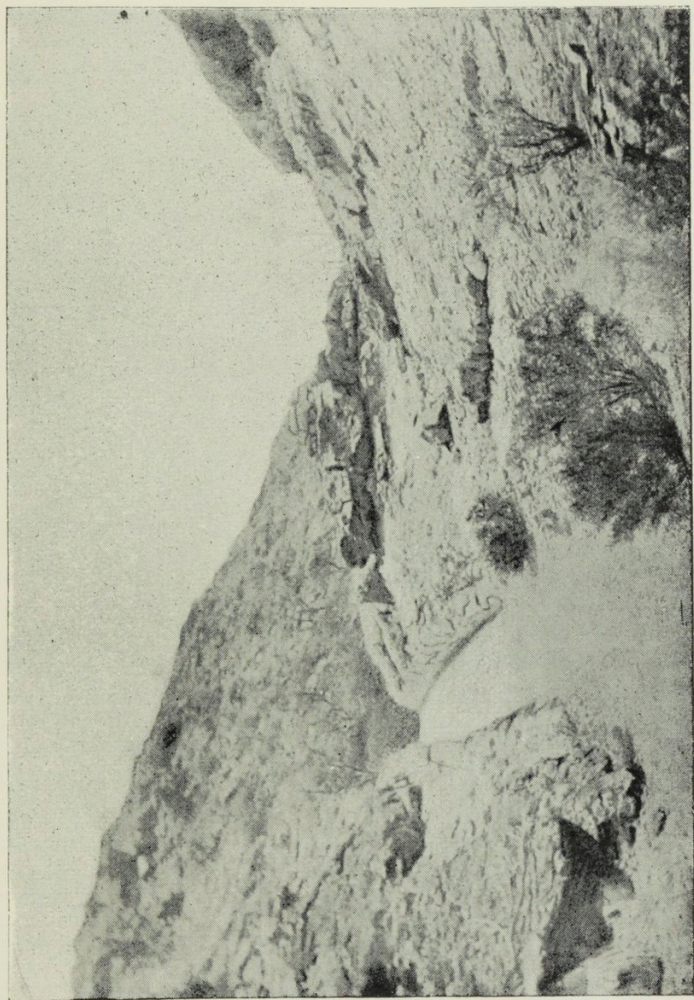
this hill Mount Sansom, after P. Sansom, Esq., Mayor of the Semaphore. The camels were taken to Ooraminna Rock Waterhole, one and a half miles to the westward, where our supply of water was replenished. I continued on a bearing of $201^{\circ} 40'$ over well-grassed flats amongst rocky sandstone ranges. At two and a half miles, near a rugged rocky hill, I altered the course to $187^{\circ} 20'$ for two miles and then to $174^{\circ} 40'$ for one and three-quarters of a mile to another rocky hill, thence $149^{\circ} 10'$ for half a mile to a small gum creek, and 211° along the creek for one mile to the Ooraminna Gate—a rocky pass through several perpendicular walls of rocks in the central portions of the range. We camped at 2 p.m. on a small creek in the midst of low rocky sandstone hills in order to enable Professor Tate to re-examine the geological structure of some portion of the country passed over to-day. Mr. Belt secured two new species of birds during to-day's journey. He is one of the most successful collectors in the party, and numerous new and rare plants from the ranges, as well as new birds, obtained by this expedition have been secured by his efforts.

Friday, July 20th. — Camp No. 52, Ooraminna Gate; bar. 28.35in., ther. 25° ; height 1,544ft. The camels gave more trouble than usual during the night, and their continual fights eventually compelled me to order four of the most savage and unruly of the bulls to be tied up. A quarter of a mile in a south-westerly direction brought us to a narrow gap in a solid wall of rock, through which a small creek takes its course. Several parallel walls of sandstone rock of no great thickness exist on the north as well as on the south side of this, the Ooraminna Gate, which is also locally known as Hell's Gate. The sandstone rocks composing the range have been worn by the weather into most fantastic shapes. Our course for the next mile was generally south among rough sandstone hills. We then descended a steep incline and traversed a small valley on a bearing of 134° . At half a mile we passed through a gap and, leaving the Ooraminna Range, we entered sandhills covered with porcupine and thickly timbered with casuarina or desert oak. To the west, and also to the east in particular, the sandstone rocks of the Ooraminna Range have assumed the form of pinnacles and towers. A prominent and peculiar-shaped rock near the James Range resembling Chambers Pillar and bearing 145° and thirteen and a half miles distant from the Ooraminna Range I have named Rigaud's Tower, after Mr. R. J. Rigaud, of New South Wales. Continued on a bearing of 173° over porcupine sandhills timbered with casuarina and an occasional well-grassed mulga flat for thirteen and a half miles to the James Range. This range is here less elevated than in its western portions, but still

retains its characteristic scrubby and rugged appearance. A high and conspicuous hill, bearing 56° and distant nineteen miles, I have named Mount Strawbridge after W. Strawbridge, Esq., Surveyor-General of South Australia. Passing through a wide opening in the northern ridge on a bearing of 190° we arrived at the Deep Well (196ft.), Alambo, in two and three-quarter miles. A Mr. Hayes has located himself here and erected yards, troughs, and a log hut. After refilling our kegs we continued on a bearing of 134° for three-quarters of a mile, to where abundant feed existed for the camels and horses, and camped. I observed until midnight in order to ascertain the correct position of the well.

Saturday, July 21st.—Camp No. 53, Alambo; bar. 28.59in., ther. 25° , height 1,293ft., lat. $24^\circ 21' 58''$ S. Being short of fresh meat I purchased a goat from Mr. Hayes this morning. Course $167^\circ 30'$ over porcupine sandhills timbered with casuarina and grassy flats. At two and a half miles the sandhills cease and low scrubby undulations covered with limestone rubble commence. At four miles we altered the course to $150^\circ 30'$, crossing at two miles a small gum creek, which I presume to be Alice Creek. At two and a half miles we reached the top of a low stony hill, and then changed the course $189^\circ 30'$. One mile and three-quarters had been travelled in this direction, and a terrific duststorm was blowing when we arrived at a large dam constructed in a tributary of the Alice Creek. The dam contains a fair quantity of good water. At two and a half miles I ascended a low scrubby ridge. At three and a half miles crossed to the western side of Alice Creek and changed the course to $175^\circ 40'$. Two miles covered on the latter bearing, and we crossed a gum creek trending eastward. At two and three-quarter miles altered route to 115° , passing at one and a quarter miles an old well near the confluence of two gum creeks. Changed bearing at two miles to 148° for half a mile, 174° for three-quarters of a mile, and $136^\circ 50'$ for half a mile, crossing meantime three low limestone ridges having a strike of 74° . I have named a prominent hill, the highest point in an isolated range, bearing 102° and distant seventeen miles, Mount Belt, after Mr. F. Belt, naturalist of the expedition. Continued on a bearing of $155^\circ 5'$ over stony undulations timbered with mulga and cassia bushes, but at the end of two and a half miles again encountered sandhills covered with porcupine, cassia bushes, and stunted gums (*Eucalyptus gamophylla*). At four miles we camped on a mulga flat amongst the sandhills, having travelled twenty-one miles in all during the day.

Sunday, July 22nd.—Camp No. 54; bar. 28.85in., ther. 20° , height 1,031ft. Last night has been the coldest we have yet ex-



Ooraminna Pinch.

(F. J. Gillen.)



perienced; the thermometer descended to 16° , and everything in the form of liquids was frozen. We started on a bearing of 150° over porcupine sandridges timbered with casuarina. At ten and three-quarter miles we again came on to the Alice Creek, which I followed seven and a quarter miles in a S.S.W. direction to its junction with the Hugh river. Sundown found us camped near the Alice Well. The work of the expedition is now ended, and the party will return to its starting point (Oodnadatta) with all possible dispatch. The camels have vastly improved in condition and appearance during the journey, and are now able to perform a fair stage across country without exhibiting signs of fatigue.

Monday, July 23rd.—Camp No. 55, Alice Well; bar. 28·99in., ther. 27° ; height 874ft. The camp remained here to-day for the purpose of enabling all work to be completed to date, but personally I was too ill to do anything. To-day Mr. Keartland obtained several crested cockatoos and a large number of other valuable birds for the collection.

Tuesday, July 24th.—Bar. 28·99in., ther. 24° . We now followed the road southward, crossing and recrossing the Hugh river seven times in twelve miles. At thirteen miles we passed a well near the junction of the Finke and Hugh rivers, and at nineteen miles camped among porcupine sandridges. Additional birds were procured by Mr. Belt during the day for the ornithologist.

Wednesday, July 25th.—Camp No. 56; bar. 28·93in., ther. 32° ; height 1,022ft. Still travelled southward. At six and a half miles we watered the horses at Engoordina, in the Finke River, and then proceeded on towards Crown Point, camping at the end of nineteen miles.

Thursday, July 26th.—Camp No. 57; bar. 28·85in., ther. 36° ; height 1,092ft. In the afternoon we camped near Crown Point Station, after having travelled nineteen miles. Mr. and Mrs. Ross hospitably entertained us in the evening, and the former presented a marsupial mole, or *Notoryctes typhlops* (the orcomita of the natives), to the zoological collection of the expedition. Mr Keartland obtained a number of rock pigeons and other birds for the collection. Crown Point appears to be the southern limit of the former birds. The camel buggy, which was left here on the outward journey, was now again added to the camel train.

Friday, July 27th.—Camp No. 58, Crown Point; bar. 29·08in., ther. 38° ; height 830ft. A disagreeably hot and windy day, with clouds of dust. Travelled nineteen miles to the Goyder river, and camped at our No. 10 camp.

Saturday, July 28th.—Camp No. 10, Goyder river; bar. 29·23in., ther. 42° ; height 677ft. Started shortly after sunrise and journeyed

all day, camping at sundown. Distance travelled, twenty-seven miles.

Sunday, July 29th.—Camp No. 59; bar. 29·62in., ther. 50°; height 552ft. A five miles' stage brought us to Charlotte Waters Telegraph Station, where we camped with the view of enabling me to complete my observations and separate and repack the various packages intended for transmission to Adelaide. Mr. P. M. Byrne, the stationmaster, insisted on our partaking of his hospitality during our stay here. He also presented two ant-eaters to the zoological collection.

Monday, July 30th.—Charlotte Waters. After wishing Mr. Byrne and his assistant, Mr. Giles, farewell we travelled until sundown, and then camped on the Adminga Creek, nineteen miles from Charlotte Waters Telegraph Station.

Tuesday, July 31st.—Adminga Creek. Travelling all day we covered twenty-three miles, and camped at sundown on the Stevenson Creek. The country round about is at present entirely destitute of grass and bushes, owing to which our stock will fare badly to-night.

Wednesday, August 1st.—Followed the Stevenson for twenty-six miles, camping at sundown on Oolabarinna Waterhole.

Thursday, August 2nd.—Again followed the Stevenson Creek. Completing seventeen miles, we camped at the Willow Well and Waterhole.

Friday, August 3rd.—At the Macumba. Mr. Thornton presented several peculiar frogs and other specimens of natural history to the expedition. Mr. Belt and I visited a large native encampment a few miles north of the Macumba Station. We travelled twenty-two miles to-day, and camped at Ross Waterhole, on the Macumba river.

Saturday, August 4th.—To-day we made a short stage of seventeen miles only, caused by the absence of edible bushes for the camels on the tablelands ahead. Camped two miles south of Storm Creek.

Sunday, August 5th.—A journey of twenty miles was accomplished, and then we camped close to Oodnadatta township.

Monday, August 6th.—I arranged for the return of the camels and equipment to their respective owners at Hergott Springs and Farina. I also repacked and forwarded all our collections to the railway station, and attended to various other matters in connection with the expedition. Moreover, Mr. Belt and I inspected a large native encampment about one mile to the south of our camp.

Tuesday, August 7th.—The whole party departed by train *en route* to Adelaide.

SUMMARY OF JOURNAL.

The expedition left Oodnadatta, the terminus of the Great Northern Railway, on the 5th of May, 1894. Apart from Mr. Horn and myself, the party then consisted of four scientists, who represented the Universities of Sydney, Melbourne, and Adelaide, and collectively the interests of anthropology, biology, botany, geology, ethnology, meteorology, palæontology, and petrology; two naturalists and collectors; four camel-drivers, a cook, and a black boy. We set out with twenty-three camels (twelve pack, nine riding, and two buggy camels) and two horses. The time at our disposal was limited to three months, the University professors not being able to be away for a longer period from the institutions with which they are associated.

Travelling northward, near the transcontinental telegraph line, we arrived at the Goyder river on the 14th of May. Meantime we obtained an additional camel at Charlotte Waters. The journeying till the Goyder was reached had to be done by easy stages, the distance covered averaging but seventeen miles a day. This was caused by the low condition of the camels, which made anything like rapid movement utterly impossible. The country traversed up to this point comprised chiefly stony undulating plains, wofully arid and desolate, and, except for a few salsolaceous plants, completely devoid of vegetation. Not long before we passed through it this part of South Australia had been visited by a heavy rainfall; consequently we had expected to find it admirably suited to scientific examination, but almost the contrary proved to be the case. A succession of dry seasons previously had resulted in a great scarcity of animal and vegetable life, and our collections suffered accordingly.

From the Goyder a five days' excursion to the west was made by a detachment of the party. This section was absent from the main caravan for five days, travelling during that time a distance of 145 miles. Numerous tent-shaped hills and ranges were discovered and correctly mapped. About fifty miles of the country covered consisted of mulga scrub (*Acacia aneura*), which was well grassed, the remainder being red sandridges densely overgrown with porcupine. In places where the latter had been burnt by the natives good feed was plentiful, indicating that the whole of this country could be made available for stock. Only one small sand soakage water was found throughout the whole of the trip, which terminated at Engoordina, on the Finke river. Here the two branches

of the expedition re-united. Meanwhile the camel buggy had been found to be somewhat of an impediment. It had therefore been left at Crown Point, twenty miles south of Engoordina, and packsaddles had been made for the draught camels. From Engoordina the whole expedition proceeded to Idracowra, passing *en route* through a detached range of table-top hills. These and all the other noteworthy natural features were mapped in detail. From Idracowra an excursion was made to Chambers Pillar, and photographs of this unique natural monument were obtained. Mr. Horn left the party at Idracowra on the 23rd May. Upon his departure I conducted the expedition towards Henbury, following the course of the Finke river. The river flats extending for a short distance on either side of this, the largest Central Australian watercourse, were found to be splendidly grassed; otherwise the country revealed itself as barren sandridges clothed with porcupine grass, the prevailing timber being mulga and casuarina or desert oak, with river gums in the watercourses. We arrived at Henbury on the 27th of May, and were joined by a couple of Government prospectors from Alice Springs, who brought two additional camels, thus increasing the camel-train to twenty-six. From sixteen miles south of Henbury the change in the nature of the country was most noticeable. Magnificently-grassed flats were in strong evidence, with but an occasional extent of barren sandridges. Hills more or less conspicuous were also observed. These characteristics continued until we reached the James Ranges in lat. $24^{\circ} 20'$, long. $133^{\circ} 1' E$. Hitherto we had been travelling in a general N.N.W. direction. On entering the James Ranges this was changed to a westerly route. The plains between these heights must be considered to be among the very best pastoral country in South Australia. Growing in rich profusion were seen splendid grasses, including the Mitchell grass of Queensland, interspersed with saltbush and cotton-bush of the best quality. Here also we found an abundance of water. The ranges, whose constitution is sandstone and quartzite, are of a very rugged character, and are densely timbered with acacia. Their elevation is from 700ft. to 800ft. above the plains, and 2,500ft. above sea level. In lat. $24^{\circ} 17' S.$, long. $132^{\circ} 55' E$. we finally left the Finke river, which in this region is a running stream, and continued on a westerly course along the valleys of the James Range near its southern limit. Crossing the Palmer river, the most important tributary of the Finke, we reached Tempe Downs on the 2nd of June.

I formed a depôt camp at a small waterhole in the Petermann Creek, six miles to the south of Tempe Downs. Here Mr. Cowle,

with nine additional horses, joined the expedition. The Petermann is the dividing line between the Levi and James ranges, which have characteristics in common, the main difference being that the former is of very limited extent. On the 7th of June we continued our journey towards Gill's Range, still going westward, and still passing through magnificently-grassed country. Various deposits of fossils were examined in the James, Levi, and Gill's ranges, and numerous specimens procured for the petrological collection. Gill's Range is similar in its principal aspects to the Levi Range. We inspected the various "permanent waters" on its south side—springs of no magnitude, but furnishing an abundant supply. The well-grassed country does not extend beyond a mile to the south of the range, sandhills then appearing as far as the vision can reach. From Reedy Creek, in lat. $24^{\circ} 17' 49''$ S., long. $131^{\circ} 38'$ E., some of the party, under Mr. Cowle's guidance, visited Ayers Rock and Mount Olga. The main body still pursued a westerly course over the same fertile plains already described. The Gill's Range terminates in long. $131^{\circ} 35'$ E. Low sandstone ridges then occur, and these extend to the west and beyond Laurie's Creek. This creek was reached on the 13th of June, and a short halt was made in order to examine the fossiliferous deposits in its vicinity. Some perfect specimens of rare fossils were obtained. Altering our course now to a northerly direction, over continuous sandridges, we came into view of several imposing mountains of the Macdonnell Ranges. At Glen Edith we found the Tarn of Auber, a reputed "permanent water," to be dry, proving the unfavorable nature of this season. On the 16th of June we arrived at Deering Creek, and once more were in well-watered country. The Macdonnell Ranges were now immediately to the north of us, and we pursued our journey in an easterly direction towards Mereenie Bluff.

On the 19th of June we entered a remarkable valley, which was subsequently found to extend, between wall-like ranges, for over 100 miles to the eastward; I have named it Mereenie Valley. The Mereenie Escarpment on the south side of this immense pass is a noteworthy feature of this part of the Macdonnell Ranges. It extends in an unbroken line for twenty miles, and recurs at short intervals for many miles farther to the eastward. In lat. $23^{\circ} 34' 23''$ S. and long. $132^{\circ} 5'$ E. we again took a northerly course and visited several mountains on the northern confines of the ranges. A most unusual geological feature was here noted. The Macdonnell Ranges in these parts consist of apparently isolated mountains joined by low ridges and interspersed with well-grassed plains. The waters, however, are limited in number and of small extent. Here, for the first time since leaving Oodnadatta, metalliferous

rocks were found, and the prospectors diligently examined various localities.

On the 24th of June we again turned towards the east, reaching Glen Helen on the 26th. Here the detachment under Mr. Cowle rejoined the main party. Mount Sonder and other mountains were correctly charted and their exact heights determined. On the 30th of June we arrived at the Finke Gorge, in the Finke river, and from there pursued a southerly course. Leaving the Macdonnell Ranges and crossing the Missionaries Plain we reached Hermannsburg Mission Station on the 2nd of July. An extended stay was made at this place for the purpose of examining the Finke river, Glen of Palms, and the Krichauff Ranges to the south, the geologist and prospectors meanwhile inspecting the Macdonnell Ranges to the north and eastward as far as the transcontinental telegraph line. On the 9th of July we departed from the mission station, and on the following day, in lat. $23^{\circ} 59' 50''$ S., long. $133^{\circ} 6'$, the main party took a direct course for Alice Springs. At the same time a contingent of the expedition started for Paisley's and Brinkley's bluffs, afterwards crossing to the north side of the Macdonnell Ranges, passing over finely-grassed plains, and eventually reaching Alice Springs on the 15th of July. Here the other members were already in camp, and here valuable additions were made to the several collections.

The expedition left Alice Springs on its return journey on the 18th of July. The biologist, however, remained for the purpose of prosecuting inquiries arising out of certain zoological discoveries, and the geologist of the expedition, with one of the prospectors, stayed in order to examine the ruby fields and auriferous country on the Hale river to the eastward, both undertaking to rejoin the party ere its arrival at its terminal point. Travelling southward over splendidly-grassed and lightly-timbered country, we crossed the Ooraminna and James ranges, and the overland telegraph line was again struck at the Alice Well on the Hugh river on the 22nd of July. Here the work of the expedition ended, and all haste was made towards Oodnadatta, by way of Crown Point and Charlotte Waters. The party reached Oodnadatta on the 5th of August. It had been absent exactly three months. During that period it travelled 2,200 miles. Over 27,000 square miles of country were correctly mapped in detail. Of this territory 14,000 square miles were of good pastoral country, consisting of loamy soil with abundance of grass and herbaceous bushes; and 13,000 square miles of inferior sandridges and porcupine, which, however, in conjunction with the former country, might be made available for pastoral purposes.

The Johnston, Chandler, Bacon, Newland, James, Levi, Gill's, Ooraminna, Krichauff, Gardiner, Waterhouse, Hart, and almost the whole of the Macdonnell Ranges were examined. Careful astronomical, meteorological, and magnetic observations were taken on every available occasion. In regard to the last mentioned, the magnetic dip, which hitherto has received but little attention in Australia, was carefully observed at regular distances. The elevation above sea level of all important points was ascertained. Several hundred excellent photographs were taken of the most striking natural features of the country passed through, types of natives, &c. Every possible opportunity of studying the habits and customs of the blacks was embraced. Much interesting information concerning them was gathered, and many native curios and relics were acquired. But the aboriginals encountered were singularly few. In the sphere of our travels they have greatly diminished in number during late years, and they are still passing away. Where not long ago they comprised hundreds they will soon be represented by units. For the most part those we saw were of the semi-civilised type who affect the neighborhood of stations. The doom of these has already been sealed. Their indescribably filthy habits and vices are fast hurrying them out of existence.

Unfortunately the expedition made no discovery of mineral wealth in the Macdonnell Ranges; still its work even in this connection is of no mean importance. The value of it is certainly of a negative nature; none the less it is real. In settling the question whether or not gold is present in the region visited an undoubted public service has been rendered. But if the country did not yield up any rich secret to the prospector, the purely scientific results secured are most noteworthy. Large collections were made in many of the departments of science. Botany and zoology, ornithology and conchology, petrology and ethnology, geology and anthropology—not to mention other branches of knowledge—had most enthusiastic votaries in different members of the expedition. Nothing, indeed, could exceed the zeal which was shown in the work of investigation and collection. How great has been the reward of this scientific ardor can be gathered only from a perusal of the reports of the specialists attached to this journal. That fact cannot be too strongly emphasized, and it is equally satisfactory to note that the journey from start to finish was accomplished without a single mishap.

APPENDIX A.
OBSERVATIONS with MAGNETIC DIP CIRCLE.

	Height above Sea Level.	Latitude South.	Longitude East.	Variation East.	Dip.	Magnetic Latitude.	Remarks.
Oodnadatta	ft. 395	27 33 10	135 28 0	2 45	56 34 0	47 6 0	Mean of 8 readings—Bar. 29·90in., ther. 55°; open plains, small waterhole 3 chains west.
Goyder River	677	25 38 50	134 39 0	2 40	55 47 30	46 37 0	Mean of 8 readings—Bar. 29·94in., ther. 80°; open country.
Henbury Station ..	1,259	24 33 20	133 15 27	2 18	54 47 30	46 2 0	Mean of 8 readings—Bar. 28·73in., ther. 73°; Finke river, with large pools of water and low stony rises 5 chains to the north.
Trickett's Creek ..	1,941	24 27 48	132 3 30	2 20	54 52 34	46 5 0	Mean of 16 readings, 2 needles—Bar. 27·96in., ther. 86°; Gill's Range, with abrupt walls 400ft. in height $\frac{1}{2}$ mile N. and N.W.
Reedy Creek,	1,903	24 17 49	131 38 25	2 37	54 17 0	45 43 30	Mean of 8 readings—Bar. 27·98in., ther. 70°; surrounded by high perpendicular rocks on W, N., and E. side, distant a few chains.
Mount Sonder	2,135	23 36 16	132 30 47	2 40	53 36 15	45 18 0	Mean of 16 readings, 2 needles—Bar. 27·56in., ther. 66°; high (metalliferous rocks) ranges from 1,000ft. to 2,000ft. in height $1\frac{1}{2}$ to 2 miles north, and low ironstone ranges from 1 to 5 miles south.
Mission Station .. (Finke River)	1,643	23 56 52	132 45 0	2 13	53 51 52	45 27 30	Mean of 32 readings 2 needles—Bar. 28·05in., ther. 76°; ranges (sandstone and quartzite) 2 miles south.
Heavitree Gap	1,713	23 44 30	133 51 55	—	53 52 30	45 27 0	Mean of 16 readings, 2 needles—Bar. 28·09in., ther. 72°; high ranges 1,000ft. in height $\frac{1}{2}$ mile to the north.

COPIES OF LETTERS REFERRING TO MAGNETIC DIP,
OBSERVATIONS, ETC.

Post and Telegraph Department, Adelaide, March 21st, 1895.

Dear Mr. Winnecke—Please accept my very best thanks for the results of your magnetic observations of variation dip, taken at Oodnadatta and other places in the interior while in charge of the Horn Exploring Expedition. So far as I am aware, these are the first systematic observations of the dip in Central Australia, and they will be very valuable. I shall publish them in my annual volume. With kind regards,

Yours, &c.,

C. TODD,

Postmaster-General, Supt. of Telegraphs, and Government Astronomer.
C. Winnecke, Esq., F.R.G.S., Adelaide.

Surveyor-General's Office, Adelaide, March 9th, 1895.

Dear Sir—With reference to your observations for magnetic dip and declination in the interior of Australia, which you have been good enough to shew me, I am glad to find that the variation of the needle as determined by you at seven places agrees closely with that indicated by my map of isogonal lines, compiled from a large number of observations by different explorers over wide areas. Your observation with the dipping needle I have reduced by calculation to magnetic latitude, and laid down with great interest. They are, I believe, the first trustworthy observations of the kind taken at any distance inland upon this great continent, and although they present some striking discrepancies, attributable no doubt to varying geological conditions, such men as the late Dr. Scoresby, General Sabine, and Sir Fred J. Evans would have been delighted to get hold of them. I have no doubt the Royal Geographical Society and the authorities of the Admiralty will consider them to have value for correcting their meteorological charts. You have established the position of magnetic latitude 45° (corresponding to dip 53) to be at the Macdonnell Ranges, a little beyond Alice Springs, thence trending a few degrees north of west. At Adelaide the dip is $63^{\circ} 14'$ and the magnetic latitude 52° with the same instrument.

Yours, &c.,

CHAS. HOPE HARRIS.

C. Winnecke, Esq., F.R.G.S.

APPENDIX B.
HORN SCIENTIFIC EXPEDITION.
PHYSICAL GEOGRAPHY.

By PROFESSOR RALPH TATE and J. A. WATT, B.Sc.

In dealing with the subject of the physical geography of Central Australia, it is necessary to mention that only a very general and brief outline will be given, as the space available does not permit of anything like a complete account.

It will be dealt with under the following heads:—

A.—MOUNTAINS.

1. Macdonnell Ranges.
2. James, Waterhouse, George Gill, and Levi Ranges.
3. Cretaceous table-topped hills, &c.
4. Ayers Rock and Mount Olga.

B.—RIVERS.

1. Finke Basin.
 - (a) Nature and position of its watersheds.
 - (b) Area of the Finke River Basin.
2. Finke River.
 - (a) Tributaries of the Finke.
 - (b) Length and rate of fall of the Finke channel.
 - (c) Nature of the course and channel of the Finke.
 - (d) Absence of surface running water.
 - (e) Waterholes.
 - (f) Rainfall in its relation to surface waters.

C.—GORGES AND GAPS.

D.—LAKES.

E.—CLAYPANS.

F.—STONY PLAINS.

G.—SANDHILLS.

A.—MOUNTAINS.

In the consideration of the physical geography of this country the mountain system should first demand our attention, as being of primary importance, for on it not only does the trend of the main valleys depend, but also the size, number, and even the very existence of the rivers, by reason of its influence on the wind and rain. For the above reasons the Macdonnell Ranges form the most important physiographic feature of Central Australia. Were it not for the presence of this chain of comparatively elevated land, with its important influence on the meteorology of the surrounding country, the greater part of the interior would resemble a sterile desert, which is the actual condition of portions of the stony and sandy plains after a more than usually prolonged drought.

The most important mountain range within the area under consideration is doubtless that of the Macdonnell, which represents the much-denuded crest

of one of the highest folds into which the crust of the earth within this area has been thrown. In the crumpling of the earth's crust the highest anticlines, being on the lines of maximum disturbance, usually have cores of plutonic rocks. This seems to have been the case with a great portion of the Macdonnell Ranges, subsequent movements having metamorphosed the originally plutonic rocks, thus causing doubt as to their eruptive origin.

The mountain system of Central Australia does not consist alone of the Macdonnell Ranges and those immediately associated with them to the north and north-east, as the Hart and Strangways Ranges, but includes also a number of parallel ranges lying to the south, such as the James, Waterhouse, George Gill, Levi, and Chandler Ranges, all representing the arches or troughs of the folds produced by earth movements in past geological time. Examples of ranges occupying the troughs of the earth-folds are to be found in the case of the George Gill and Levi Ranges. In each of these ranges, which really are portions of one and the same range (their continuity being broken merely by the transverse valley of Trickett Creek, a tributary of Petermann Creek, the latter a branch of the Palmer), the rocks occupy a perfect synclinal trough, in which the sandstone dips from the north and south towards the centre of the range at an angle of from 10° to 20° .

The mountain system of Central Australia may be conveniently treated in three divisions, the mountain ranges in each division for the most part comprising rocks of one and the same geological age, while they differ from those of the other divisions.

Thus (1) the Macdonnell Ranges proper, as well as the Hart Range, are situated wholly, or nearly so, within the area occupied by metamorphic rocks of presumably Pre-Cambrian age; while (2) the James, Waterhouse, George Gill, and Levi Ranges are wholly contained within the country occupied by Ordovician strata; and lastly (3) the low table-topped hills and groups of them, which one feels disinclined to dignify with the name of mountains and mountain ranges, are entirely formed of Cretaceous strata. Now, as each of these geological systems are represented by rocks differing in lithological character and structure, while they have suffered differently from the dynamic forces of nature, the physical features of the ranges occupied by strata of these different geological systems differ widely, and will therefore be described separately.

(1) THE MACDONNELL RANGES.

Dealing with the features of the most important first, we find that the Macdonnell Ranges trend in a nearly east and west direction for a distance of about 400 miles, and have a width varying from twenty to fifty miles, thus covering an area of more than 10,000 square miles.

In the meridian of Alice Springs Telegraph Station, which is situated from three to four miles north of Heavitree Gap, where the River Todd breaks through the southern boundary of the ranges under consideration, they have a width of about twenty miles.

Westerly from this point they extend as a rugged main ridge, containing the most elevated peaks, often capped by Ordovician quartzite, with a band of varying width of "jumbly" hills flanking this main ridge on each side. About the longitude of Mounts Liebig and Palmer (*i.e.*, about $131^{\circ} 15'$) the range becomes much broken up.

Easterly from Alice Springs the range extends to about 136° east longitude; at $134^{\circ} 10'$ it becomes confluent with the south-east extension of Strangways Range, with which it may be further considered to be linked by the Georgina Range, about $134^{\circ} 20'$; while further east (about 135°) it is joined by Hart Range. It may be said to extend approximately from the 130th to the 136th meridian of east longitude, a distance of nearly 400 miles, and to lie between $23^{\circ} 7'$ and $23^{\circ} 35'$ south latitude, with an average width of between twenty to thirty miles.

These ranges have a very irregular outline and have no parallel longitudinal valleys; in fact they present in no degree that uniformity of physical features, produced by earth movements and meteoric agencies, so familiar in the case of the Ordovician ranges.

The original stratification of the once sedimentary strata and the joints, that were perhaps present in the original granites, have played to all appearances no part in the moulding of the present physical features out of the metamorphic rocks, the age of which is considered to be Pre-Cambrian. Rising abruptly out of the elevated area of the Macdonnell Ranges, with no linear arrangement, but irregularly distributed, are a series of eminences, whose summits are in some cases, as in that of Belt Range and Mount Sonder, capped by a northern extension of Ordovician quartzite. To the presence of this protective covering, which has effectually warded off the levelling forces of nature from the underlying less weather-resisting metamorphic rocks, is probably due the comparative elevation of these peaks.

Ranged in order west to east the altitudes above sea level of the chief peaks are as follows:—Mount Edward in Belt Range, 4,649ft.; Mount Heughlin, 4,756ft.; Mount Zeil, 4,040ft.; Mount Sonder, 4,496ft.; and Mount Giles, 4,210ft.

The average elevation of the surrounding country is over 2,000ft. above sea level, so that these mountains are not so prominent as one might be inclined to imagine judging alone from their altitude above sea level. They are nearly all accessible, as the slopes are not usually very precipitous, except, for example, the Belt Range (Fig. 3).

The movements of the earth's crust, to which these ranges bear witness, were to a great extent of Pre-Ordovician age, and were continued, though much diminished in intensity, down to Post-Cretaceous times. During the earlier part of the Ordovician period the Pre-Cambrian rocks probably underwent subsidence, so as to allow of the deposition of Ordovician sediment that originally covered much at least of the area now occupied by Pre-Cambrian rocks. Later they partook of the Post-Ordovician upheaval, which converted much of the area occupied by Ordovician sea into dry land. Later again this area has probably participated in the gentle and gradual Post-Cretaceous upheaval, to which are attributable the very slight undulations in the Desert Sandstone.

The extreme metamorphism of the Pre-Cambrian rocks is to a great degree Pre-Ordovician; but, as indicated by the gneissic character of much of the intrusive granites, it was partly at least contemporaneous with that of the Ordovician quartzites, &c. As should, perhaps, have been pointed out previously, the elevated area occupied by the Macdonnell Ranges forms a great part of the northern boundary of the Lake Eyre Basin. In travelling southwards from this elevated region towards the centre of the basin, we descend by

means of a series of terraces formed by the Ordovician ranges, each one on a lower level than its predecessor on the north, on to wide and extensive plains occupied by Cretaceous rocks and by stony and loamy plains and sandhills.

These last features have been formed from the *débris* derived partly from the Cretaceous strata, which *débris* has been accumulating through the Late-Tertiary and Post-Tertiary epochs, and is still accumulating at the present day. Such plains, near their northern limit at least, are not less than 1,000ft. above sea level. Still they slope so gently to the south towards the centre of the basin, *i.e.*, towards Lake Eyre, that their elevation above sea level is no index to their altitude above the surrounding country. The streams which have eroded them have not generally excavated their channels deeper than from 200ft. to 250ft. below the original surface of the country.

(2) THE JAMES, WATERHOUSE, GEORGE GILL, AND LEVI RANGES.

The next division of the mountain system includes the ranges situated within the Ordovician area. Beginning from the north these comprise the quartzite ridge which forms the southern boundary of the Pre-Cambrian area, and in which are the Heavitree, Emily, Temple Bar, &c., Gaps. This ridge is succeeded on the south by the Waterhouse, James, George Gill, Levi, and Chandler Ranges. These ranges consist of a series of parallel ridges of quartzite and sandstone, with a nearly east and west trend, separated by numerous parallel and often very persistent and regular longitudinal valleys. These valleys are generally very narrow, often less than a mile wide, but sometimes open out, as in the case of the Missionary Plain, to a width of from twelve to fifteen miles.

Intersecting these ranges are numerous short transverse valleys, frequently entirely occupied by the channels of the creeks, which have eroded them. One of these creeks often extends for long distances along one of the longitudinal valleys, and then suddenly bursts through the range through a narrow gorge, to resume its course along a second longitudinal valley at a lower level than the first, and perhaps to pass through a second gorge in its passage towards Lake Eyre. These ranges extend easterly, as far at least as those of the previous division have been traced, while westerly they practically terminate at $131^{\circ} 20'$ (about) east longitude.

They have a mean combined width, if we include the intervening plains and valleys, of from sixty to seventy miles. The area occupied by them, therefore, must be more than 15,000 square miles. The highest points are situated in the most northern ridge, as in the case of Mount Gillen, which must be nearly 3,000ft. above sea level. The mean elevation of this ridge is about 2,500ft. above sea level, that of the Waterhouse Range about 2,200ft., that of the James Range about 2,000ft., while, lastly, the mean elevation of Chandler Range is only about 1,500ft. to 1,600ft. From these figures it can be clearly seen that there is a gradual decrease in elevation in the ranges from north to south, each range to the south constituting, as it were, a step in the descent from the Macdonnell Ranges to the plains.

The chief factors, in addition to the position of the longitudinal valleys occupying the original troughs of the folds, that have influenced the direction of the lines of denudation are (1) the lines of weakness on the crowns of the anticlinal arches, and (2) the position of the bands of limestone. An example of the influence of (1) is furnished by the valley of Petermann Creek, which

has been eroded out of an anticlinal arch, while the rocks of the corresponding synclinal trough now form the George Gill and Levi Ranges. The influence of (2), as might have been expected, is to be observed throughout this region, the greater number of the valleys within these ranges having been, to a great extent, eroded out of the limestone beds.

The angle of inclination of the mountain slopes depends to a great extent on the nature of the strata and on their dip. On one side of the ridge the slope often conforms to the dip of the strata when these are inclined at fairly steep angles. On the south side of the quartzite ridge, for instance, which forms the northern boundary of this area, the inclination of the strata (quartzite and limestone), as well as that of the mountain slope, is from 60° to 70° .

The north face of this ridge, however, presents for almost the total thickness of the quartzite a sheer perpendicular escarpment extending from the summit downwards 200ft. or 300ft. Below this quartzite, as at Mount Gillen, the remaining 600ft. to 700ft. of this face, composed of Pre-Cambrian gneiss, has a slope not exceeding 30° to 40° . A similar difference in the inclination of the slopes of a ridge is also to be seen in the case of the Mereenie Escarpment, which probably extends almost continuously as far east as the Finke River. On the north side there is a steep, almost perpendicular, escarpment from 500ft. to 600ft. high, whereas on the south the slope conforms to the dip of the strata.

In those ranges where the sandstone is dipping at very low angles, as in the George Gill and Levi Ranges, we find very steep, almost vertical, escarpments on both sides. The northern face of Levi Range, for instance, rises to an elevation of about 500ft. above the valley of Petermann Creek, for nearly 300ft. of which it is almost vertical. At the foot of this escarpment there is a talus slope nearly 200ft. high, with an inclination of about 30° .

(3) CRETACEOUS TABLE-TOPPED HILLS AND TABLELANDS.

Although there are no mountains or mountain ranges worthy of the name within the Cretaceous division, the altitude of the Cretaceous plains near the northern limit of this area is as much as 1,000ft. above sea level. These elevated plains slope gradually towards Lake Eyre from an altitude of 1,000ft. above sea level to 39ft. below sea level at Lake Eyre.

Rising out of these plains are numerous table-topped hills and low flat ranges and tablelands, isolated from one another by denudation. Some of the highest of these rise to an altitude of from 300ft. to 400ft. above the surrounding plains, and thus in the northern part of this Cretaceous area to 1,200ft. to 1,300ft. above sea level. These isolated masses are separated by "stony" and "loamy" plains and "sandhills." The hills are usually crowned by a layer a few feet in thickness of an exceedingly hard rock, representing sometimes a sandstone, sometimes a grit, and at other times a finer-grained and more argillaceous rock. Between the grains of this rock hydrated silica has been deposited from solution. To the presence of this cement is to be attributed its extreme hardness and often more or less conchoidal fracture. This so-called "Desert Sandstone," or porcellanite, when finer-grained and more argillaceous, protects the underlying strata from denudation in a way that may be compared to the protective action of the boulders in the case of the famous earth-pillars of certain villages in the Tyrol.

Chambers Pillar, for instance, a well-known feature situated ten miles north of the old Idracowra cattle station on the Finke, might be likened to an earth-pillar, the indurated ferruginous sandstone of its summit taking the place of the boulder of the earth-pillar, and protecting the sandstone of the pillar from removal by denudation. The isolation of Chambers Pillar, for it is surrounded on all sides by red sandhills, is probably due to the purely local character of the indurating process, or rather perhaps to the induration having been more intense in the locality of the Pillar than in the once surrounding rock, now entirely denuded. The Pillar, if we include in this term the whole structure from base to summit, is divisible into two parts—a basal portion or pedestal 500 yds. in circumference at its base and 100 ft. high, and a column surmounting it, 67 ft. high and 80 yds. in circumference at its base. The whole, with the exception of the few feet of more indurated rock on its summit, consists of a yellow and white friable sandstone slightly tinged yellowish-red externally by hydrated ferric oxide. The presence of this layer of indurated rock explains the fact that the isolated Cretaceous table-topped hills have usually the form of truncated cones, the topmost stratum generally presenting a vertical edge for its whole thickness, while the slope of the portion of the hill occupied by the underlying softer strata varies from 32° to 40° from the horizontal.

(4) AYERS ROCK AND MOUNT OLGA.

In addition to the foregoing mountain ranges, there are some isolated mountains within the area examined that require a brief description. Rising like an enormous waterworn boulder, half buried in the surrounding sea of sandhills, is that remarkable isolated monolith known as Ayers Rock. It is situated about thirty-two miles S.S.W. of Lake Amadeus. The summit of this monarch of the desert can be seen from a distance of more than forty miles. At a nearer view its smooth, bold, flattened, dome-like outline stands out clear and distinct. This interesting relic of an ancient geological formation has puzzled explorers in no small degree. It rises to an elevation of about 1,100 ft. above the surrounding plains, and about 2,500 ft. above sea level. The sides of the rock, which has a circumference at its base of nearly five miles, are very steep, almost vertical in places and practically inaccessible, although Mr. Gosse succeeded after great trouble in ascending it. The rock is quite bare, with the exception of a few fig-trees, which maintain a precarious footing in the few crevices on its bare sides.

The rock has been often mistaken for granite, to which it bears some superficial resemblance, both in its lithological aspect and in its mode of weathering. The original sedimentary character of it, however, is unmistakable, numerous very small rounded pebbles of quartz and felspar being distinctly visible in hand specimens. Although once a sedimentary rock, it has been to some extent altered by metamorphic agencies, a small amount of mica, perhaps of secondary origin, having been formed. The rock is very indurated, and to some extent altered, arkose sandstone, decidedly gritty in parts.

The sides of this rock ascend in places quite vertically for a distance of 500 ft. to 600 ft., while some of the more sloping faces are marked by a series of terraced waterfalls rising one above the other. A peculiar netted appearance is to be seen on some of the faces, a good example being visible on the northern face. This is due to the irregular weathering of the rock, the softer spaces,

which have disappeared, having been separated by small intersecting veins of a harder material, perhaps due to segregation along certain lines, which now stand out as low reticulate ridges.

A noteworthy feature of the rock is the manner in which it peels off. Firstly, on a small scale, thin flat flakes an inch or two in diameter and from one-eighth to a quarter of an inch in thickness are seen to be separating from the rock in all directions, and along no definite plane or set of planes. Secondly, on a large scale there may be seen, sometimes leaning against the base of the rock, having slipped from a higher level, or lying round its base, immense blocks of rock which have peeled off from the mountain, the phenomenon resembling on a large scale the concentric weathering of many eruptive rocks. In one or two places large blocks can be seen detached sufficiently to allow the sunlight to pass between them and the main mass, but still not entirely separated. One of these measures 8ft. x 5ft. x 200ft., while others which are leaning against the base of the rock measure 6ft. x 5ft. x 20ft. and 12ft. x 6ft. x 60ft. Caves, usually of a small size, occur both near the base and on the sides and slopes of the rock. Lastly, a ridging is observable, which probably indicates the direction of foliation planes, trending in a N.W. and S.E. direction.

Fifteen miles west of Ayers Rock is another remarkable mountain mass, the most prominent and elevated portion of which is called Mount Olga. This, with numerous other peaks which rise from a common base, forms an isolated mass surrounded by red sandhills. Mount Olga rises to an elevation of about 1,500ft. above the plain, and over 3,000ft. above sea level. It appears to be composed of a coarse conglomerate from top to bottom, which consists for the most part of pebbles of granite and other eruptive rocks. The southern face of this mass is about five miles in length, and its western extremity rises perpendicularly for nearly 1,500ft.

Mount Olga from a distance presents a most remarkable outline, the many rounded dome-like elevations reminding one of the features usually presented by granite ranges.

B. — RIVERS.

The country traversed by the Expedition between Oodnadatta and the Macdonnell Ranges lies wholly within a region of internal drainage, divisible into two basins, the centre of the largest and most important being Lake Eyre, and that of the other being Lake Amadeus. The basins of Lakes Eyre and Amadeus will be described in detail later. We will in the meantime confine our attention to that portion of the Lake Eyre Basin which is drained by the Finke, one of the most important rivers of Australia.

The Macdonnell Ranges and the eastern extension of the Hart Range may be said to divide the drainage of the interior into two areas, of which the southern, which forms part of Lake Eyre Basin, contains the most important rivers. The Finke, with its large tributary, the Hugh, takes its rise on the southern slope of these ranges, and flows toward Lake Eyre in a general southerly to south-easterly direction. The majority of the small creeks, which issue from the northern slope, do not discharge their waters into any common basin, but each maintains an independent course for a longer or shorter distance from the ranges, to become sooner or later absorbed by the sandhills and loamy plains. These latter creeks, of which the Darwent, Dashwood, Charley, Six Mile, Muller, &c., are examples, leave the ranges and flow northwards over the surface of the elevated plain, which is known to the north of Alice Springs as Burt Plain.

They have dry sandy channels, the banks of which are lined with gums, which are numerous and of vigorous growth near the ranges. There are a few creeks of this character heading from the south-western extremity of George Gill Range, *e.g.*, King and Laurie Creeks. The former of these flows southwards in the direction of Lake Amadeus, but the flow of the water at fifteen or twenty miles from its source is not strong enough to form a channel, with the result that the flood waters spreading out over wide "gum flats" become absorbed by the surrounding sandhills.

There are, in addition to the above-mentioned small creeks, two or three larger ones taking their rise on the north slope of the Macdonnell and Hart Ranges near their eastern extremities, which after a short northerly course sweep round to the south and flow towards Lake Eyre. As an example of these may be mentioned the Hale, the Sandover, and the Plenty, the two last of which ultimately unite to form the Marshall or Hay River. Speaking generally, one may say that the drainage from the southern slope of the Macdonnell Ranges and from those ranges lying immediately to the south is sooner or later collected into one main channel known as the Finke, which trends in a general south-easterly direction towards Lake Eyre.

(1) FINKE BASIN.

(a) *Nature and Position of its Watershed.*—The northern limit of the Finke Basin is to a great extent formed by the Macdonnell Ranges, the line of water-parting extending along the northern edge of these ranges. The water-parting does not, therefore, traverse what are now the most elevated points in the ranges, such as Mounts Gillen, Sonder, &c., but lies wholly to the north of the ridge containing these points. This fact probably indicates that the summit of the arch, which originally determined the line of water-parting, lay near the northern edge of the Macdonnell Ranges.

The mean elevation of the northern watershed is nearly 3,000ft. above sea level. The water-parting of the Finke Basin runs along the northern edge of the Macdonnell Ranges westerly to about Mount Ziel. From this point a straight line to the north-western extremity of Gardiner Range would nearly represent the north-west boundary of the basin. The western line of water-parting extends from this latter point to George Gill Range, and thence E.S.E. along the southern face of Levi Range. From Levi Range the rest of the western watershed is not well known; it passes at all events through the eastern extremity of the Musgrave and Everard Ranges. The exact eastern limit of the basin is practically unknown.

(b) *Area of the Finke River Basin.*—The area of the Finke River Basin cannot be less than 80,000 square miles. The basin is roughly triangular in shape, with the apex situated at Lake Eyre and the base coincident with the northern water-parting. The northern portion of the basin is the most elevated, the drainage being to the south and south-east. The mean elevation of this northern portion cannot be less than from 2,500ft. to 3,000ft. above sea level. About half the way between the northern watershed and the apex of the basin the mean elevation is about 1,000ft., while at Lake Eyre itself it is a few feet below sea level. A rough calculation of the average elevation of the basin makes it at least 800ft. above sea level.

(2) THE FINKE RIVER.

(a) *Tributaries of the Finke.*—On the north side of Finke Gorge, through which the Finke flows in its southerly course, this river is formed by the junction of two creeks. The eastern branch, known as Ormiston Creek, rises on the northern edge of the Macdonnell Ranges, and bursts through the prominent quartzite ridge between Mounts Giles and Sonder. The western branch, the Davenport, which is the more important of the two, takes its rise two to three miles S.E. of Mount Ziel, and flows for a few miles to the south, where it is known as the Crawford. It then suddenly turns to the east and is known as the Davenport. Before, however, it junctions with Ormiston Creek it is joined by several small creeks, notably Redbank and Rockybar Creeks, both of which take their rise in the northern portion of the Macdonnell Ranges, and, going south, force their way through narrow gorges in these ranges. The Finke flows southwards from the junction of Ormiston Creek and the Davenport, and at twelve miles from that junction, measured in a direct line, it is joined on the west by Rudall Creek, which rises in the south-western extremity of the south Macdonnell Range, about 132° E. longitude, and which flows almost due east to the Finke.

Bending more towards the east, the Finke flows past the Mission Station (Hermannsburg), entering the Krichauff Range one mile south of this point. After a meandering course of from ten to fifteen miles through this range in a general S.S.E. direction, it is joined on the east by an important tributary, known as Ellery Creek. This latter takes its rise on the northern edge of the Macdonnell Ranges, about $132^{\circ} 50'$ E. longitude, and, flowing S.S.W., forces a passage through two quartzite ridges on its way to join the Finke. On its exit from the Krichauff and James Ranges, the Finke is joined on the west by Ippilla Creek, a small tributary having its source in the James Range.

From this point the general course of the river is S.E. and is extremely tortuous. When it reaches $21^{\circ} 45'$ S. latitude and $133^{\circ} 22'$ E. longitude it is joined on the west by a very important tributary, the Palmer. The Palmer takes its rise on the northern slope of the James Range, about 132° E. longitude and $23^{\circ} 40'$ S. latitude, and flows in a general S.E. direction through this range for sixty miles, when it is joined on the west by an equally important tributary, the Walker. This latter has its source in the north-western extremity of Gardiner Range, and flows with a general E.S.E. course. The united streams, known as the Palmer, flow in an E.S.E. direction to junction with the Finke, 100 miles from the point where the Walker junctioned with the Palmer.

Petermann Creek, of less importance than the above-mentioned tributaries, takes its rise in what is known as Petermann Pound, a plain nearly five miles in diameter encircled by a line of hills about 400ft. to 500ft. high. This semicircle of hills unites George Gill Range with a western extension of that portion of the James Range known as the Station Range. From the Petermann Pound, Petermann Creek flows about due east, and occupies a longitudinal valley between George Gill and Levi Ranges on the south and a portion of the James Range on the north. In its passage eastwards it is joined by numerous small creeks flowing from the ranges on each side, one of the largest being Trickett Creek, which takes its rise on the south-east face of George Gill Range, and flows N.E. The valley of Trickett Creek separates George Gill Range from Levi Range, which would otherwise constitute one continuous range.

Petermann Creek, after a nearly easterly course of about forty-five miles, joins the Palmer at ten or twelve miles below the Walker junction. From the Petermann junction the Finke pursues a nearly E.S.E. course for sixty miles, when it is joined by a very important branch, the Hugh. This river has its source on the northern edge of the Macdonnell Ranges, about twenty-five miles west of Alice Springs, and, sweeping through the range at Brinkley Bluff, flows in a general E.S.E. direction. The Finke is next joined on the west by the Lilla at a point thirty-two miles in a direct line S.S.E. from the Hugh junction. About thirty-six miles in a direct S.E. line from the last point another creek, the Goyder, joins the Finke on the west. Further south still, and to the east of Charlotte Waters, it is joined by the Coglin.

Below the junction of this creek the Finke has no defined channel, but spreads out over wide alluvial flats. Sixteen miles S.S.E. of Charlotte Waters the telegraph line crosses Adminga Creek, which runs easterly to the flats over which the Finke waters spread. Still further to the south the Alberga, which takes its rise in the eastern extremity of the Musgrave Range, after being joined on the north by a tributary, the Stevenson, and being then known as the Macumba, flows E.S.E. towards Lake Eyre. It is into the Macumba that part of the floodwaters of the Finke flow on their way to Lake Eyre. The greater portion, however, disappears from the surface, and is absorbed by the vastly extensive sandhills and plains which stretch round the north and east sides of Lake Eyre. In the above description of the Finke and such of its tributaries as occur in the area examined by the Expedition no mention has been made of the Todd, an important stream which takes its rise on the northern edge of the Macdonnell Ranges to the north of Alice Springs. It leaves these ranges at Heavitree Gap, and at first has for many miles an easterly course, after which it turns S.S.E. towards Lake Eyre. It is very probable, but this is not certainly known, that the Todd junctions with the Finke south of Charlotte Waters.

(b) *Length and Rate of Fall of Finke Channel.*—The total length of the Finke from its source in the Macdonnell Ranges to Lake Eyre must be about 1,000 miles, although the distance in a direct line is not greater than 500 miles. A few calculations have been made on the rate of fall of the channel of the Finke over different portions of its course. The difference in the altitudes above sea level of the channel of the Finke at Mount Sonder and at the Mission Station, a distance of fifty-four miles, is about 490ft. These data give a rate of fall of about 9ft. per mile. Between the Mission Station and the junction of the Palmer with the Finke the rate of fall is 5ft. per mile, the difference in the altitude of the two places being 699ft., and the distance between them 135 miles. Lastly, the difference in the altitudes of the Finke Channel at the Palmer junction and at Lake Eyre, a distance of 536 miles, is 980ft., which gives a mean rate of fall of less than 2ft. per mile. Between Heavitree Gap (1,713ft. above sea level) and Oodnadatta (397ft. above sea level), a total distance in a direct line of 337 miles, the fall of the slope of the surface averages about 3.7ft. per mile.

The above figures show, as might have been expected, that the rate of fall is at its maximum in the Macdonnell Ranges, and at a minimum on the Cretaceous plains near Lake Eyre, between which places there is a gradual decrease in the rate of fall as we go from north to south.

(c) *Nature of the Course and Channel of the Finke.*—As one might expect, judging from the figures just given, the course of the Finke from the Macdonnell Ranges to the southern slope of the James Range is not so sinuous as it is after it debouches upon the Cretaceous plains. On these plains its course becomes extremely meandering, the river making its way down the very gentle incline from these ranges to Lake Eyre only after performing numerous sweeping curves. The width of its channel varies considerably, being usually narrower and deeper in the ranges, but widening out as it leaves them. On emerging on to the plains it becomes flatter and shallower and dotted with gum trees, which are not confined to the banks only as in the ranges, but grow often in patches even in the middle of the channel.

(d) *Absence of Surface Running Water.*—The absolute dependence of the presence of running water in the bed of the Finke upon direct supplies of rain has its explanation in the following facts:—

- (1) The basin of the Finke, although of great extent, is entirely confined, or nearly so, to an area over which the climatic conditions are the same.
- (2) Rain falls usually only at certain seasons, there being long intervals of drought.
- (3) There is an almost total absence of springs at the head of the Finke and its tributaries, and in the few instances of their occurrence the discharge is very small.

The influence of these three factors on the absence of surface running water is obvious. After the floodwaters caused by a heavy downpour have subsided, and during the long intervals of dry weather, surface running water is absent from the greater length of the channel, its appearance for short distances only at certain parts being due purely to local causes. The absence or paucity of springs is to be attributed to the absence of a sufficiently thick layer of soil on the mountain slopes to act as a reservoir by absorbing the rain water and giving it out gradually at lower levels in the form of springs. It is also due to the absence of joints in the Pre-Cambrian and their scarcity even in the Ordovician rocks. The rain waters are, therefore, not absorbed, but form torrents, and rush down the bare mountain slopes into the valleys. When the waters have reached the beds of the watercourses, their rapid absorption by the porous strata and the excessive amount of evaporation that is always taking place cause the almost total disappearance of surface water from the river channels.

(e) *Waterholes.*—At certain seasons of the year, should the fall of rain be sufficiently great, the supply of water in the channels of the rivers exceeds the amount that can be absorbed by their sandy beds, and this produces a flow of water down the channel. This is often spoken of locally as a flood, as the waters as a rule are not confined to the channel by the low river banks, but spread out over the wide alluvial flats which border the main channel.

When rain ceases to fall the flow of water diminishes almost immediately in volume. This it continues to do until running water disappears from the surface over an ever-increasing length of its course. There are, however, for a month or two after a heavy rainfall portions of the channel over which running water may still be seen; but these gradually decrease in length until the channel assumes what may be termed its normal state. In this state the channel is occupied by long stretches of white sand devoid of surface water,

separated at rare intervals by short lengths of the channel, where water may be seen flowing gently over a rocky bed. In the apparently waterless stretches, however, water may be obtained by sinking to depths varying with the nature of the bottom and the lapse of time since the last heavy fall of rain. The appearance of surface water at rare intervals in the bed of the river is due to the presence of "bars" of rock, which cross the channel at these places.

As the water in its downward progress cannot filter through these rocks as it does through the sand and gravel at other parts, it has to rise to the surface to pass over them. The change from the normal state of the channels to their next condition is a more gradual one. As the supply of water becomes less and less, the amount and rate of flow over the rocky bars gradually diminish, until finally the supply becomes too small to cause the water to rise over them at all.

When the river has reached this stage in its desiccation, the isolated and often widely-separated waterholes and rockholes become economically important features. The principal waterholes occurring in the beds of the rivers and creeks may be described under the three following headings:—

1. Rockholes confined to gaps and gorges.
2. Waterholes on the upper sides of bars of rock.
3. Waterholes not associated with rocky bars, but occurring in the rivers where the bed is impervious.

1. *Rockholes Confined to Gaps and Gorges.*—These occur in the many gaps and gorges through which the rivers and creeks have forced their way in their southerly course from one longitudinal valley to the next. In the quartzite ridge, for instance, forming the southern boundary of the south Macdonnell Ranges proper, there are many gaps, the beds of the rivers in these being partly occupied by pools of usually excellent water. Such waterholes occur in the Redbank, Finke, and Ellery Creek Gorges, and in Simpson and Emily Gaps.

The great strength of the current of the water flowing through these gaps, due to the fact of the streams being confined within narrow bounds, sweeps all detritus out of them and erodes the river bed to a greater extent here than elsewhere, thus often producing deep rockpools which retain large quantities of water. Many of these rockholes, owing to their sheltered positions, are practically permanent.

2. *Waterholes on the Upper Sides of Bars of Rock.*—The second class of waterholes are those situated on the upper side of some rocky bars. If the flow of water over the portions of the river channels in which these occur is strong, then the eddy in front of the bar causes the removal of sand and gravel from this side, and leaves, as the water subsides, a depression filled with water. Unfortunately, however, at a later period a light rain often causes a flow of water just strong enough to carry sand, &c., into this hollow and thus obliterate it. For this and other reasons one cannot always depend upon getting water on the surface at these places, even though one may have seen on a former occasion a fine pool of water at the same place. A very good example of this class of waterholes occurs in the Finke near Henbury cattle station.

3. *Waterholes not Associated with Rocky Bars.*—The third class of waterholes owe their existence to their being situated over the portions of the river beds where fine silt or mud takes the place of porous sand and gravel, and thus prevents the percolation of the water below the surface. When the floodwaters

abate over these portions, there usually remain a string of waterholes occupying the depressions in the river bed. If rain does not fall for some time these one after another lose their water by evaporation and become dry. Only those which occupy the deepest and most sheltered depressions hold out for any length of time. Such waterholes prevail in the Cretaceous area as in the Stevenson, Macumba, and Coglin Rivers, and form the chief sources of supply in the districts where they occur.

What a valuable provision of nature in reality are the sandy beds of the rivers! Through the sand and gravel the water creeps slowly down its course protected to a great extent from evaporation, and here it may generally be obtained by sinking; whereas if it had remained on the surface it would have been rapidly evaporated. Only in those places where ledges of rock cross the channel do the waters appear at the surface, and then usually for a short distance only, disappearing again in the sand on the other side of the rocky bars.

Seldom do the floodwaters of the Finke and Macumba flow over the surface to Lake Eyre; for the lacustrine delta of these rivers, consisting for the greater part of deposits of sand and loam which have been accumulating during the Late-Tertiary and Post-Tertiary epochs absorb the immense body of water brought down by these rivers.

(f) *Rainfall in its Relation to Surface Water.*—The rainfall throughout the area of the Finke Basin is somewhat variable, ranging from an average of less than 5in. per year in the central and southern portions to 10in. or 12in. over much of the mountainous country in the northern part of the basin. The mean annual rainfall throughout the basin cannot be more than 6in. to 7in.

A great part of the moisture that falls as rain throughout this area is lost by evaporation. From claypans and all shallow depressions which expose large surfaces to the desiccating agents, the water disappears in two or three months after a fall of rain. From the waterholes, too, during the dry season, the water disappears at an alarming rate. Waterholes which have been examined by one explorer during a good season, and declared to be permanent, have, when examined later by a second explorer in a rather dry season, been often found to be dry, or nearly so. Explorers have indeed been rather too hasty in forming conclusions as to the permanency of waterholes, which visited perhaps during a good season, contained a good supply of water, but which had in reality no element of permanency. In the great majority of cases they are not fed by springs nor situated in places sufficiently sheltered to give practical permanency to them.

Besides the great quantity of water directly evaporated, some of it goes to supply the wants of the gums which line the banks of the creeks. In times of heavy flood some of the water may reach Lake Eyre along the channel of the Macumba, while a large portion filters gradually down towards Lake Eyre through the bed of the creek at a moderate depth from the surface. Lastly, an important portion of the rainfall percolates through the outcrops of the porous strata of Cretaceous age, travels downwards towards Lake Eyre, and forms the supply from which the artesian water is derived. Some of this water reaches the surface again in several localities by natural outlets, and issues from the mouths of mound springs. Some of the water probably percolates the sand and gravel of the river beds, and in this way reaches the water-bearing strata of the artesian basin.

C.—GORGES AND GAPS.

The next features to be described are the gorges and gaps, which are rather numerous in the ranges in the northern portion of the region under consideration, and through which many of the rivers flow on their ways southwards towards Lake Eyre. These features are in the form of narrow rocky passes with walls usually of quartzite, but sometimes of sandstone, rising almost vertically to heights varying from 200ft. to 700ft. or 800ft. above the valleys. Their length varies exceedingly, while in width they range from a few feet to 40yds. or 50yds. Many of the rivers after flowing equatorially for some distance along the longitudinal valleys turn abruptly to the south, and cross the ranges through these gaps.

In most of the gaps are beautiful pools of clear fresh water, in which large numbers of fish live, belonging, however, to a few species only. It has been thought that these gaps occupy the sites of faults in the strata, but it appears to us to be quite unnecessary to call in the aid of such dislocations to account for their origin. The origin of the majority of the gaps is probably due to the erosion of the river beds in the positions of the present gaps keeping pace with the upheaval and folding of the strata in those places. By thus lowering their channels the rivers have maintained their original positions. In a few cases, however, the gorges may owe their existence directly to faults, the water readily eroding a passage for itself along the fault planes and their associated cracks.

D.—LAKES.

The interior district of Australia, *i.e.*, the portion which has an internal drainage, comprises an area of nearly a million and a half square miles, and is, therefore, seven times as large as the Great Basin of North America. It will thus be readily understood that the lakes, which form the centres of the several drainage basins, are physical features of the greatest interest and importance. Surrounding the area of internal drainage is a strip of country stretching inland from the coast for varying distances, throughout which the rivers carry the surface water to the ocean.

Only two lakes occur in the region considered in this paper, *viz.*, Lakes Eyre and Amadeus, each of which forms the centre of one of the divisions of the internal basin. Both of these are fast passing into the state of dry basins. This is due in the first place to the aridity of the climate throughout the region occupied by them, from which results an almost total absence of superficial flow of water into the lakes, *especially Lake Amadeus*; and in the second place it is due to the accumulation in the lakes of sand, &c., transported thither by running water or wind. These statements apply in a special manner to Lake Amadeus, the absence of surface water near its western extremity at any rate being specially noticed by Mr. Tietkens.

From the sandhills bordering the lake near Gosse's Crossing, *i.e.*, towards its eastern extremity, we could make out no water on its surface. There the dry bed of the lake was crossed without trouble *en route* to Ayers Rock and Mount Olga.

Of these two lakes Eyre is the larger and the more important, and will be considered first.

LAKE EYRE.

Lake Eyre receives the drainage from the Macdonnell Ranges, and the ranges lying immediately to the south of them, together with the drainage from a great part of west and south-west Queensland. Its basin includes those of all the rivers that drain into it, and having no outlet it is entirely encircled by a line of water-parting. The drainage throughout the basin is to the S.E., S., and S.W., Lake Eyre itself being situated close to the southern border of the basin.

The Lake Eyre Basin occupies the eastern half of South Australia between the northern termination of Flinders Range and the Macdonnell Ranges, and the greater portion of west and south-west Queensland from the Great Dividing Range westwards. The rivers which drain this enormous area are taken in order from west to east—the Neales, Macumba, Finke, Todd, Hale, Sandover, Plenty, Mulligan, Diamantina, and Cooper or Barcoo.

The western boundary of the Lake Eyre Basin is formed by the Cretaceous plains flanking on the east the Everard Range, in which the Neales River takes its rise, by the eastern extremity of the Musgrave Range, from which the Alberga heads, and by the western extremities of the George Gill and Gardiner Ranges, where some of the large tributaries of the Finke have their sources. The northern boundary is formed by the Macdonnell and Hart Ranges. The north-eastern and the eastern are formed by the Selwyn, McKinlay, and the Great Dividing Ranges, in which the sources of the Mulligan, Diamantina, and Barcoo (Cooper's Creek) are situated. Lastly, the southern boundary is for the most part formed by the northern slope of the Flinders Range, from which short narrow creeks flow northwards to Lake Eyre.

Form, Area, &c.—The general form of the basin is roughly quadrilateral, with one angle situated on the northern slope of Flinders Range, to the south of Lake Eyre south. Another of the angles coincides with the western extremity of the Macdonnell Ranges about Mount Ziel. A third lies near the head of the Mulligan, and the last is situated about the source of the Barcoo River. The total area of the basin cannot be less than 500,000 square miles, the greatest breadth, lying along the 24th parallel, is about 900 miles, and the greatest length, occurring about the 137th meridian of E. longitude, is about 750 miles.

Lake Eyre itself, including Lake Eyre south, lies within the 137th and the 138th meridians of E. longitude and between 27° 50' and 29° 29' S. latitude, and occupies an area of about 5,000 square miles. It is situated almost at the very southern extremity of the basin, the south edge of Lake Eyre south being only a few miles north of the northern extremity of Flinders Range. The margin of Lake Eyre has been calculated to be 39ft. below sea level.

LAKE AMADEUS.

The Lake Amadeus Basin is not well known, but it appears to be of small extent as compared with that of Lake Eyre. It comprises in all probability an area of between 20,000 and 30,000 square miles. The northern boundary of the basin extends probably from the western end of George Gill Range to Watson Range, and thence along the north of the 24th parallel to about the Western Australian border. The southern limit of the basin lies possibly along the Rawlinson and Petermann Ranges, while its eastern and western boundaries are apparently unknown.

Lake Amadeus itself was discovered and named by Mr. Ernest Giles in 1872, when it proved an insuperable obstacle to him in his westward course towards Western Australia. In 1873 it was crossed by Mr. Gosse at a narrow neck near its eastern extremity; but in the next year Mr. Giles was again forced to retrace his steps, the bed of the lake, where examined by him, being found to be so boggy as to be impassable. In 1889 Mr. Tietkens examined the western portion of the lake, and was consequently able to define approximately its true outline, which had previously been extremely hypothetical. His examination of the lake resulted in the shortening of its length, as shown on the maps up to that time, by more than 100 miles.

Its extreme western portion, which was previously supposed to be situated about $128^{\circ} 10'$ in Western Australia, and to be about twenty to thirty miles wide, is now known to be situated in South Australia, about $130^{\circ} 18'$, and to be only from two to three miles wide.

According to Mr. Tietkens, its extreme length is about ninety-two miles, while its width varies from two to fifteen miles, the maximum width of fifteen miles occurring about the 131st meridian. At the narrow neck, however, where we crossed, it is not more than three-quarters of a mile wide.

The area of the lake is approximately 700 square miles, and its altitude above sea level must be more than 1,000ft.

One set of calculations of its elevation were based on Mr. Winnecke's figures for the altitudes of the camps at Bagot Creek and Reedy Hole, and on the differences between the barometrical readings at those places and at Lake Amadeus; while another set were based on the barometrical readings given by Mr. Tietkens in his journal, &c.

As far as known, Lake Amadeus receives the drainage of a few small creeks only, as no rivers of any importance have up to the present time been discovered within the area of its basin. The view of the lake gained from the neighboring sandhills is a very remarkable one. Stretching away to the east and west as far as the eye could discern was a dazzling white, flat expanse, on whose surface no water could be seen, but in its place a coating of a white saline material, which on analysis proved to be composed almost entirely of common salt, with a small amount of sulphate of lime (gypsum). On closer examination the saline crust was found not to exceed a quarter to half an inch in thickness, under which was a red argillaceous sand passing down into similar material of a grey color. The surface of the lake was found to be tolerably firm, the horses only sinking to the depth of a few inches. On each side of the lake the sandhills rise to a height of 50ft., and have a nearly east and west trend.

E.—CLAYPANS.

After the description of the lakes it is necessary to say a few words about those miniature lacustrine features known as "claypans." They are usually in the form of flat shallow depressions, often nearly circular, but in the majority of cases of irregular outline, and usually devoid of vegetation. They are generally surrounded by loamy plains or sandhills, and while they are more frequently met with throughout the Cretaceous area, they are still not uncommonly found on the plains and in the valleys of the ranges within the Ordovician area. Mr. Streich suggests that claypans owe their existence* to an

* Trans. Roy. Soc. of South Australia, vol. xvi., part ii., p. 90.

ascent of subterranean water at the junction between the "sedimentary and the metamorphic formations," as he found them numerous in the neighborhood of the junction line. We, however, observed no such relation, and give below our explanation of their formation.

Claypans vary in diameter from a few feet up to as much as three-quarters of a mile, a common size being from 50yds. to 100yds. They are exceedingly shallow; the depth of the bottom below the general level of the surrounding sandhills or plains is seldom greater than 5ft., and usually much less, being in the majority of cases not more than 2ft. to 3ft. In some cases the edge of the depression is ill-defined, the plain merging almost imperceptibly into the claypan, and the only indication of the circumferential limits is the ring marking the edge of the deposit of fine silt which covers the bottom and sides of the claypan. In other cases the sandhills come to the very edge, and form a well-defined rim to it. The area drained by them is limited to a very narrow peripheral belt. As a general rule water does not remain in them very long; some of the best hold water for three or four months, but in the great majority of cases, especially of the smaller ones, the water disappears from them at the end of a month or two. There are exceptional instances, however, of which Conlon Lagoon is an example, in which water would remain for very much longer periods.

The water of the claypans has generally a reddish-yellow color, due to the presence of a quantity of very fine mud of that color held in suspension, which on evaporation of the water is deposited on the bottom of the claypan as a fine silt with a peculiar glazed surface, due perhaps to the extreme fineness of the last portion of the sediment deposited. On drying, this mud loses water and splits in all directions, cracks as much as a quarter to half an inch wide making their appearance and separating the more or less rectangular masses from each other.

The following explanation of the method of their formation has suggested itself to us. They naturally occur only where the country is flat, *i.e.*, where the slope of the ground is not decided enough in any particular direction to cause the surface water to flow in that direction. There is therefore a tendency for the water to lie on the surface, or rather to be gathered into slight depressions, which are sure to exist even on otherwise almost level surfaces. At first the water that was gathered into these slight depressions would almost immediately percolate the porous strata, but in doing so it would leave behind a deposit of silt. This would happen with every subsequent heavy fall of rain, until the silt suspended in the water and carried into the depression and deposited there was in sufficient quantity to prevent further percolation.

The claypan has now become established and will retain water for a longer or shorter period, and as there is now very little percolation through the bottom there will be no further settling of the floor as there may have been in the early stages. The depth of the claypan in many cases will, however, be increased by the growth of the rim by the deposition at the water's edge of the fine particles of sand, &c., driven along the surface of the ground by the wind. In this manner the rim may be added to from time to time, and the holding capacity of the claypan thereby increased.

The largest example of a claypan seen during the expedition is one that occurs a few miles to the south of Heavitree Gap, and known locally as Conlon Lagoon. In its greatest dimensions it is a quarter of a mile wide and three-

quarters of a mile long. The depth of the bottom of the lagoon below the surrounding country does not exceed 4ft. or 5ft., and as there was at the time it was visited not more than 3ft. of water in it, it was already in process of drying up. Where dry the bottom was seen to be formed of a clayey sand. Conlon Lagoon lies between two ranges trending east and west, the drainage from which finds its way into the lagoon. There is, however, no indication of an outflow eastwards to the Todd (the only possible direction), the lagoon and the ranges on the north and south forming a miniature internal drainage system of their own.

F.—STONY PLAINS.

The whole of the area from the northern extremity of Flinders Range northwards to within a few miles of Mount Burrell cattle station on the Hugh river, and for many miles in an easterly and westerly direction, may be said to be occupied by rocks of Cretaceous age, covered over large areas by Post-Tertiary deposits and over very limited areas by Pliocene beds of lacustrine origin. The upper strata of the Cretaceous system have been removed by denudation over extensive areas, the remaining portions being in the form of more or less isolated table-topped hills dotted about throughout the whole area. The materials set free by this denudation have gone to form the superficial accumulations known as "gibber" or "stony plains," loamy plains, and to a large extent also the sandhills.

"Stony plains" is the name given to those portions of the Cretaceous area over whose surface are strewn "gibbers," *i.e.*, rounded or sub-angular fragments of silicified sandstone or grit known as "Desert Sandstone." The Desert Sandstone is extremely hard and weather-resisting, and has a somewhat sub-conchoidal fracture. With such properties it is not surprising to find fragments of it covering much of the country from which the sandstone has been denuded.

The uniform distribution of the gibbers, which is a very characteristic feature of this class of country, is due to the fact that the fragments derived from the layer of "Desert Sandstone" which extended over this area, now strewn with gibbers, have not undergone redistribution to any large degree. In a flat district like this the surface water has not been able to sweep them into watercourses. The removal of the argillaceous sand by the wind and rain has permitted the gibbers to settle down, until in many places they present a flat surface resembling an artificial pavement. The outer surface of the gibbers is of a dull red color, due to the presence of a thin film of oxide of iron coating them. They also present a glazed sub-angular or pseudo-waterworn appearance, produced by the polishing action of the sand grains as they are driven along the surface of the ground.

The stony plains gradually merge into loamy plains, which possibly occupy the sites of areas of the Upper Cretaceous, which were devoid of the "Desert Sandstone" capping.

On either sides of the banks of many of the rivers, especially along their serpentine courses over the plains, are extensive alluvial plains. During floods the channels are too flat and shallow to carry off the immense body of water that occasionally comes down them, and the water spreads out on either side, sometimes for miles. The "box flats," which are met with on the sides of the Finke Channel, are flood plains, on which *Eucalyptus microtheca* flourishes in large numbers.

G.—SANDHILLS.

The last features of importance are the sandhills, which occupy the surface over immense areas of the interior. These are ridges of usually a red argillaceous sand, having in many localities an approximately parallel arrangement, and therefore with a constant trend usually N.E. and S.W., due to the prevalence of S.E. winds, but elsewhere occurring quite irregularly. The trend of the sandhills is to a great degree dependent upon the direction of the prevailing wind, being almost at right angles to this. Separating the ridges are the corresponding diminutive valleys, the floor of which is usually of a much more clayey character than the material of the sandhills. They have one steep fall inclined at an angle of about 30° and situated on the side opposite to the quarter from which the wind blows, the other side having a gentler slope.

The sandhills rise to very varying heights, 30ft. or 40ft. being a very common height, while in some cases they reach 70ft., or even in some extreme cases 100ft. above the level of intervening flats. The highest sandhills were crossed during the trip from George Gill Range to Ayers Rock, where also the greatest development of them was seen. The surface of almost the whole of this strip of country is occupied by sandhills, which are clothed over very large areas with "porcupine grass" (*Triodia*).



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