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OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

VOLUME IX.

TRANSACTIONS AND PROCEEDINGS.

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1895. Olive, W. T., M.I.C.E.
1884. Péringuey, L., F.E.S., F.Z.S.

1895. Purcell, F., Ph.D.
1895. Raffray, A. (Chev. de la Légion d'Honneur).
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1880. Tooke, W. H.
1896. Tredgold, C. H.
1896. Treleaven, F.
1877. Trimen, R., F.R.S., F.L.S., F.Z.S. (*Honorary Member*).
1895. Trotter, A. P., B.A., M.I.C.E.
1895. Turner, G., M.D.
1894. Van der Riet, B., Ph.D., M.A.
1896. Veale, H. B., M.B.
1892. Westhofen, W.
1878. Wiener, L., M.L.A.

MINUTES OF PROCEEDINGS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

ORDINARY MONTHLY MEETING.

Wednesday, September 25, 1895.

Mr. R. MARLOTH, Ph.D., M.A., Vice-President, in the Chair.

Messrs. J. P. CREGOE, GARWOOD ALSTON, and Dr. E. BARNARD FULLER, were duly elected ordinary members of the Society.

The undermentioned donations were announced, and the thanks of the Society voted to the donors:

Records of the Geological Survey of New South Wales, Vol. IV., Part 3.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, Tome II., No. 3.

Bulletin du Muséum d'Histoire Naturelle, 1895, No. 3.

Feuille des Jeunes Naturalistes, Nos. 297, 298.

Annual Report of the Geological Survey, Canada, Vol. IV., 1888–89; Vol. VI., 1892–93.

Johns Hopkins University Circular, Vol. XIV., No. 119.

Proceedings of the Royal Society of Victoria, Vol. VII.

Papers from Geological Society of South Africa.

Vierteljahrschrift der Naturforschenden Gesellschaft in Zürich, Vierzigster Jahrgang.

Annual Report of the Library Syndicate.

Report of the Trustees of the Australian Museum, 1894.

Revista de la Facultad de Agronomia y Veterinaria, La Plata, Nos. 5, 6, 7, 1895.

Proceedings of the American Philosophical Society, Nos. 143–146.

Journal of the Cincinnati Society of Natural History, Vol. XVII., Nos. 2, 3, 4.

The American Anthropologist, Vol. VIII., Nos. 1 and 2.

Proceedings of the California Academy of Sciences, Vol. IV., Part 1.

The Minnesota Academy of Natural Sciences, Occasional Papers, Vol. I., Part 1.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1895, No. 1.

Epidemic Diseases and their Prevention in the Eastern Suburbs of Sydney, by G. L. Mullins, M.A., M.D.

Mr. Bolus exhibited specimens of a new orchid (*Disperis*) which was found last month by Professor Bodkin, and which he proposed to describe as *Disperis Bodkini*. This raised the number of orchids found within the limits of the Cape Peninsula to about 117—a number probably not exceeded upon a like area in any part of the world. Mr. Bolus remarked that he had found, on a recent visit to Geneva, that an orchid was found at the Cape exactly two hundred years ago.

Mr. Schwarz exhibited various fossils from Clanwilliam district, including some interesting specimens of Trilobites, in one of which the facetted eye was particularly well shown. Specimens of the various Reptilia from the Karoo beds, mainly from Prince Albert and neighbourhood, were also exhibited, and the interesting commingling of reptilian and mammalian characters described. Some casts were shown of specimens which have already been chiselled out for Professor Seeley; and Mr. Schwarz mentioned that he was himself busy at similar work, the product of which, in the event of its proving scientifically valuable, would find a place in the South African Museum.

The Chairman exhibited a few scratched pebbles from the Dwyka conglomerate. He explained that his reasons for exhibiting these pebbles with striæ and scratches on them were the following:

At the last meeting of the South African Geological Society, held at Johannesburg on the 2nd instant, Mr. D. Draper read a very interesting paper on the Dwyka conglomerate. In the comprehensive review which he gave of the various theories of its origin, he mentioned also Mr. R. D. Oldham's view, according to which the fine matrix was apparently deposited in quiet water, while the pebbles and boulders were dropped into it from above by floating ice. Mr. Draper did not think this probable on account of the absence of striæ on the included fragments. "No investigator," he said, "had yet succeeded in finding the striæ on the included fragments." As Mr. Dunn said, "They may exist nevertheless, but if they were as numerous as they were in the Scandinavian Drift, they would have been discovered ere this." Some members would remember that Mr. Dunn exhibited some pebbles with such striæ on them at the meeting of the Society held on the 24th of June, 1885. Unfortunately their minutes did not say where Mr. Dunn had found them, and whether they had been taken out of the rock or picked up loose on the surface. It appeared that the latter was the case. Two other cases he knew for certain, *viz.*, one specimen figured in Dr. Stapff's paper on the Dwyka conglomerate, which was found by Mr. Dunn on the farm Elandsfontein, near Griquatown, and two others found by Dr. Schenck near the confluence of the Vaal and Orange Rivers. These specimens, however, which he exhibited were taken out of the weathering rock by himself not far from the homestead of the farm Hard Castle, on the banks of the Orange River, about twelve miles above Prieska. As no such authenticated find seemed to have been made before, he thought the matter of sufficient importance to bring it before them.

Dr. Corstorphine said he would not take these stones as evidence of the glacial origin of the Dwyka conglomerate, the scratches on them not showing the characters of glacial striations.

The Chairman said he had not at all advocated the glacial theory. He did not pretend to form a theory on the origin of the conglomerate. He exhibited these stones simply as they might support Mr. Oldham's views.

Dr. Corstorphine promised to bring some genuine ice-scratched stones to the next meeting, which could be compared with those already exhibited.

The Chairman said he would be very pleased if Dr. Corstorphine would do so. Opinions differed on the matter.

Dr. Corstorphine showed specimens of the rocks from Kimberley and Johannesburg. The relations of the diamond-bearing rock and the surrounding strata were illustrated by a diagrammatic section, and the nature of the various rocks described. The main features of the Johannesburg section were then described, and a short reference made to the importance of a thorough survey of the Rand before anything could be settled as to the further outcrop of the main reef and other gold-bearing reefs.

Mr. Stewart, in proposing a vote of thanks to Dr. Corstorphine, said the specimens shown were very interesting as showing the various kinds of rock and reef from which valuable minerals were obtained, and threw some light upon the gold-bearing properties of Witwatersrand. The question that was full of interest was where all this gold came from. Certainly the strata of the Rand mines nonplussed the miners and prospectors in the early days. The reason had, of course, come to the front since, but if the men who went to Johannesburg in the early days had had the remotest idea of the true condition and arrangement of things underground, vast sums of money would have been saved. It struck him forcibly when he went to Johannesburg in 1888 that there were cuts lengthwise and diagonally with the reef. If the people had only known how to go to work they would have saved, as shown by subsequent results, thousands of pounds.

Ordinary Monthly Meeting.

Wednesday, October 30, 1895.

Mr. T. Muir, LL.D., M.A., F.R.S. Edin., President, in the Chair.

Professor Thomson, Dr. Gregory, Dr. Impey, and Messrs. E. H. L. Schwarz, H. P. Saunders, C. P. Lounsbury, H. Baker, and D. Grove were duly elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

Journal and Proceedings of the Royal Society of N. S. Wales, Vol. XXVIII.

Annuaire de l'Académie Royale des Sciences de Belgique, 1894.

Bulletin de l'Académie Royale des Sciences de Belgique, Vols. XXVI., XXVII., XXVIII., and XXIX.

Feuille des Jeunes Naturalistes, Nos. 299, 300.

Report of H.M. Astronomer at the Cape of Good Hope for 1894.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1895, No. 2.

Boletin de la Academia Nacional de Ciencias en Cordoba, Tomo XIV., No. 2.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. IX., Nos. 3, 4, 5 and 6.

Dr. Gill read a paper by Mr. A. W. Roberts on the variable star S. Velorum, and made the following remarks:

The variability of this star was discovered by Mr. C. Ray Woods. By comparing two photographs taken at the Cape Observatory on March 18, 1893, and January 20, 1894, and on February 1, 1894, it was shown to be a variable of the Algol type. Mr. Roberts finds the period of the star to be 5 days 22 hrs. 24 mins. 22 secs., with the probable error of + 2 seconds. The star's normal magnitude for 5 days 7 hrs. is $7\frac{3}{4}$ magnitude; it then begins to decline in brightness till it reaches $9\frac{1}{4}$ magnitude, remains at that magnitude for the next $6\frac{1}{2}$ hours, when it begins to return to its normal magnitude. Mr. Roberts investigates the form of the light curve, and concludes that S. Velorum is a binary star, the central star being large and faint, the smaller but fainter companion revolving round it. The third portion of the paper refers to a graphical method of determining the orbit of an Algol variable.

Dr. GILL remarked on the excellent work done by Mr. Roberts, with simple and inexpensive means, in the field of the discovery and observation of variable stars, and by his skill and perseverance he had become the first authority on variable stars in the Southern Hemisphere.

Mr. RAFFRAY read some notes on blind and partially blind insects found in South Africa. The statement made that no such insects had been discovered here was an erroneous one, and he exhibited microscopical slides showing the total absence of eye and the partial obliteration of this organ in two examples of Coleoptera he had captured in the neighbourhood of Cape Town. Neither of the two insects exhibited were inhabitants of caves, nor did it follow that cave-inhabiting insects or arachnids were necessarily blind.

ORDINARY MONTHLY MEETING.

Wednesday, November 27, 1895.

Mr. T. MUIR, LL.D., M.A., F.R.S. Edin., President, in the Chair.

Messrs. J. W. CROWHURST, F. PURCELL, and W. STONEY were elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

Proceedings of the American Philosophical Society, No. 147.
The American Anthropologist, Vol. VIII., No. 3.
Bulletin du Muséum d'Histoire Naturelle, 1895, No. 6.
Proceedings of the California Academy of Sciences, Vol. IV., Part 2.
Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg, Série 8, Vol. I., Nos. 1, 2, 3, 6 and 7.
Paper of the South African Geological Society, Nov. 11, 1895.
Journal and Proceedings of the Hamilton Association, No. 11.
Maps of the Geological Survey of Canada.
Feuille des Jeunes Naturalistes, No. 301.
Annalen des K. K. Naturhistorischen Hofmuseums Wien, Meteoreisen Studien, IV., Von E. Cohen.

Professor GUTHRIE exhibited a portion of what looked like a water-worn mussel-shell, alleged to have been taken out of the inside of an eel, where it was found lying alongside the water-bladder. He admitted that he was doubtful as to whether an eel possessed an air-bladder or not, and asked if any member could enlighten him on that point.

Dr. FULLER read a paper on "Antitoxins," in which he stated that when the poison of disease enters the blood an effort is made to counteract its effect by the body cells. These latter produce a substance inimical to the action of the poison, or toxin, and this substance is known as an antitoxin. Theoretically, it should be possible to have an "antitoxin" for every disease produced by a toxin; but many practical difficulties occur, such as mixed infection in disease and delayed diagnosis. The poison, or toxin, entering the blood of an individual need not necessarily be one of disease, but may be a poison, such as snake poison, in which case an antitoxin is also produced to counteract its effect if the dose of poison be not a lethal one. In the case of one attack of disease conferring immunity in an individual for subsequent attacks of a disease, it is probably due to the fact of the antitoxin of a particular disease poison being stored up in the system, and so preventing a second attack of the disease. The theory of antitoxins is in its infancy, and great advances may be expected from it in the treatment of disease in the near future.

Dr. ROSS made some remarks on this paper.

Mr. STEWART exhibited some specimens of the Table Mountain rocks, and made lengthy remarks upon them.

Dr. VAN DER RIET then read his paper "On the Analysis of some South African Prehnites."

ORDINARY MONTHLY MEETING.

Wednesday, January 29, 1896.

Dr. J. A. ROSS in the Chair.

Lieutenant-General GOODENOUGH, C.B., Colonel NIXON, R.E., and Messrs. HENRY DE SMIDT, and W. T. OLIVE were elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

Proceedings of the Scottish Microscopical Society, 1894–95.
Recent Measures of Double Stars, by H. C. Russell, F.R.S.
Feuille des Jeunes Naturalistes, Nos. 302, 303.

Revista del Museo de La Plata, VI., 2.

Records of the Geological Survey of New South Wales, Vol. IV., Part 4.

Select Extra-Tropical Plants, &c., by Baron F. von Mueller.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, II., 5; III., 1.

Memorias y Revista de la Sociedad Cientifica, 'Antonio Alzate,' VIII., 1, 2.

Sitzungberichte der Kaiserlichen Akademie der Wissenschaften, CIII., 4 and 5, 6 and 7, 8–10.

It was moved by Dr. J. A. Ross, and seconded by the Rev. G. H. R. Fisk:

"That the Council of the South African Philosophical Society be requested to take into consideration whether it is advisable to bring before the notice of the Government the desirability of encouraging scientific research by admitting instruments for that purpose free of duty, and if so to take steps accordingly."

Dr. F. Purcell read some notes on the structure and development of the eyes of certain arachnids. He stated that the eyes of arachnids belong to one or other of two types, according as the cells or the retina are inverted or not. The eyes of the *Phalangiidæ*, or Harvest-men, belonging to the inverted type, were described in detail. In this family the cells of the retina are arranged in characteristic groups of four cells each, one central being surrounded by three peripheral ones. Each cell secretes at its distal end a hyaline visual rod, assumed to be the sensitive portion of the cell. The four rods of each group of cells are fused to a single piece of complicated structure called the rhabdome. Their outer ends only are exposed to the light which enters the eye through the lens, while the rest of their surface is cased in black pigment. When, however, the animal is kept in a very dimly lighted place for some hours, the pigment changes its position, so as to leave a large portion of the rhabdome exposed to the light. Some reference was made to the phylogenetic origin of the eye.

An interesting discussion followed upon the evolution of the different types of eyes, in which Messrs. Fuller, Raffray, Stoney, Corstorphine, and the Chairman took part.

Ordinary Monthly Meeting.

Wednesday, February 26, 1896.

Mr. W. H. Finlay, M.A., F.R.A.S., in the Chair.

Dr. Gilchrist, Professor Jas. Holm, and the Rev. Dr. Kolbe were elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

Vierteljahrschrift der Naturforschenden Gesellschaft in Zürich, Vierzigsten Jahrgang, drittes und viertes Heft.

Bulletin du Muséum d'Histoire Naturelle, 1895, No. 7.

Description of an Artificial Eye intended for the Study of Opthalmoscopy, and the Objective Determination of Ametropia, by C. A. Oliver, M.D., of Philadelphia.

Geological Survey of Canada, Maps, 3 Packets.

Dr. Purcell exhibited sections of spiders' eyes, to illustrate his paper read at the last meeting.

Mr. Garwood Alston exhibited a mass of heavy black rock found at Kenhardt, and formerly thought to be an aerolite, as no similar rock is found in the neighbourhood.

He also exhibited seed capsules of *Acanthus*, which split and distribute the seeds when moistened with water.

Mr. Raffray communicated a paper on the *Pselaphidæ* of South Africa, in which he recorded 76 species. In the Cape Peninsula there were found 16 genera, of which 10 genera and 45 species were peculiar to the locality. In Natal there were 12 genera, of which 1 genus and 14 species were peculiar. In Mashonaland 6 genera. The result of an exhaustive study of these beetles confirmed the opinion derived from other animals and plants, that whereas the Natal fauna and flora are common to the whole of the East Coast of Africa, yet the Cape Peninsula formed a little province of its own, most of its plants and animals being peculiar to itself.

Mr. Péringuey exhibited some specimens of the Natal locust, which had succumbed to a natural disease similar to that investigated by Pasteur in the silkworms called "Muscardine," and produced by a fungus of *Bothritis Bassiana.* He had previously described the presence of devouring ichneumon-fly maggots in the eggs of the locusts, so that it seemed probable that, with the artificial propagation of both of these enemies of the locust, they might be able to carry on a successful destruction of the plague.

Dr. Corstorphine exhibited casts made by Dr. Schönland of two boulders showing glacial striæ, discovered by Mr. Dunn in the bed of the Vaal River, and at present in the Albany Museum.

Dr. Muir made an appeal to the Society to have demonstrations of new and remarkable discoveries in science repeated here. For instance, a discovery had recently been made that if a photograph be taken with an ordinary dry plate, against which a screen was placed covered with fine lines, some four hundred to the inch, coloured alternately red, orange, and blue, and the dry plate developed in the ordinary way, then if this plate be put in a lantern and projected on a screen, it looked like an ordinary photographic negative; but when the screen was placed over it, the picture was seen to be coloured exactly as in nature, thus affording a most beautiful illustration of Clerk-Maxwell's theory of the three fundamental colours in nature.

Again Professor Röntgen's discovery could be so easily repeated, that very little expense was sufficient to enable us to see for ourselves this truly wonderful discovery.

Dr. van der Riet read a paper on the Dolerites of South Africa.

Ordinary Monthly Meeting.

Wednesday, March 25, 1896.

Mr. T. Muir, LL.D., M.A., F.R.S. Edin., President, in the Chair.

Messrs. A. W. Rogers, B.A., and A. P. Trotter, B.A., were duly elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

Journal of the Manchester Geographical Society, Vols. II., III., VI., VII., VIII., IX.

Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, Jahrgangs, I.–XII.

Das Grundwasser in Hamburg, Parts 1, 2, 3.

Annales de l'Institut Colonial de Marseille, 3rd year, 2nd vol. (1895).

Bulletin de la Société Impériale des Naturalistes de Moscou, 1895, No. 3.

Bulletin du Muséum d'Histoire Naturelle, 1895, Nos. 1, 8.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. IX., Nos. 3, 4, 5.

Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. VIII., Part 4.

Abhandlungen u. Berichte XXX des Vereins für Naturkunde zu Kassel, 1894–95.

Journal of the Cincinnati Society of Natural History, Vol. XVIII., Nos. 1 and 2.

The American Anthropologist, Vol. VIII., No. 4.

Report of British Association, 1895.

The PRESIDENT announced that two days after the last meeting a gentleman wrote to him stating that he had placed £25 in the hands of an agent to procure the necessary apparatus to show the Society the new discovery of photographing in colours.

He also stated that in a few weeks the tubes would be received to illustrate Professor Röntgen's process of photographing through opaque objects.

The CHAIRMAN exhibited some diagrams of rainfall at the Royal Observatory from 1841 to the present time.

Mr. FINLAY made some remarks on the relationship between sunspots and rainfall.

Dr. MARLOTH said that members would remember that last year he had exhibited a butterfly with the pollinium of an orchid on its body. Since then he had captured a butterfly of the same species with two pollinia of another *Disa* on its body, so that this occurrence was not so rare as was thought on the previous occasion.

Dr. MARLOTH then read Dr. Schönland's papers:

1. On a case of Peloria in a South African orchid (*Disa patula*).
2. The structure of the flower and the method of pollination in *Crassula canescens*, Schult.
3. On some points in the morphology of *Aizoaceæ*.

ORDINARY MONTHLY MEETING.

Wednesday, April 29, 1896.

Mr. T. MUIR, LL.D., M.A., F.R.S. Edin., President, in the Chair.

Messrs. W. L. SCLATER, M.A., and E. T. LITTLEWOOD, M.A., were duly elected ordinary members of the Society.

Dr. CORSTORPHINE stated that in connection with the work of the geological survey of the Colony he was able to make a statement of considerable scientific value, and of the utmost importance to all interested in the stratigraphy of South Africa. In the clay-slate and grit series underlying the sandstone of Table Mountain, and into which the granite of this portion of the Colony has been intruded, till now no fossils had been discovered. He was glad to say that in the course of his mapping last week, and as a result of diligent searching, Mr. A. W. Rogers, assistant geologist to the Geological Commission, discovered outcrops in the clay-slate near Houw-Hoek, Caledon, which have yielded fossils belonging to the invertebrate groups *Brachiopoda* and *Gasteropoda*, as well as more indefinite remains, probably of Trilobites. The importance of the discovery was twofold. They were now likely to be in a position to assign the clay-slate series to some definite geological age, and they also had evidence, apart from structural conditions, that ought to enable them to settle whether the Bokkeveldt fossiliferous shales and these clay-slates were the same as Von Hochstette and R. N. Rubidge held, or whether, with Bain and Wyley and most succeeding geologists, they were to consider this one as lying below and the other above the Table Mountain sandstone.

Professor Holm said that from 1865 Clerk-Maxwell, from theoretical considerations, propounded his electro-magnetic theory of light which suffered electrical phenomena to be due to disturbance of the same medium and of the same kind as those which excite the sense of sight. The experimental verification came thirty years later from Dr. Hertz, of Bonn, who not only verified Maxwell's suppositions, but performed all the ordinary optical experiments, such as reflection, refraction, interference, polarisation, &c., with electrical waves. Hertz used as his generator of electrical oscillation two large sheets of brass, separated by a small spark-gap. The sheets were connected to the terminals of a Ruhmkorff induction coil, and when the coil was in action a rapid succession of sparks passed across the spark-gap, these giving rise to electrical disturbances, which radiated out into space. These disturbances in the neighbourhood of the oscillator were detected by means of a simple circle of stiff wire having two metal knobs on its ends which could be separated by a small distance, giving a second spark-gap. It was found that when the length of the latter was suitably adapted with reference to the former, the disturbances caused minute sparks to pass across this second spark-gap. The methods by which Hertz showed reflection, refraction, and polarisation with these electrical waves were then explained. Since Hertz's time other observers had substituted for the spark-gap a Geissler vacuum tube which glowed at each discharge, thus rendering the effects of the Hertzian waves visible to an audience. The appearances presented when the discharge takes place in a vacuum tube were explained. When the exhaustion is fairly high, bluish bands of violet light pass from the negative cathode, a reddish light passing from the anode. The two were separated by a dark space known as the Faraday space. As the exhaustion proceeded the light from the anode retreated, so that the dark space nearly filled the whole tube. The cathode rays could only be rendered visible by impinging on some fluorescent substance; the glass walls of the tube gave with English glass a bluish and with German glass a greenish phosphorescence. The cathode rays proceeded in straight lines from the cathode, and were deflected by a magnet. Leonard modified the Crookes' tube by inserting a small aluminium window opposite the cathode. The cathode rays were found to pass through the window and render the outside air feebly luminous. He also showed that these cathode rays were photographically active, and certain substances in thin layers were transparent to them.

Röntgen, while experimenting with a Crookes' tube, as modified by Leonard, noticed that a strip of paper painted with barium platino-cyanide and glued on a block of wood became phosphorescent when the paper was turned towards the tube. He turned the wooden side towards the tube and the phosphorescence still appeared. This suggested to him to try the transparency of various other substances. A book of one thousand pages produced only a perceptible weakening; metals in the form of foil were transparent, but as the thickness of the metal increased the transparency diminished, so that shadows were cast on the screen. Thus with a wooden box containing metal weights the wood was transparent while the metal weights cast distinct shadows on the screen. When the hand was interposed it was found that distinct shadows of the bones were visible, surrounded by much fainter outlines of the surrounding tissues. He obtained similar results when the rays were allowed to impinge on a photographic plate completely enclosed in a dark slide, and the photographs were now familiar to every one. Röntgen proved that these rays are distinct from the cathode rays, and from the fact that they appeared to be incapable of regular reflection and refraction through a prism, he threw out the suggestion that they might be due to longitudinal vibrations. He concluded that they originated from the points where the cathode rays impinge on the surface of the glass and produce fluorescence. It had since been shown that the rays could be produced without the aid of electricity by merely allowing sunlight to fall on some fluorescent substance. Edison in a telegram to Lord Kelvin stated that out of 1,800 substances examined he found that calcium tungstate when properly crystallised gave the finest fluorescence with the Röntgen rays, far exceeding that produced by platino-cyanide. Professor Hahn had kindly prepared some of the salt, and experiments were being made by Mr. Trotter and Professor Holm at the South

African College, the results of which would be communicated to the Society in due course. A tube of the most recent type had been ordered, which, in conjunction with the induction coil belonging to College, would enable all the Röntgen experiments to be performed at an early date.

Dr. Muir said that six names were to him of most importance in the history of the discovery—those of Maxwell, Hertz, Crookes, Leonard, Röntgen, and Becquerel.

Mr. Trotter said that Professor Holm and he had been making some attempts to produce Röntgen photographs by means of calcium tungstate under the influence of concentrated sunlight, but the experiments had so far been unsuccessful. Professor Hahn had prepared some calcium tungstate, but it appeared that the salt should be crystallised in a special manner in order to give the best results.

The most general hypothesis at that date was that Röntgen rays were longitudinal vibrations, and there were reasons for supposing that the velocity of propagation was very great, and that the wave-length also was very great. A wave-length of ordinary light was about one fifty-thousandth of an inch. The present method of producing light was a most barbarous one, and was to be compared to depressing all the notes from the bass upwards of an organ in order to produce a few shrill notes. The present mode of producing light was to raise a body to white heat, and all the lower vibrations of heat were wasted. Some day, however, light would be produced without heat. This secret is known only to the glow-worm and the firefly, and it seemed possible that these creatures would be found to emit Röntgen rays, since there appeared to be a connection between fluorescence and phosphorescence and Röntgen action.

Vibrations producing radiant heat were longer than those producing light, but the vibrations discovered by Hertz were much longer. They were of the same nature as light but were invisible. Such rays consisting of vibrations a yard long would traverse a brick wall. Low musical notes, too, could penetrate a wall which stopped higher notes. It seemed likely, then, that Röntgen rays were of considerable wave-length. If this were so their velocity must be great, and a most important question arose whether there could be any connection between these rays and gravitation. Gravitation appeared to act instantaneously—but instantaneous action at a distance was almost unthinkable. The velocity would have to be very large. Even if it were one million times faster than light, it would occupy as much time to act between the earth and the sun as light would take to travel ninety-two miles. This would produce effects of aberration which would be easily detected by astronomers. He hoped to be able to assist Professor Holm in producing some successful results at a later date.

Mr. Finlay mentioned that Mr. Ray Woods, of the Royal Observatory, had taken some photographs that afternoon with extraordinary results.

Mr. Woods, at the invitation of the Chairman, explained and exhibited his work. The letters R O had been cut in tinfoil and placed next to the film of a plate in the dark room. A twenty minutes' exposure to a $1\frac{1}{2}$ inch spark had just given an appreciable impression, with a very bright effect on the outer side; but one of forty minutes had given a very distinct image. A third experiment was the exposure for forty minutes to daylight, so as to show that the rays that penetrated the wood were not ordinary light rays. In a fourth experiment there was tinfoil on both sides of the sensitive plate. The under or glass side which was farthest from the electric spark was most affected.

Ordinary Monthly Meeting.

Wednesday, August 5, 1896.

Mr. T. Muir, LL.D., M.A., F.R.S. Edin., President, in the Chair.

Dr. Turner, Medical Officer of Health for the Colony, was elected an ordinary member of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

La Feuille des Jeunes Naturalistes, Nos. 304, 307, 308, 309.

Memorias y Revista de la Sociedad Cientifica 'Antonio Alzate,' Tome IX., 1 and 2, 3 and 4, 5 and 6.

Jahrbüchen der K. K., Central Anstalt für Meteorologie und Erdmagnetismus, Wien, 1893.

Bulletin of Johns Hopkins Hospital, Nos. 59, 60, 61.

Johns Hopkins University Circulars, No. 123.

Transactions of Canadian Institute, Vol. IV., Part 2.

The Functions of a Great University, by J. M. Clark, M.A., Toronto.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. X., Nos. 1, 2, 3.

Journal of the Manchester Geographical Society, Vol. XI., Nos. 4–6.

Results of Rain, River, and Evaporation Observations in New South Wales, 1894.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1895, No. 4.

Report of Her Majesty's Astronomer at the Cape for 1895.

Occasional Papers of the Trustees of the John Slater Fund, Nos. 1–7.

Transactions of the Royal Society of Victoria, Vol. IV.

Annales de la Faculté des Sciences de Marseille, Tome V., Part 4; VI., Parts 1, 2, 3.

Pamphlets by Mr. H. C. Russell, B.A., F.R.S.

A Chart of Circumpolar Stars.

The Meteor of June 27, 1894.

A Map showing the Monthly Average Rainfall in New South Wales.

Recent Measures of Double Stars, made at Sydney.

Icebergs in the Southern Ocean.

Design for a Photographic Transit Circle.

The SECRETARY (Mr. L. Péringuey) deposited the manuscript of a bibliography of books, pamphlets, maps, and magazine articles relating to South African Geography from the time of Vasco da Gama to the formation of the British South Africa Company in 1888, compiled by a member of the Society, Mr. H. C. Schunke Hollway, F.R.G.S. This catalogue was most exhaustive, and would prove of great utility. Two such catalogues have already been published by the Society, one on botanical, the other on meteorological bibliography.

The PRESIDENT announced that the Geological Commission was also having a catalogue of the geology and mineralogy of South Africa published on similar lines.

Mr. PÉRINGUEY exhibited two large stone implements, one of which was evidently the work of man; the other might prove not to be so. Still there was some analogy between them. The first one was presented to the museum as being a Bushman's anvil, but from further inquiries it has transpired that the stone was used as a beacon by the Hottentot or perhaps Bushman tribes to denote the limits of their grazing or hunting ground. If a dispute arose between two tribes, the chief would direct a search to be made for the beacon, which would be dug up at the spot mentioned, and the claim of the tribe would be thus established. The second stone had been found while building the railway between Kalk Bay and Simon's Town. In shape it was more symmetrical than the other, but a flat depression could still be detected on one side. This would seem to prove that the shape of that stone was not due to accident. He had produced these two stones, hoping to obtain information bearing on the use they might have been put to. It was very important indeed to record all information on a subject of which, after all, little was known. His inquiries had been instrumental in obtaining some interesting information, which goes far to show that certainly Bushmen have distinctive boundary marks for their territory. Dr. Theo. Hahn had written the following letter on the subject:

"STELLENBOSCH, *July* 28, 1896.

"DEAR MR. PÉRINGUEY,—With regard to your inquiries about Bushman beacons, I must say that what you told me about stones shaped in a certain form and used by the Bushmen as landmarks is new to me. But that Bushmen tribes occupy certain territories, and observe certain boundaries, is well known to me; for instance, in Great Namaqualand, that of the Obanin on the Lower Fish River; that of the Ganin and the Geinin north-east of Angra Pequena; of the Hei-guis between lat. 26°—28° south, and about long. 20°—22°; further, that of the Gabe and Ai Bushmen between Gobabis and Kaitses; but these landmarks are certain sand dunes, hills, kopjes, periodical rivers, vleys, springs, and also trees, and in one instance a grave.

"That the above-named Bushmen have not changed their abode since the commencement of this century can be conclusively proved.

"You doubted what I told you about the manner in which the Bushmen and Namaquas find honey by following the bee. I repeat it here again, and you are at liberty to write to the Rev. Mr. Carl Wandnes at Warmbad, who will corroborate to you what I say. When a bee passes a Bushman or Namaqua in search of honey, the man will follow the bee as far as he can with his eyes, say at least fifteen to eighteen yards; in that line of flight he will search for a dropping of the bee, and will find it, *coûte qu'il coûte;* he will then in the next line of ten or fifteen yards search for another dropping, and the line of these two droppings will indicate the course the bee took to the nest. I first heard of it from my late father, who observed it among the Namaquas at Ghamis, twenty-five miles north of Bethany. I afterwards read of it in Sir James Alexander's 'Expedition of Discovery into the Interior of South Africa.' Then I heard of it repeatedly among the Namaquas and Bushmen: every child in the country knows it. There is a Hottentot at Warmbad who is a great expert in brewing honey beer. I have forgotten his name, but will at any time recognise him. This fellow told me himself of this manner of finding honey by following up the droppings of the bees. The missionary, the chief, and under captain, in fact every one on Warmbad knows the fellow.

"Now, if a Bushman has found honey, and has not skinbags of a leguan or any other utensils in which he can take the honey home, he will take a small piece of wood, break it and bend it into a certain form, and put it into the ground alongside the honey. And should any one else attempt to take that honey so marked away it would mean war to the knife. The same when a Bushman has killed game, and had to leave it covered to fetch assistance.

"Once two Bushmen, brothers, got a rock rabbit, and the elder one who killed it made a fire, and put it into the hot ashes to cook it. He then went to look for some gum (heira) on the mimosa trees. The younger brother, almost famishing, ventured to take a bit of the roasted rabbit during the absence of the elder. The elder on his return simply held the hand of the younger into the fire and burnt it, as he had taken a bit of meat without his permission. The poor fellow is one of the late chief of Bethany's herds, and as far as I know still alive."

Mr. Péringuey observed that without wishing to underrate the acumen of Bushmen it was more likely that the droppings of the bee were small drops of water expectorated by the insect when reaching the hive. This expectoration consists of the superfluous moisture elaborated in the gizzard of the bee in the honey-making process, and is got rid of when approaching the hive. These drops of water would thus denote the vicinity of the bee-hive to the Bushman.

The Secretary further said that, so far as he knew, nothing was known how long the stone age had lasted in South Africa. He had brought for exhibition specimens which went, he thought, far to show that stone implements had been used by Bushmen up to a comparatively recent period. In the museum they had the skeleton of a Bushman, or perhaps a "Strand Looper," that had been found wrapped up in a bushbuck-skin, and having alongside a stone implement fixed by some rosin to a short wooden handle, somewhat in the manner of the Australian aborigines. The skeleton was fairly preserved, and had been found buried, with the shell of a tortoise under its head and feet. The wooden handle was very much decayed, and the implement, perhaps on account of the mode of burial, might have belonged to a wizard, and been a token of authority or craft, and might have been much older than its owner. He was, however, exhibiting now fragments of pottery, two stone scrapers, a bone bodkin, and two diminutive models in wood of a gun and a spade, three and two inches long respectively, found near or under a heap of ashes on a krantz at Brandy Kraal, Sunderland district, by Master M. Nightingale. The shape of the spade, he was informed, is more that in use forty years ago than the present one. Further, he exhibited several small stone implements, found in digging a well in the Clanwilliam district. Among these implements (one which, by the by, seemed to be made of silex), were two beads, one of which was a small jagged leaden bullet, perforated, so as to be used as a bead. Now, they knew that these two districts had not been occupied by Colonists for a great length of time, and the specimens he had exhibited would seem to substantiate the theory that stone implements were used up to the end of the last century.

The President said that in consequence of the steps taken by him in connection with the then Colonial Secretary three years back, with the view of obtaining from the Civil Commissioners all information about Bushmen paintings, &c., to be found in their respective districts, a great deal of information had been received and tabulated, and a list submitted to gentlemen moving a good deal about the country had led to a good many more additions. He thought that the next step was now to act in co-operation with the Photographic Society, to have these Bushmen drawings photographed on the same size of plates, and to agree to draw rules and regulations that would make the publication of uniform size and type. He would endeavour to have this done.

Mr. A. W. Roberts's papers on 'The Latitude of Lovedale' and 'Variation of Lacaille 5861' were read.

Dr. Purcell exhibited some examples of *Peripatus*, a prototype of the *Arthropoda*, linking, perhaps, the worms with the insects. The number of species described are four. He has, however, found no less than five new South African species of *Peripatus* : (1) new *Peripatus*, from the Knysna, with seventeen pairs of claw-bearing legs, and of a black colour above; (2) *Peripatus*,* from Table Mountain, with eighteen pairs of legs, very like *P. balfouri*, Sedgw., but the terminal pair of legs is as large in the male as in the female, and pink papillæ occur on the back; (3) new *Peripatus*, from Kalk Bay, very like the last, but all the papillæ on the back are deep black; (4) new *Peripatus*, from Knysna, with twenty pairs of legs, and reddish brown, with three longitudinal black bands above; (5) new *Peripatus*, from the Cape, with twenty-one and twenty-two pairs of

* This form has since been found to be *P. balfouri*, Sedgw.

legs, and pink papillæ above, individuals with twenty-two pairs being twice as numerous as those with twenty-one pairs in both sexes. It is to be noted that in the Cape as well as in the extra African species, the number of the pairs of legs is constant for the species when not exceeding twenty, and variable when above that number.

Ordinary Monthly Meeting.

Wednesday, August 26, 1896.

Mr. W. H. Finlay, M.A., F.R.A.S., in the Chair.

Mr. Charles Currey, Mr. C. H. Tredgold, and the Hon. J. D. Hugo, M.L.C., were duly elected ordinary members.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

The American Anthropologist, Vol. IX., Nos. 1–5.

Report of National Academy of Sciences, Washington, 1895.

Report of 5th Tuskegee Negro Conference, 1896 (Papers of John Slater Fund, No. 8).

Transactions of Wisconsin Academy of Science, Vol. X., 1894–5.

Bulletin of Johns Hopkins Hospital, Nos. 62, 63.

Bulletin of U.S. National Museum, No. 48.

Proceedings of American Philosophical Society, No. 148, 149.

Proceedings of California Academy of Sciences, Vol. V., Parts 1 and 2.

La Feuille des Jeunes Naturalistes, No. 310.

Annalen des K. K. Naturhistorischen Hofmuseums, Wien, Band IX., Nos. 1–4; X., Nos. 1–4.

Smithsonian Report, U.S. National Museum, 1893.

Proceedings of U.S. National Museum, Vol. XVII., 1894.

Professor Holm proceeded to make a few experiments illustrative of the Röntgen rays.

Mr. W. L. Sclater then read Dr. Schönland's paper on some supposed Bushman inscriptions and rock-carvings found by him in Bechuanaland.

Dr. Schönland stated that the drawings had been recently discovered at Vryburg, and the peculiarity of them was that, instead of being, as usual, simply representations of animals, they were designs which seemed to indicate the existence of some kind of writing among the Bushmen hitherto entirely unsuspected. The drawings were found on Mostert's farm, about fourteen miles north-west of

Vryburg, and were on the vertical strata of the rock, and, as usual with Bushman drawings, in the vicinity of water.

Some photographs of these drawings taken by Dr. Schönland were exhibited.

Dr. Marloth said he had seen carvings and drawings on the rocks north of the Kuruman Mountains, but he had always thought that they were the work of Bechuanas rather than of Bushmen.

Annual General Meeting.

Wednesday, September 30, 1896.

Mr. T. Muir, LL.D., M.A., F.R.S. Edin., President, in the Chair.

The Reports of the Secretary and Treasurer were read and adopted.

The Meeting proceeded to the election of a President and Council for the ensuing year, with the following result:

T. Muir, LL.D., M.A., F.R.S. Edin., *President.*

H. Bolus, F.L.S.
G. S. Corstorphine, B.Sc., Ph.D.
W. H. Finlay, M.A., F.R.A.S.
E. Barnard Fuller, M.B., C.M., F.R.C.S. Edin.
D. Gill, C.B., LL.D., F.R.S., F.R.A.S.
L. Péringuey, F.E.S., F.Z.S., *Secretary.*
P. Ryan, M.L.A.
W. L. Sclater, M.A., F.Z.S.
Hon. C. Abercrombie Smith, M.A., *Treasurer.*
A. P. Trotter, B.A., M.I.C.E.

} *Council.*

MINUTES OF PROCEEDINGS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

Ordinary Monthly Meeting.

At the conclusion of the Annual General Meeting.

Wednesday, September 30, 1896.

Mr. T. Muir, LL.D., M.A., F.R.S.E., President, in the Chair.

Mr. C. Mayer and the Hon. D. P. Schreiner, Q.C., were nominated as ordinary members.

Dr. C. McGowan Kitching and Mr. Arnold Cooper, were duly elected members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors :

Report of the 6th Meeting of the Australian Association for the Advancement of Science, Brisbane, 1895.

Über Geschiebe aus Neu-Vorpommern und Rügen, von E. Cohen und W. Deecke.

Die Meteoriten von Laborel und Guareña, von E. Cohen. (Extr. Ann. d. k.k. Hossm. Wien.)

Actes de la Société Scientifique du Chili, Vol. V., Part 4.

Bulletin of the Johns Hopkins Hospital, Vol. VII., No. 64.

Memorias y Revista de la Sociedad Cientifica, "Antonio Alzate," Tomo IX., Nos. 7 and 8.

Festschrift der Naturforschenden Gesellschaft in Zürich, 1746–1896, Parts 1 and 2 (complete).

La Feuille des Jeunes Naturalistes, No. 311.

Australian Museum, Report of Trustees for 1895.

The President, speaking in regard to Bushmen paintings, said that the Photographic Society had agreed to co-operate in the matter, and had promised to take photographs of the pictures. They would readily understand that the plates should be of uniform size and correct as regards details. The Photographic Society had elected a Committee to attend to this matter, and it was proposed that a Committee of the Philosophical Society should be appointed to act with them. General Goodenough took great interest in the subject, and had stated that the Royal Engineers had a photographic apparatus which would be useful. It would be well also to appoint some one interested in the Museum, and he thought they could not do better than take the director of the Museum, Mr. Sclater.

A Committee of five, which includes General Goodenough, Mr. W. L. Sclater, Mr. H. G. Fourçade, and R. Marloth, was appointed.

The PRESIDENT said he thought provision should be made for the election of honorary members. He gave notice that he should move, at the next meeting that honorary members may be elected in the same manner as ordinary members, but not more than two in a year, and not more than twelve altogether.

It was decided to leave the question of numbers over for discussion.

The SECRETARY exhibited a Sarcophagous fly that had been sent to him by the Speaker of the House (the Hon. H. H. Juta, Q.C.), who captured it at Caledon. This fly has no less than seven pollinia of orchid affixed to its back. It is interesting to find that this fly (*Sarcophaga consobrina*) is thus the means of occasional fertilisation. The Hon. H. H. Juta informed him that he saw a great number of these flies with the pollinia, but he could not see any orchid about.

Dr. CORSTORPHINE exhibited some Dwyka conglomerates showing glacial action, discovered by Mr. Schwarz, of the Geological Commission, north-east of the village of Ceres.

Mr. PÉRINGUEY read some notes on a fly that is parasitic on human beings as follows: In September, 1891, I brought to the notice of the South African Philosophical Society an example of dipterous—*i.e.*, true fly—insect which was bred from larvæ extracted from the arm of a child in Natal, who turned out to be the child of the Rev. C. Pettman, late of this city. I exhibited also the larva of what I took to be that of a similar fly, which a friend of mine had extracted from his own leg and sent me, with a very unpleasant account of his sufferings. I received some time ago from Dr. H. P. Veale, of Pretoria, also a larva extracted by him from the leg of one of his patients. I could not, unfortunately, breed that interesting specimen, but, on comparing it with the notes I made of the first larva I obtained, I find that the two are identical, and are probably the grub of the same fly that had attacked the Rev. Pettman's child, and which I suggested at the time would, perhaps, prove to belong to the genus *Bengalia.* I was quite right in my surmise, the genus *Bengalia* and *Ochromyia* being partly synonymous. The year following Dr. Blanchard published in the Transactions of the French Entomological Society, a paper on such American Æstrid flies, the larvæ of which live in the skin of man, and in which he dealt at great length with the authenticated cases of such larvæ that have been found *in situ* or exuding from pustular sores. He concludes that they are caused by Æstrid or bot flies. He stated also in his 'Treatise on Medical Zoology' that all the known cases occurring in Africa were due to the Æstrid, which statement is erroneous, as he himself acknowledged later on. On receipt of this publication the late curator of the Museum (Mr. Trimen) caused to be sent to Blanchard the invaluable two specimens we had in the collection, in order that the mistake should be corrected. I had pronounced the fly not to be an Æstrid at all, but a true Muscid.

I should here mention that the family *Æstridæ* include flies which are true parasites of the large mammals, and occasionally of small ones, even accidentally of man himself. The perfect insect is usually covered with short, dense hairs, the proboscis is entirely absent, or very little developed, and the animal does not take any food; the female is provided with a long retractile oviduct.

In the larval stage they inhabit the domesticated or wild animals, and can be divided in three groups: (1) the *Cuticulous* Æstrids, living under the skin, and often producing large tumours. I have not observed any such Æstrid here on our domesticated animals, but three instances of them being found on the steinbok and ouribi have come under my notice; (2) the *Cavicolous* Æstrids live in the nostrils and frontal sinuses, and are extremely common here. I have not yet examined any sheep's head that did not contain them; the gnu and bontebok are full of them, and the hartebeest might perhaps be called the sneezing antelope, on account of its pertinacity in trying to get rid in that way of the numberless larvæ, which, on account of, perhaps, the peculiarity of the frontal bone of that animal, are said to infest it more than others; (3) the *Gastricolous* Æstrids, on the contrary, live affixed to the internal covering of the stomach of horses, cattle, and pachyderms. To this belong the well-known bot fly of the horse, and according to Delegorgue,* the *Rhinoceros Simus*, or white rhinoceros, harbours only a small number of Æstrid, while those inhabiting the *Rhinoceros Africanus*, or black rhinoceros, might be measured by the bushel. He suggests that the presence of these parasites might be the cause of the irritability of that animal. The Æstrids are the direct agents of the tumours in which their larvæ

* Delegorgue, 'Voyage dans l'Afrique Australe,' vol. ii. p. 429.

live; the Muscid cannot perforate the skin, and therefore either deposit their eggs or larvæ on the skin, or on the mucous membrane of a cavity. This is a very important point, as will be seen hereafter.

Blanchard set immediately to work to identify the fly. Unfortunately the precious specimen had reached him totally shattered, and the one mounted for the microscope was too much compressed to be of much use; but from the neuration of the wings and other characters he concluded that the species was referrable to *Lucilia* or *Ochromya*, &c., thus justifying my diagnosis. The *Muscidæ*, with known cuticolous larvæ, are very rare, but I have often heard, while in Senegambia, of the so-called "Cayor worm," and this so-called worm has been successfully bred by Berenger-Féraud, and been named *Ochromya anthropophaga.* The species bred in Natal might prove to be identical, and the description tallies, more or less, with that of the Senegal one. In the Royal College of Surgeons there is found the larva of a Muscid, extracted from the leg of Livingstone during his journey to the Zambesi by Sir John (then Dr.) Kirk. The larva is apparently not sufficiently developed to enable one to decide as to the genus it belongs to, but it is a true Muscid, according to Blanchard. I have heard from other parties that have been, or fancy they have been, suffering from the effects of that fly in the Transvaal low country, but have not been able to see the actual specimen. Being very desirous of procuring more to replace the destroyed one, I wrote again to Dr. Veale, and he has been kind enough to communicate the following.

Mr. Péringuey then read a letter from Dr. Veale, Pretoria, giving particulars of a case which occurred there, from which the following is an extract: "On March 16th minute irritable pimples, red, like minute fly-bites. From March 16th to 26th, these pimples increased in size, becoming vesicular, and ultimately pustular on the top, large induration around, patient's temperature gradually increasing until 104° was reached. Great depression and inability to move legs. I first saw the case March 25th. Fomenting with hot water and opium in the course of four hours caused the vesicles to break, and the larvæ to escape to the number of twenty-four, with a consequent fall in temperature and convalescence. Two escaped notice, and were extracted the following day. They were active enough to crawl across the room. The pain for the ten days was described as being very great and like neuralgia. The effect remaining was anæmia, with great prostration and nervousness, which disappeared under suitable treatment." The trouble is not generally known in Pretoria. The cases are very few.

Ordinary Monthly Meeting.

Wednesday, October 28, 1896.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, in the Chair, and twelve members.

Professor Morrison, Dr. Veale, Dr. Anderson, Dr. Stark, and Mr. Sydney Cowper were nominated as ordinary members.

Hon. W. P. Schreiner, Q.C., and Mr. C. Mayer were duly elected ordinary members of the Society.

The undermentioned presents were announced, and the thanks of the Society voted to the donors:

La Feuille des Jeunes Naturalistes, No. 312.

Journal of Manchester Geographical Society, Vol. X., Nos. 9–12; Vol. XI., Nos. 9–12.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1896, No. 1.

Actes de la Société Scientifique du Chili, Vol. II., Part 5, Vol. VI., Part 1.

Congreso Cientifico Jeneral, Chilenode, 1894.

It was resolved that a special meeting for the consideration of the proposed new rules should be held on the night of the next ordinary meeting.

The President stated that in regard to the Bushman paintings the Photographic Society had appointed a Committee of five, who had met another Committee of five of the Philosophical Society, and the first draft as to the mode of photographing the Bushman paintings had been drawn up. This had been sent around to the members for suggestions and corrections. When the draft was returned the members would have another meeting, and finally put it into shape for publication.

The President exhibited two interesting photographs of Bushman paintings in the Clanwilliam district. They were on a mountain only reached with danger to life, and by creeping through holes and jumping over deep crevices.

Justice Buchanan drew attention to the fact that at a previous meeting, held at Observatory, he had mentioned some five Bushman paintings at Cala, in the Transkei, near St. Mark's. There was not only a cave of them, but there were walls extending for hundreds of yards covered with them. They were in various colours, one of them representing a scene very much like the photograph exhibited, which seemed to picture a white man running away from the inhabitants of a kraal. He also referred to the fine specimens at Dordrecht. Had any arrangements been made for photographing these paintings?

The President could not answer this question without referring to the list. A fine painting had been destroyed on the Wodehouse Division by a farmer, who, doubtless with the best intentions, had varnished it, and the chemical action had helped to destroy it. The President went on to say that he was in possession of what seemed a paint-box, which had been used by Bushmen. This was found in Mashonaland, and he intended eventually to present it to the Museum. When arrangements for photographing the Bushman paintings were completed, he hoped that every member of the Society would assist in the work, which would take a long time. He hoped, however, that in the end they would get something like a fair record of these paintings.

Some notes on the natural history of some Natal plants, by Mr. Maurice S. Evans, F.Z.S., were held over until the next meeting of the Society.

Dr. Marloth read some notes by Mr. J. Meiring, of Worcester, on some experiments with the active principle of *Mesembryanthemum Tortuosum, L.* This plant, which goes under the broad designation of Hottentot's Kauwgoed, grows in the Karroo, and, like many other Cape plants, it has great medicinal virtues ascribed to it, chief of which are its soporific influence on young children, and its curative and quieting effect on them when suffering from acidity.

Dr. Marloth injected a certain quantity of the liquid into a frog, and showed its soporific influence.

Ordinary Monthly Meeting.

Wednesday, November 25, 1896.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and twenty-one members.

Dr. Muir proceeded to rehearse what had been said at previous meetings on the subject of the Röntgen rays, and gave the history of the theory which led to the discovery; after which Dr. J. H. M. Beck and Professor Holm gave a successful display of the rays in conjunction with a large fluorescent screen.

Dr. Marloth gave an account of a new South African plant, belonging to a new genus of *Scrophularineæ*, and found at Jonker's Hoek in the Stellenbosch district.

This plant, *Petrokote capensis*, Marl., which belongs to the order *Scrophularineæ*, of which the foxglove is a well-known representative, differs from the other genera of this order by its floral character, as well as by its appearance. In its general habit it somewhat resembles a small Gloxinia, but the genus *Gloxinia* belongs to another order, viz., *Gesneraceæ*. The leaves are large, showy, and beautifully soft; the flowers pale blue, about half an inch long; the pedicels curve downwards after flowering, hiding the capsules between the leaves just as is done by the pretty little *Linaria cymbalaria*, which grows on most walls at home.

The plants fade rapidly in dry air, even when standing with their roots in water. It is surprising that such a conspicuous plant should have escaped the eye of botanists until now.

Mr. Péringuey exhibited a dead wasp, *Mygnimia capensis*, caught dragging a very large *Harpactira* spider, one of the so-called Tarantula, to its burrow. The spider was intended as food for the progeny of Mygnimia, and was not dead, but paralysed by the wasp's sting. It had been in this state for now over a month. The specimens were sent by Mr. Wilson, of Hopefield.

Professor J. T. Morrison, Dr. Veale, Dr. Anderson, Dr. Stark, and Mr. Sydney Cowper were duly elected ordinary members of the Society.

Messrs. F. Treleaven, I. Meiring, and Dr. Hugo, were nominated as ordinary members.

The undermentioned presents and exchanges were announced:

Memorias y Revista de la Sociedad Cientifica 'Antonio Alzate.' Tome IX., Nos. 9 and 10.

Bulletin of the Johns Hopkins Hospital, Vol. VII., Nos. 66, 67.

Boletin de la Academia Nacional de Ciencias en Cordoba, Tome XIV., Nos. 3 and 4.

Ordinary Monthly Meeting.

Wednesday, January 27, 1897.

Present:—Dr. Gill, LL.D., F.R.S., in the Chair, and eight members.

Dr. Alexander Eddington, the Government bacteriologist, and Dr. V. F. Manikus were nominated as ordinary members.

Messrs. F. Treleaven, Isaac Meiring, and Dr. Hugo were duly elected ordinary members of the Society.

The following accessions to the Library were announced, and the thanks of the Society voted to the donors:

Annual Report of the Geological Survey of Canada, Vol. VII., 1894, with Maps.

Bulletin of the Geological Institution of the University of Upsala, Vol. II., 1896.

La Feuille des Jeunes Naturalistes, Nos. 313–315.

Jahresbericht des Vereins für Erdkunde z. Dresden, Vol. XXV., 1896.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1896, Part 2.

Memoirs and Proceedings of the Manchester Literary and Philos. Society, 1896–97.

Transactions of the Texas Academy of Sciences, Vol. I., 1892–95, 4 Parts.

Annuaire de la Academia Mexicana, Vol. I., 1895.

Boletin Mensual del Observatorio Meteorologico Central de Mexico, 1896.

Bulletin of the Johns Hopkins Hospital, Vol. VII., Nos. 68, 69.

Sundry newspapers sent by Dr. Emil Holub.

Dr. Gill exhibited some Röntgen rays photographs, and Mr. Fourcade a calculating machine, and made some remarks.

Mr. Schwarz exhibited some specimens of fossil plants from South Africa.

The first set came from the lower Stormberg beds, that is the coal-bearing series of the group. They were obtained from a disused drive in the Cyphergat mine, and consisted of specimens of *Thinnfeldia odontopleroides*, Feistm., which is characteristic of this zone.

Associated with these was a cone-like fruit of doubtful affinity, but which is unknown from beds of equivalent age in India or Australia. A large slab of black shale covered with grass-like impressions was then shown from the same locality, in a zone immediately below that of the *Thinnfeldia*.

Mr. Schwarz had removed a thin layer of shale from one-half of the slab, exposing a fine stem of a *Calamite* with four whorls, the internodes being about two inches in length. The grass-like impressions were seen to be attached at their bases to the nodes of the *Calamite* stem, and thus are conclusively proved to be the foliage leaves of that genus.

A beautiful example of a fossil Alga was then exhibited, which Mr. Schwarz had obtained from the Zwarteberg sandstone (Devonian) near Worcester. It can be referred to the genus *Spirophyton*, and is probably identical with the *S. cauda-galli* of the New York Devonian. There is a close similarity between the Lower Devonian rocks of our Bokkeveld and those of South America, and hence the discovery of a similarity in the Upper Devonian of South African and North America is interesting, as showing an enlargement northwards of the sea in which these rocks were deposited.

Mr. Sclater exhibited the skulls of three species of Cetacea, lately obtained for the South African Museum.

The first of these was *Kogia breviceps*, the smaller sperm whale which was stranded on the rocks near Green Point and was secured for the Museum.

The specimen proved to be a young one, measuring only 9 ft. 5 in. in length; the skull and skeleton have been cleaned and mounted for the Museum.

This is apparently a somewhat rare animal, though it has been obtained in such widely-apart localities as the Cape, the Madras and Australian coasts.

The second skeleton exhibited was that of a species of Delphinus, probably *Delphinus delphis* the dolphin of European seas.

A complete animal in the flesh together with two heads were obtained from the Malay fishermen of Green Point; the length of the animal was 7 ft. 7 in., the number of teeth were approximately $\frac{50 \cdot 50}{47 \cdot 47}$.

The third skull was obtained by Mr. P. J. F. Truter on the Muizenberg beach, and was presented by him to the Museum. It proved to be that of a species of Prodelphinus, probably *Prodelphinus obscurans*, but until the diagnostic characters of the species of this genus are more clearly defined it is impossible to be certain. The number of teeth in this specimen were $\frac{34 \cdot 35}{33 \cdot 32}$ and measured about 5 mm. in diameter.

Ordinary Monthly Meeting.

Wednesday, February 24, 1897.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and eighteen members.

Dr. A. Eddington and Dr. V. F. Manikus were elected ordinary members of the Society.

The PRESIDENT announced the election by the Council of Mr. R. TRIMEN, F.R.S., and the Rev. G. H. R. FISK as honorary members of the Society, in accordance with the amended rules, and mentioned that—

The Royal Society, finding it impossible to continue the cataloguing of all scientific literature, 4 vols. of which have already appeared, had endeavoured to enlist the sympathies of other nations, and requested their co-operation in the work. There had been a conference in London, and Dr. Gill and R. Trimen had been appointed delegates of the Cape. A circular had been received from the Secretary of the Society, and the Report will be issued very shortly.

Dr. MUIR called the attention of the members to the production of Mr. Bolus's second vol. on the Cape Orchids, and also to Dr. Marloth's Adaptation of Edmond's Botany to S. Africa.

Dr. CORSTORPHINE read his paper on the Cango Cave, and exhibited a plan of the cave made by Mr. H. M. Luttman-Johnson during a recent geological survey in the Oudtshoorn district. Special attention was called to the fact that a large portion of the cave had only been discovered during the survey, and that probably other unknown chambers await discovery.

In the discussion which followed several members called attention to the interesting zoological and botanical features which a little exploration would probably reveal, and it was felt that such work as had already been done was only a step towards more investigation.

The following accessions to the Library were announced:

Anales del Museo Nacional de Buenos Aires, Tome IV., 1895.

Report of the British Association for the Advancement of Science. Liverpool, 1896.

British Association for the Advancement of Science. Toronto Meeting, 1897. Preliminary Programme, Toronto, 1896.

Mémoires de l'Académie des Sciences de St. Petersburg, 8th Series, Tome II., Nos. 1, 2, Tome III., No. 6, Tome IV., No. 1.

Proceedings of the Philosophical Society of Glasgow, 1895–96, Vol. XXVII.

Boletin Mensual del Observatorio Meteorologico Central de Mexico, Nov., 1896.

The Canadian Record of Science, Vol. VII., Nos. 1, 2, 3. Montreal, 1896.

The Proceedings and Transactions of the Novia Scotia Institute of Science, Vol. IX., Part 1, 1896. Halifax.

Abhandlungen u Bericht des Vereins für Naturkunde zu Kassel, 1895–96. Kassel, 1896.

The American Anthropologist, Vol. IX., Nos. 6, 7, 8, 9, 12.

Journal of the Cincinnati Society of Natural History, Vol. XVIII., Nos. 3 and 4, and Vol. XIX., No. 1.

Proceedings of the American Philosophical Society, Vol. XXXV., Nos. 150, 151.

Raffray, A. Note sur les Bryaxides de l'Afrique Orientale et de Madagascar. (Extr. Annal. Soc. Entom. de France, 1896.)

Ordinary Monthly Meeting.

Wednesday, March 31, 1897.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and nineteen members.

Dr. J. W. B. Gunning, Director of the State Museum, Pretoria, Mr. J. R. Sutton, B.A., Kimberley, and Mr. D. E. Hutchins, Conservator of Forests, were duly nominated as ordinary members.

The following accessions to the Library were announced:

The Australian Mining Standard.

Boletin Mensual del Observatorio Meteorologico Central de Mexico, Dec., 1896.

Proceedings of the Royal Society of Victoria, Vol. VIII., 1896.

The Scottish Geographical Magazine, Vol. XIII., Nos. 1, 2, 3.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1896–97.

The Journal of the Manchester Geographical Society, Vol. XII. Nos. 1 and 3, 1896.

Bulletin of the Johns Hopkins Hospital, Vol. VII., Nos. 70, 71.

Jahrbuch der Hamburgischen Wissenchaftlichen Anstalten XIII., 1875.

Records of the Geological Survey of New South Wales, Vol. V., Part 2, 1897.

La Feuille des Jeunes Naturalistes, Nos. 316, 317.

The American Anthropologist, Vol. IX., Nos. 10, 11.

Transactions of the Texas Academy of Science for 1896, Vol. I., No. 5.

Bulletin de l'Académie Impériale des Sciences de St. Petersburg, V[e] Série, Vol. VI., No. 1.

Proceedings of the Philosophical Society of Glasgow, Vols. VII.–XXVI.

Dr. G. S. Corstorphine communicated Mr. T. R. Sutton's paper: "An Inquiry into the Origin of the Mud Rushes in the De Beer's Mine."

Ordinary Monthly Meeting.

Wednesday, April 28, 1897.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and twenty-two members.

Dr. J. W. B. Gunning, of Pretoria, and Messrs. R. J. Sutton, of Kimberley, and D. E. Hutchins, of Cape Town, were duly elected ordinary members of the Society.

The following accessions to the Library were announced:

La Feuille des Jeunes Naturalistes, No. 318.

Boletin de la Academia Nacional de Ciencias en Cordoba, Tome XV.

Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich, 1896 Supplem.

Neujahrsblatt herausg. v. d. Naturforsch. Gesellsch. in Zürich (99stes Neujahrsbl.).

Mons. Raffray announced that he had been instructed by the French Government to make known to the medical authorities of the Cape Colony that Dr. Calmette, of the Pasteur Institute, has now succeeded in obtaining a sufficient number of horses immunised against snake poison to allow of the distribution to medical establishments or private individuals of doses of serum, as has been done for some time past for the anti-diphtheric serum.

Mr. A. P. Trotter read his paper on "The disturbance of the Submarine Cable by the Cape Town Tramways."

Ordinary Monthly Meeting.

Wednesday, May 26, 1897.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and thirteen members.

The following accessions to the Library were announced:

Smithsonian Report, 1894. Washington, 1896.

Report of the U. S. National Museum for 1894. Washington, 1896.

Bulletin U. S. National Museum, No. 47, Part 1. Washington, 1896.

The American Anthropologist, Vol. X., Parts 1, 2, 3. Washington, 1897.

Proceedings American Philos. Soc., Vol. XXXV., No. 152. Philadelphia, 1896.

Bulletin Minnesota Academy of Natural Sciences, Vol. IV., No. 1, Part 1, 1896.

Bulletin de la Société Impériale des Naturalistes de Moscou, 1896, No. 3. Moscow, 1897.

Das Meteoreisen von Forsyth Co., Georgia, von Prof. Dr. E. Cohen. Sitzungsber. d. k. p. Akad. d. Wiss., 1897.

Über ein neues Meteoreisen von Locust Grove, Henry Co., Nord Carolina, von Prof. Dr. E. Cohen. *Ibid.*

The Proceedings and Transactions of the Nova Scotian Institute of Science, Vol. IX., Part 2. Halifax, 1896.

Bulletin de la Société des Sciences Naturelles de L'Ouest de la France, Vol. VI., Parts 1, 2, 3, 1896.

Annales de la Faculté des Sciences de Marseille, Vol. IV., Part 4, 1895, and Vol. V., Parts 3, 4, no date.

Bulletin of the Johns Hopkins Hospital, Vol. VIII., No. 72. Baltimore, 1897.

Two numbers of the Illustrated Christian World. (Dr. Holub's contribution.)

Boletin Mensual del Observatorio Meteorologico Central de Mexico, 1897.

Report of Her Majesty's Astronomer at the Cape of Good Hope for the year 1896. London, 1897.

Proceedings of the Scottish Microscopical Society, Vol. II., No. 1, 1896.

The Scottish Geographical Magazine, Vol. XIII., No. 4. Edinburgh, 1897.

Bulletin de l'Académie Impériale des Sciences de St. Petersburg, Vol. VI., No. 2, 1897.

Mr. A. W. Rogers, Assistant Geologist to the Geological Commission, read a paper on "Geological Surveying in South Africa," of which the following is an abstract:

A geological map shows as far as possible the nature of the rock to be found at the surface, and also at moderate depths below the surface, at any point in the country. Owing to the recurrence of the requisite conditions, particular varieties of sedimentary and igneous rocks have been formed, or brought to the relative positions in which we now find them, at different times during the past history of the earth; therefore the colours representing rock masses on our maps have in most cases reference to the age of the rock represented.

Two of the main points of scientific interest on which light is thrown by the geological survey of this country are :—

(1) The distribution of land in the Southern Hemisphere during past times. In this connection facts brought to light in other countries have to be considered. The most important result hitherto obtained with regard to this subject is the close connection between India, Australia, and South Africa in early mesozoic times.

(2) The development of the present surface features of South Africa, such as the long ranges of mountains between the Karroo and the south coast districts, and the rivers which cut through them. That the main rivers draining the Karroo are older than the mountains is proved by the conformity between the rocks of the Karroo and those at present seen in the mountains; and also by the complete independence of these rivers and the rock folds forming the mountains.

Dr. Gilchrist showed a number of pearl oyster-shells from Algoa Bay as well as one or two from Zanzibar and Australia for comparison. In addition a number of Cape pearls were shown, also from Algoa Bay, and Dr. Gilchrist gave an account of the past work in pearl fishing in the Colony. A discussion followed, in course of which reference was made to the possibility of assisting the production of pearls by insertion of irritant substances into the pearl oyster's mantle.

Ordinary Monthly Meeting.

Wednesday, July 28, 1897.

Present:—Mr. T. Muir, LL.D., M.A., F.R.S.E., President, and fifteen members.

The following accessions to the Library were announced:

Calendar of the University of Sydney, 1897.

The Canadian Record of Science, No. 4, Vol. VI., 1897.

Proceedings of the Canadian Institute, New Series, Vol. I., Part 1, Nos. 1 & 2, Toronto, 1897.

Transactions of the Canadian Institute, No. 9, Vol. V. Part 1, Toronto, 1896.

The Scottish Geographical Magazine, Nos. 5, 6, 7, Vol. XIII., Edinburgh, 1897.

A Study in Black and White. Trustees of the John F. Slater Fund, Baltimore, 1897.

La Feuille des Jeunes Naturalistes, Nos. 319, 320, 321, Catalogue de la Bibliothèque, XX., XXI., fasc.

The Journal of the Manchester Geographical Society, Nos. 4, 6, Vol. XII.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, Vol. XLI., Part 3, 1896–97.

Do., Complete List of the Members and Officers.

Vierteljahrsschrift d. Naturforschenden Gesellschaft in Zurich, Part 1, 1897.

Actes de la Société Scientifique du Chili, Vol. V., Part 5, 1895; Vol. VI., Parts 2, 3, 1896.

Annales de la Faculté des Sciences de Marseilles, Vol. VI., Parts 4, 5, 6; Vol. VIII., Parts 1, 2, 3, 4.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, Fifth Series, Vol. VI., No. 3, 1897.

(La Fumagina del Cafeto.)

Instituto Fisico-Geofrafico Nacional, Costa Rica, 1881–96, 1897, San José.

Revista del Museo de la Plata, Vol. VII., Part 2, 1896.

Boletin Mensual del Observatorio Meteorologico Central de Mexico, 1897.

Johns Hopkins University Circulars, Vol. VIII., Nos. 73, 74; Vol. XVI., Nos. 129, 130. 1897.

Royal Society of Edinburgh, Vols. X.–XXI.

The President called the attention of members to the handsome donation of the Royal Society of Edinburgh, which sent their Transactions from Vol. VIII. to XXI. inclusive. This was a very valuable addition to the library of the Society.

Seven members were nominated for election at the next meeting, viz.:—Dr. F. D. Brown (Maritzburg), Ed. G. Alston (Carnarvon), Dr. Brauns (Port Elizabeth), Dr. J. F. Marais (Stellenbosch), G. A. K. Marshall (Salisbury), C. N. Barker (Durban), and C. Stewart (Cape Town).

The President informed the Society that the number of members on the roll was now one hundred.

Dr. F. Purcell exhibited some parasitic barnacles taken from the two whales recently captured in Table and False Bays. One of these barnacles, called *Tubicinella,* has the shape of a tube about one inch and a quarter long and half an inch in diameter, and occurs entirely embedded in the skin of the whale, while another kind, known as the coronet barnacle (*Coronula diadema*) only adheres to the outer surface. In the latter case the shell of the parasite, which may attain a diameter of two inches, is provided with eighteen deep cavities on its adherent surface, into which a corresponding number of processes of the whale's skin project and serve to firmly hold the barnacle.

Mr. Schwarz, of the Geological Survey, read the following note on the physiography of South Africa:—

Land surfaces all over the globe are constantly altering their position in regard to their height above sea-level. In some parts of Sweden, for instance, rings used for attaching the cables of ships many centuries ago are now found far inland, while on the west coast of England a contrary movement has taken place, and in many parts forests can be seen under the sea. In Africa the mountains near the sea coast have been formed by the folding of the earth's crust due to the contraction of the globe; the earth is cooling and the hard rock masses on the exterior are compelled to occupy a smaller space, and therefore crumple up just as a sheet of paper does when it is laid on a smooth surface and the two ends pushed together. The mountain ranges on the inside of the coast belt are probably still in course of formation; as they rise, the rivers that flow through them have to cut their channel. If there was no movement going on, the rivers would have time to broaden their courses, but in the Langebergen, for instance, at Waaikloof especially, the kloof is so narrow that there is not space for even a footpath alongside the river. There is another cause that is lifting South Africa out of the sea, namely, the loss of attraction on the water due to denudation. In the Karroo one sees isolated hills that were once evidently connected together in one great sheet, but the intervening masses of rock have been removed by the agency of wind and water. On the coast, a similar amount of denudation is apparent in the way the ranges of Table Mountain sandstone are now disconnected. When we come, however, to examine these regions more closely, we arrive at the astonishing result that a far greater denudation has gone on. I was first led to this conclusion by the discovery of beds at Worcester and Robertson that were once thought to be confined to the Karroo. These Ecca beds were thought to have been formed in a basin of which the Zwartebergen were the southern shores. At Worcester we find the Ecca beds folded in with the Dwyka and Zwarteberg beds in exactly the same way as we find in the Gouph, and beyond doubt these more recent Karroo beds once extended as a sheet over the older beds of the south-west districts. I have roughly estimated the thickness of the beds above the Table Mountain sandstone as follows: Bokkeveld, 2,000 feet; Zwarteberg, 2,000 feet; Dwyka, 500 feet; Ecca (at Worcester), 500 feet; giving a total of 5,000 feet.

This mass of rock, about a mile in thickness, has been entirely removed over the whole area of the mountain ranges of the coast. Matroosberg, for instance, if it had not been subjected to weathering, would have been 12,000 feet high instead of 7,000 feet. In the Malmesbury clay-slate valleys, where the Table Mountain sandstone has also been removed, we must add 4,000 to 5,000 feet of rock to our aggregate. In the Tulbagh Valley, ending at Breede River Station, 432 cubic miles of solid rock have been washed out, not counting that underlying the Table Mountain sandstone. One cubic mile of rock weighs about 7,000 millions of tons, so that an estimate may be got of the whole amount that has been denuded from this small tract of country. In applying all this to the alteration of sea-level, we know that water is attracted by the mass of the moon, which is the cause of tides. In the same way the mass of the continents exert a pull on the waters of the sea. Fischer first pointed this out, and Listing calculated constants for various places; thus he gives: Berlin, 37·7 M.; London, 118 M.; Paris, 268 M.; St. Helena, 847 M.; that is, if the land masses were absent in these places the sea-level would be so many metres lower. If now an enormous mass of material is removed from a continent, as it has been in South Africa, there is less matter to attract the water, and the sea-level must consequently sink. The material that is taken from the land is deposited at the bottom of the sea within two hundred miles of the coast, so that the difference of attraction on the whole mass of the ocean is not great; but water being a fluid, that round the coast obeys the attraction of the land mass immediately near it, and if larger portions of this are removed the sea-level must sink. Thus without bringing in any earth movements we can explain the deserted sea beaches around our coasts. Whether the sea-level is actually sinking is another matter, and we have not yet materials for determining it. Earth movements may be going on that are increasing or compensating the sinking due to loss of attraction, but the latter is a factor in the sum total. I have brought these few remarks forward to show the sort of problems that are always before us apart from the dry routine work of map and specimen-collecting.

Dr. Corstorphine criticised Mr. Schwarz's view that there was still an uplifting taking place in the Zwartebergen, the evidence of the river kloofs being in his opinion insufficient. It was also pointed out that we have no evidence of any repeated uplifts of the mountains here, such as are shown by the Alps, and reference was made to the vastly different conditions the country would be in had nature been more generous of such movement in this part of the world. With regard to the main part of the paper, Dr. Corstorphine agreed that the material removed from the land surface was after all spread out on the sea floor at relatively slight distance from the coast-line, and that the change of value in the amount of attraction could not be great. Great difficulty would be found in eliminating all other influences and getting observations on which such theories must be based to prove the actual change due to variation in attraction of land on the sea. Every one must feel the subject an interesting one, and feel indebted to Mr. Schwarz for bringing it forward.

Mr. Rogers (Assistant Geologist) referred to experiments being made in India to test the attractive influence of the Himalayas on a pendulum swung at their base, and asked Dr. Muir, as a mathematician, to say what difference would be shown by the pendulum were the mass of the Himalayas to be spread out evenly over the ground between their present position and the sea.

Dr. Muir said of course the pendulum, instead of swinging towards the centre of gravity of the mountain, would swing towards the centre of gravity of the material as lying spread out.

Mr. T. Stewart spoke of the uncertainty attaching to the altitudes given for any of the places surveyed in former times, and stated that he had had the height of Table Mountain taken by spirit-levelling by three separate parties, and found it did not agree with any of the previous figures. Mr. Stewart also pointed out that the beach marks in the Colony were not trustworthy, as often a purely empirical level had been made use of.

Dr. Marloth pointed out that Mr. Finlay had published a paper in the Society's Transactions on the changes of mean sea-level in Table Bay.

Mr. Schwarz replied to the observations made, and Dr. Muir proposed a hearty vote of thanks to him for bringing such an interesting question before the Society.

Mr. Saunders spoke about some recent water divination in South Africa, and referred to the credulity of the confiding public.

Dr. Muir showed a series of Colonial rain charts which had just been drawn up by Dr. Buchan, of Edinburgh, to show the monthly rainfall of the Colony for the past ten years. The observations upon which the charts are based were made by the observers of the Colonial Meteorological Commission, and Dr. Buchan will complete the work by publishing a memoir, copies of which will be placed at the disposal of those interested.

Ordinary Monthly Meeting.

Wednesday, September 6, 1897.

Dr. Muir in the Chair.

The following gentlemen were elected as members of the Society: Dr. F. D. Brown, Mr. E. G. Alston, Dr. Brauns, Dr. J. F. Marais, Mr. G. A. K. Marshall, Mr. C. N. Barker, Mr. C. Stewart.

The following gentlemen were nominated for election at the next meeting: Mr. J. Medley Wood (Durban), Dr. Macpherson (Stellenbosch), and Dr. Beattie (South African College).

The President stated that henceforth the Council would consist of eight instead of ten members. Four members would be elected every year for two years after the present year; and it would be necessary at the present meeting to elect four members to the Council for two years and four for one year.

THE HON. TREASURER IN ACCOUNT WITH THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY FOR THE HALF-YEAR ENDED

December 31, 1896.

1896	Receipts.	£ s. d.	£ s. d.
July 1st.	To Balance from 1895–96...		301 17 0
July–Dec.	,, Subscriptions	125 0 0	
	,, Overpayments on Subscriptions	0 1 6	
			125 1 6
	,, Sales of Transactions ...		135 4 0
	,, Repayment of Advance to Assistant-Secretary		5 0 0
	Total		567 2 6

1896	Expenditure.	£ s. d.
July–Dec.	By Printing	70 1 7
	,, Clerical Assistance	16 0 0
	,, Sundries (as per detailed Voucher)...	9 0 0
	,, Advance for Printing of Plates ...	10 16 0
		105 17 7
Dec. 31st	,, Balance	461 4 11
	Total	567 2 6

C. Abercrombie Smith,
Hon. Treasurer.

We, the undersigned members of the South African Philosophical Society, hereby declare that we have examined the above account, compared the receipts with the counterfoils of the receipt-book, the cash payments with the vouchers, and the balance with the Bank Pass Book, and have found the same correct.

W. L. Sclater, }
A. P. Trotter, } *Auditors.*

THE HON. TREASURER IN ACCOUNT WITH THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY FOR THE HALF-YEAR ENDED

June 30, 1897.

1897		**Receipts.**	£	s.	d.
Jan. 1st.	To	Balance received from the Hon. C. Abercrombie Smith...	461	4	11
	,,	Subscriptions	99	19	0
	,,	Sale of Publications	15	16	3
		Total	577	0	2

1897		**Expenditure.**	£	s.	d.
Jan.–June	By	Attendant at Meetings	5	0	0
	,,	Advance for Plates	15	0	0
	,,	Printing of Transactions	208	0	4
	,,	Freight of Transactions	10	9	5
	,,	Postage of Transactions	4	0	0
	,,	Clerical Assistance	1	8	0
	,,	Stationery	5	1	6
	,,	Petty Cash (as per detailed Voucher)	10	0	0
	,,	Stamps, Exchange and Cash Book	1	13	6
			260	12	9
June 30th	,,	Balance	316	7	5
		Total	577	0	2

(Signed) W. L. Sclater, *Hon. Treasurer.*

We, the undersigned members of the South African Philosophical Society, hereby declare that we have examined the above account, compared the receipts with the counterfoils of the receipt-book, the cash payments with the vouchers, and the balance with the Bank Pass Book, and have found the same correct.

(Signed) G. Corstorphine, L. Péringuey, } *Auditors.*

REPORT OF THE SECRETARY FOR THE YEAR 1896–97.

Since the last annual meeting ten ordinary meetings have been held, with an average attendance of sixteen members. Three papers and numerous notes have been read on botany, zoology, geology, and anthropology. They will duly appear in the Transactions of the Society for the year 1896–7. During the year seventeen ordinary members have been elected, and also two honorary members, one has resigned, and the Society has lost one member by death. The total number of ordinary members is 100. The number of books and pamphlets received is greater than that of last year, owing to the generous presentation of the Proceedings of the Philosophical Society of Glasgow, from vol. vii. to xxvi. ; and of the Proceedings of the Royal Society of Edinburgh, from vol. x. to xxi. inclusive. The trustees of the South African Library have agreed to take charge of the library of the Society as soon as they enter into possession of the wing formerly occupied by the museum, and a slip catalogue will probably be made. A beginning has also been made in compiling tables of contents of the Society's publications from vol. i. to x., inclusive. Part ii. of vol. vii. (523 pp., 28 plates) has been distributed to members during the year ; proofs of vol. ix., part i. (76 pp.), and vol. x., part i. (128 pp. and 4 plates), have been corrected, and are expected soon ; while part ii. of vol. ix. is at the printers, and I hope to have that part completed and in the hands of the members towards the end of the present year.

The financial statement shows a balance in hand of £316 7s. 5d. for the half-year ending June 30th.

L. Péringuey, *General Secretary.*

Annual General Meeting.

Wednesday, September 6, 1897.

Mr. T. Muir, LL.D., M.A., F.R.S.E., President, in the Chair.

The Reports of the Secretary and Treasurer were read and adopted.

The Meeting proceeded to the election of a President and Council for the coming year, with the following results:

T. Stewart, F.G.S., M.I.C.E., *President*.

H. Bolus, F.L.S.
G. S. Corstorphine, B.Sc., Ph.D.
W. H. Finlay, M.A., F.R.A.S.
D. Gill, C.B., LL.D., F.R.S., F.R.A.S.
R. Marloth, M.A., Ph.D.
T. Muir, LL.D., M.A., F.R.S.E.
L. Péringuey, F.Z.S., F.E.S.
W. L. Sclater, M.A., F.Z.S.
} *Council*.

The President delivered the annual address, at the conclusion of which a cordial vote of thanks was awarded to him not only for his paper but for his indefatigable labours whilst he had been President of the Society.

ANNUAL ADDRESS TO THE MEMBERS OF THE SOUTH AFRICAN PHILOSOPHICAL SOCIETY, ON SEPTEMBER 6, 1897.

By the President, T. Muir, LL.D., M.A., F.R.S.E.

My first duty, as retiring president, is to render some account to you of the progress of the Society's affairs during the two years which have just ended, and thereby to try to encourage the working members to increased interest and effort, to stir up a little enthusiasm among those who are less active but none the less friendly, and, if possible, to enlist the practical sympathy of any well-wishers of science who may still remain outside the fold. As regards the membership, there is nothing but good to report. At a recent meeting of Council the secretary intimated that two years ago the number of members on the roll was fifty-nine, and that at the close of our proceedings to-night, if all the new candidates should find favour in our eyes, the number would be 109. This amounts, you will see, almost to the doubling of the membership—a fact which I am sure will be a cause of unalloyed satisfaction to you all. Personally I am most grateful to all those who have aided in bringing about this pleasing result. In the matter of our publications there seems also to be reason for congratulating ourselves. In the period referred to there have appeared one very handsome volume of 524 pages with eight plates, and another of about half the size, the result being the completion of the 7th and 8th volumes of the Society's Transactions. In addition to this the first part of Volume IX. is ready for issue, the second part of the same volume has been passed for the press, and so also has been the first part of Volume X. According to the secretary this means something like 1,050 pages of print. The quality of the matter, of course, varies, but there can be little doubt that all of it was worthy of permanent record. In ordinary circumstances it would be invidious on an occasion like the present to refer specially to an individual paper; the circumstances, however, are not quite ordinary, and I therefore feel sure of being excused when I recall to you the fact that one entire volume, and that by far the largest, is the unaided work of Mr. Péringuey. I may also be permitted to repeat what I had to say at the time of its appearance, viz., that it is an enduring monument of unflagging industry and devotion to science, a credit alike to this Society and to the institution of which he is the assistant director.

In regard to the state of our finances, a mere word or two will suffice. Naturally the large amount of printing which has been done made serious inroads on our savings; but, thanks to the increase in membership, to the increased sale of the Transactions, and to the abolition of expenditure on rent and salaries, the effects of these inroads are not now perceptible. In fact, on June 30th our balance was somewhat better than at the corresponding date in 1895, and it stands to-night at the very respectable figure of £315 7s. 5d. Such, in brief, ladies and gentlemen, is the account which the office-bearers of the Society have to render of their stewardship. Having given it, I wish now to direct your attention for a few additional minutes to the objects and aims of the Society, and to offer for your consideration a few suggestions as to how these objects and aims may be successfully promoted.

When originally formed the Society had for its express purpose the promotion of research and the recording of results; and apparently its founders were prompted to their action merely by a love for truth, and by a conviction that it was part of their duty as citizens to use their talents in any direction that might promise to be for the public good. It was a case entirely of private effort; the Government gave no direct assistance, however benevolently it may have looked on. In some countries a close official connection would have been expected, and in others there would have been at least that connection which is involved in the giving or receiving of a subsidy. It would be wrong, however, to infer that the absence of this connection implied indifference on the part of the Government; it might simply mean that the Government had resolved to provide for research in some totally different way. It could not well be indifference, for no truer words were ever spoken than these: "A nation's progress either in peace or war depends on her science," and the progress of a nation is naturally a matter of supreme concern to those who administer its affairs. Well, this being the object of the Society, its members ought of course to look round for co-workers, and for other agencies which it can turn to good effect in the attainment of its ends. Now there are three sources to which we are accustomed to look for the advancement of knowledge in a country: (1) Universities, (2) paid specialists or professionals, (3) private individuals or amateurs. Let us consider these in order.

First, then, by reason of affinity of purpose we ought to take an interest in the University of the Colony, observe what it is doing for the promotion of research, and use our influence to see that it does more. Conversely, the university ought to take an interest in us; and united action should be possible in the case of any outside undertaking in which the advancement of knowledge is concerned. On this subject I have so recently had occasion to speak that I will not try your patience by dwelling on it again at any length. Let me only recall to you that in the best educated countries research is viewed as the main function of a university; that in England the chief effort of reformers during the last quarter of a century has been to regain for the old universities the proud position which was once theirs as "bodies of learned men, devoting their lives to the cultivation of science and the direction of academical teaching"; and that even the first-founded purely examining university—that extraordinary product of modern times—has been constrained of late years to give its highest degrees only to those who have shown diligence in investigation and aptitude for original work. The change which men interested in learning and science seek to effect has not been indicated more plainly or with greater moderation than in the words of the English Science Commission of 1873, which run as follows: "There can be no question that it is of the utmost importance to impress upon teachers and learners alike that one, and perhaps the chief, criterion of success in the teaching of science is its leading to new discoveries. To promote this end the universities probably can do nothing more useful than to increase the number of persons employed, under whatever name, in the teaching of science, taking care at the same time that whilst such duties are assigned to them as may prevent their offices from being sinecures, they shall be left with time and energy enough to carry on original work. We consider this to be a point of great importance, and we should regret to see any scientific office whatever established in either university without its being understood that it is expected from the holder that he shall do what is within his power, not only for the diffusion, but also for the increase of scientific knowledge."

The second class of persons with which the Society ought to have community of interest is the class of professional scientific specialists. These are well known in the Colony, where many of them have been at work—so many, in fact, as to lead to the presumption that this has been the Government plan for supporting research. Not a few of them, however, have been men to whom only one definite practical problem was set—in geology the examination of an auriferous area, in bacteriology the investigation of a particular disease. Now, isolated work of this latter character could scarcely meet with the approval of a scientific society; and it is almost equally questionable whether from a purely financial point of view it would secure the favour of practical men. There can be little doubt that if the separate sums which the Colony spent up to 1893 in obtaining reports from geological experts had been devoted to the maintenance of an organised survey, the results would have been infinitely more satisfactory. Fortunately the day of disconnected efforts in this particular subject is over, and it is so far pleasing to know that the Society had a hand in bringing about the desired change. It is, however, still important that the public should be got to recognise generally the fact that in science it is plodding, continuous, skilful effort that eventually pays; and that nature does not as a rule yield up her secrets to those who make only sudden and short-lived assaults upon her citadels. For what may be termed perennial scientific specialists—the whole tribe of them, from Her Majesty's Astronomer downwards—a Society like ours could have no feeling but cordial goodwill and sympathy; the more of such men the better, provided they be imbued with the spirit of research and be whole-hearted, zealous workers, bent on extending the boundaries of their science.

The third class of contributors to the advancement of knowledge is that of the men unconnected with a scientific profession but possessed of a scientific hobby. Such men seem almost to have a purer and deeper love for science than the average professional scientist. A slight acquaintance with history suffices to show how much is due to their efforts, and perhaps in no country of the world has this been more conspicuous than in England. To take only a few names of recent times, what a serious diminution of English scientific fame would result from the deletion of such names as Lyell in Geology, Joule in Experimental Physics, Spottiswoode in Pure Mathematics, Darwin in Biology, and Rayleigh in Mathematical Physics! It is related of a Continental savant who attended a meeting of the British Association, and took part in the proceedings of Section C, that at the outset he dubbed everybody "professor," and that after receiving enlightenment as to the daily calling of a number of the members, he jocularly apologised to a real professor for his mistakes by saying that he had temporarily forgotten that the English were a nation of shopkeepers. Long may this characteristic continue; and long also may it flourish, as it bids fair to do, in our own and the other colonies under the British Crown. It is worthy of note that almost every one of the scientific men just mentioned had considerable pecuniary means, and point is thus given to the contention that in order to secure due prosecution of research the Government of a country should set apart men for this purpose alone, and by providing proper endowment free them as much as possible from the worry of worldly cares. At one time in the history of France something like this was actually in operation, any man who had acquired renown in a particular line of investigation having no difficulty in obtaining State assistance to enable him to proceed with his researches, even if a whole special laboratory were needed for the purpose. And France in the time of the Empire is matched by some of the cities of the great Western Republic in our own day. These are the words of a prominent American citizen: "There is another duty which this city owes to itself and to the civilisation of the world. I allude to the endowment for the support of a college of discoverers and a number of men capable not only of expounding established and known truths, but of interrogating nature and discovering new facts, new phenomena, and new principles. The blindness of the public to the value of the abstract sciences and the matter of endowments of colleges for their support is remarkable. It is not every one, however well educated he may be, that is capable of becoming a first-class scientist. Like poets, discoverers are born, not made; and when one of this class has been found he should be cherished, liberally provided with the means of subsistence, fully supplied with all the implements of information, and his life consecrated to the high and holy office of penetrating the mysteries of nature. What has been achieved in the knowledge of the forces in operation in nature and the uses to which it is applied in controlling and directing these forces to useful purposes, constitute the highest claim to the glory of our race." To many people language of this kind would doubtless seem in the last degree extravagant. Were they, however, to study thoroughly the history of the interaction of the pure and applied sciences they would soon recognise it to be simply the words of soberness and truth. And fortunately it was viewed in this latter light by the speaker's fellow-citizens, for his words in time became deeds, and the deeds have already led to honour and profit. We may not be ready in South Africa for a Utopian scheme which commends itself to an eminently practical people like the Americans; but in skimming over the volumes of the Society's Transactions I felt myself sometimes wishing that even a little step towards it were possible. Several astronomical papers are there to be found, the author of which is a hard-working Colonial teacher; and when one thinks of the skill and of the midnight labour involved in their production, and the considerable number of additional papers of like character published by him in European and American journals, one begins to question whether things have been well ordered in his case, and whether in fact the Colony is not in this instance thoughtlessly using a razor to chop sticks.

Leaving now these general considerations regarding the various agencies for the promotion of research, and the services which they might render to one another, allow me in a word or two to deal with matter of a much narrower character, viz., the question as to what things it may be worth while for the members of the Society to attend to without going outside the Society itself. One line of effort which is open to all of us without exception is in the direction of a further increase in the membership. A large society, it should be remembered, is an influential society; and there are many public occasions on which the interests of science are at stake, when an influential society may be a powerful instrument in guiding legislation or in beneficently modifying public opinion. Further, there are many branches of observational science in which the professional scientist as an individual is almost powerless; his raw material is never found in bulk, but is widely scattered, here a little and there a little; and therefore every additional observer, actual or potential, every additional collector of data is welcomed by him with open arms. It is exactly twenty years ago this month since the Society held its first ordinary meeting, and in looking over the records of these two decades it is curious to observe how the membership has waxed and waned. It reached its maximum in 1880, that is to say only three years after the opening meeting, and while, doubtless, the enthusiastic zeal of the original founders was yet warm within them. This is a common phenomenon in the history of societies, and therefore ought not to be wondered at or to be viewed at the time with alarm. It should be sufficient for those interested to know what history teaches, and to take steps accordingly. In all human affairs a period of prosperity should be a period of increased watchfulness; and when the membership of a society seems to be approaching its maximum then is the very time for its leading spirits to be prepared for an extra effort. To follow the fluctuations in the Society's fortunes would not serve any good purpose. It will be more to the point if I put the straight practical question: There being eighty-nine members so long ago as 1880, how many ought there be to-day when the population of Cape Town and neighbourhood has almost doubled? Again, I notice in glancing over the old records that a considerable number of former members who are still alive and vigorous have not for some considerable time been connected with the Society. The cause or causes of this I do not know, but it seems to me a matter for great regret. We need them all. I should have been glad if they had seen fit during my term of office to come back to their allegiance, and I trust sincerely that they may yet do so.

Another possible line of effort arises from the fact that one of the most important functions of a society is to promote the accomplishment of work which a mere individual may find impossible or difficult to do. An instance of this, besides that already referred to, is to be found in investigations which require long-continued labour, or which, for other reasons, must be spread over a considerable period of time. The individual dies; the society lives on. The members of Council, therefore, if they be wise, will see to it that the plans of their predecessors are not forgotten, but that, on the contrary, there is a steady continuity of purpose and effort. Now, I observe that on the 14th of October, 1878, that is to say nineteen years ago, it was resolved that subject-catalogues of scientific works relating to South Africa should be prepared by certain members designated for the duty, and should be published at the Society's expense. The subjects selected were six in number, viz., Zoology, Botany, Geography, Ethnology, Meteorology, and Geology. No wiser or more important decision, you will readily own, could the Council of a scientific body have come to, and one is deeply interested in following up the volumes of Transactions to see what was the outcome. After the reasonable period of two years there appeared the first instalment of the projected work, viz., the part dealing with botany—a workmanlike production. Three years later came the second part, dealing with meteorology, the plan of arrangement not being quite so satisfactory as the first, but the zeal of the compiler being equally evident, and the material brought together large in amount. With this instalment the work seems to have come to a close; certain it is that in the dozen years which have elapsed since then nothing additional has appeared in the Transactions of the Society. Now, it is surely desirable that so important an undertaking should be resumed without delay. If a good reason for action existed nineteen years ago, the need now must be clamant indeed. Without knowing of the scheme, I suggested in 1893 that the cataloguing of all writings on South African geology should be taken up, preparatory to approaching Government with a petition for the initiation of a geological survey; and thanks to the secretary of the Commission which followed on this, an excellent first-approximation to such a catalogue has been compiled and published. In view of this, and of the existence of a Geological Commission, another of the six subjects may, therefore, be considered as having been fully attended to. Recently, also, I have learned that the member to whom the subject of Geography was originally entrusted, Mr. Schunke, has not at all been neglectful of his duty, and that about two years ago, when his whole attention had to be directed to other affairs, his manuscript was almost ready for the printer. It would be a matter for extreme regret if the immense labour which had been spent on this compilation during so many years should run any chance of being thrown away, or that further delay in publication should be the cause of another student wasting valuable time in producing a similar manuscript through ignorance of what has already been done. The delay may be due to a desire for perfection, but perfection in such an undertaking is practically unattainable; it is a will-o'-the-wisp, which may be pursued until lasting harm is done. No real worker in science objects to an incomplete bibliography, when it is the only one in existence; all that he asks for is that additions be steadily made to it, and that the man who publishes a second shall produce a fuller and better. If Mr. Schunke would entrust the Society with his manuscript in its present form, I think we might guarantee to him that every effort would be made to secure a competent editor; indeed, I believe that in the headmaster of the Grey Institute at Port Elizabeth would be found a man who would look upon the editing as a real labour of love. In regard to the two remaining subjects, Zoology and Ethnology, I have no information. Perhaps in the case of these also the compilation has in part been accomplished. It is surely not too much to expect that present members of the Society who are interested in Zoology and Ethnology will take the matter up, and see what can yet be done. The subject of Ethnology, I should infer from the records, was once in far higher favour than it is now. On May 29, 1878—again more than nineteen years ago, be it observed—a Mr. Prosser formally moved and carried a resolution to the effect that "it is desirable to form a section of the South African Philosophical Society, to be entitled the Ethnological Section, which, while paying attention to Ethnology generally, will devote itself specially to the work of the preservation of Bushman paintings and other Bushman remains." This I naturally found a little interesting, and I immediately classed Mr. Prosser as a man and a brother. I regret to say, however, that his zeal must very soon have been quenched. The section actually came into existence, and appointed a separate secretary; but almost the whole work that was ever done consisted in reporting once for all that it had been found impossible to do anything. Mr. Prosser was clearly before his time. I am still trying hard to believe that this is not the case with me; but after another score of years some amateur with similar leanings will be better able to pass judgment on the point.

A third and last suggestion is made mainly in the interest of working members, that is to say authors of papers and country members, but all others would unquestionably also profit by its adoption. It is well known that the contributor of an original paper is always anxious, and justly so, to have it printed and published at the earliest possible moment, and as the number of workers increases, this anxiety will naturally become greater. Even as matters at present stand, the first question an investigator puts to himself when his manuscript is ready is as to the medium of publication, and there is no more important consideration in bringing him to a decision than the probable date when his work will see the light. Now, even after a recent resolution of the Council in regard to the avoidance of delay in publication, it is to be feared that we can offer very little inducement to authors in this particular. Again, let us consider the position of the country member, meaning by this the member who finds it impossible to attend the monthly meetings. The return which such a member receives for his annual subscription is at present nothing very substantial, consisting mainly, one would think, in an occasional glow of virtuous feeling caused by the thought that he is somehow or other, by means of his subscription, helping on the cause of science. At lengthy intervals he receives, it is true, a volume of the Society's Transactions; but unless he happens to have a specialty, and that specialty be also the hobby of the author whose paper fills the volume, he is bound to find the whole thing about as dry as the proverbial Sunday-school prize. Now what I would suggest for consideration is that we do as other societies have done which have been brought face to face with the like difficulties, viz., publish the Proceedings at regular intervals, say monthly or every two months, making the papers read at our meetings the mainstay of each part, but also including other notes on South African science, and pertinent excerpts from other scientific journals. The working member could in this way be more easily satisfied, the country member would have a better chance of receiving what he considers value for his money, and the yearly volume so produced would practically contain all that was worth preserving in South African science for the period covered, and would therefore supply interesting reading to every subscriber, even the veriest scientific novice. All that is done at present would still be done, but there would also be something additional and better. Further, there would be no financial risk in the venture, as the cost would practically remain as before, and the income would almost certainly be increased. To preserve continuity in title as far as possible, let the publication be named *The South African Philosophical Magazine*, and to ensure that all branches of science be fairly represented, let there be an editor-in-chief and an editorial staff, consisting of a specialist for each branch. Such a magazine would be read in places where our present Transactions are never seen, and would thus give a new impetus not only to the Society, but to South African science itself. I may add that no society which has made a similiar change has, so far as is known to me, ever regretted it or gone back to its old irregular ways.

Ladies and gentlemen, in taking leave of the presidential chair, I desire to remind you that as a busy man I accepted it with the greatest possible reluctance, and to assure you of my real regret that I have accomplished so little, and have had to content myself to so large an extent with merely pointing out possible paths of progress for the future.

TRANSACTIONS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

NESTING HABITS OF TOCKUS MELANOLEUCUS, Licht.

By Dr. S. Schönland, Hon. M.A. Oxon, F.L.S.,
Director of the Albany Museum, Grahamstown.

(Read March, 1895.)

The nesting habits of the 'crowned hornbill' (*Tockus melanoleucus*) are so very extraordinary that they have repeatedly been noticed by various writers, but owing to the difficulties of finding the nests of this bird many details of the earlier accounts are not quite accurate, while others are not touched upon at all. As it has been my good fortune to have been able during the last few years to examine no less than seven nests together with the birds belonging to most of them, and as they appear to me to furnish a clue to the most important of the hitherto obscure points in the nesting habits of the crowned hornbill, I propose shortly to pass in review what is known to me about these curious habits. Nothing has, to my knowledge, been published on the nesting habits of any other South African hornbill. The bird I am dealing with is, in winter, often seen in large numbers in the gardens of Grahamstown, whereas in summer they are only to be met with in the country in close proximity to wooded kloofs. The reason for this slight migration will be very obvious, as we shall see presently that with us they nest in places where hollow trees are to be found. About five years ago Mr. C. Wilde, who was then taxidermist to the Albany Museum, discovered a nest in Driver's bush, about twenty-five miles south-east of Grahamstown. It was purchased by the Committee of the Albany Museum. In addition to the examination of the specimens which were brought to me, I made a careful examination on the spot of a nest found at Berkhleys, Lower Albany, before it was removed, and gleaned some further information from the discoverers of the various nests.

The main point in which all observers * agree is this, that during incubation the female is a prisoner in a kind of cage, the entrance to which is closed to such an extent that it has to be broken open before the female can leave the nest. In all cases with which I have become acquainted the birds selected a hollow tree to make the nest in. Mrs. Barber says that they may also make the nest "between the crowded stems of the tall *Euphorbia*." However, I cannot reconcile this statement with the succeeding sentences in Mrs. Barber's account, to which I shall refer again presently. In the country of the Hereros, Pechuel—Lösche found a nest in a small cleft of a rock which had also been closed up to form a kind of cage. In our neighbourhood the birds do not seem to be very particular about the kind of tree they choose as long as it is suitable for their purposes. I have seen four nests made in the stem of *Euphorbia grandidens*, one in the stem of *Sideroxylon inerme*, one in the stem of *Schotia speciosa*, and one in the stem of another kind of tree which I could not identify. The essential points in guiding the birds in their selection seem to be only whether the hollow part of the stem is sufficiently large for the female to move about in the nest, and whether it has one or more comfortable entrances, which lastly must be of such a nature that they can be partially or completely closed up. The female, when once inside the nest, is fed by the male either through a narrow slit left in the material with which the entrance has been closed or through a natural cleft in the wood. In the latter case the main entrance is closed up completely. Mrs. Barber also states "that while the process of incubation is going on, the male bird builds the female into the nest, closing up the entrance in such a manner that it is impossible for her to escape, leaving only a small hole for the purpose of feeding her during her long imprisonment." "This peculiar habit may be a precautionary measure to protect the female during the season of incubation; for it may be that during that time she is too weak and dull to fly away from any approaching danger." It will be seen at once that these statements can scarcely be reconciled to Mrs. Barber's previously mentioned statement that the nest is sometimes formed between the crowded stems of the tall *Euphorbia*. I have further to question the statement that the male builds the female in. Livingstone was told so by a native, but I have not come across any evidence that this is

* See Mrs. Barber's account in 'The Birds of South Africa,' by E. L. Layard, new edition by R. B. Sharpe, p. 128; also Livingstone's, Kirk's, and Anderson's observations in 'Brehm's Tierleben,' Neue Ausgabe, 1891, vol. v. p. 13.

correct. On the contrary, I have evidence to show that at all events the female takes an essential part in the plastering up of the entrance.

The nests which I have seen may be conveniently divided into two types. The majority of them were formed in the hollow of a tree which was naturally closed above and below, a hole on one side leading into it through which the female could enter (page 5, fig. A). This hole is plastered up by a kind of cement, in which legs of beetles, grasshoppers, hard wings of insects, broken bits of shell, bits of wood, &c., are recognisable. There is, however, always a narrow slit left (about ½ inch wide and 4–6 inches long) through which the male feeds the female. One of the nests (page 5, fig. B) received last year had two such holes, both of which were plastered up partially in the same fashion. The second type of nest (page 5, fig. C) was found in two perpendicular hollow stems of *Euphorbia grandidens*, which resembled big chimneys and had no large hole at the sides. One of these was examined by myself before it was removed.

The stem showed several cracks, one of which was utilised by the birds in the same manner as the slit in the cement found in the first type. The female had to go into the stem from above, a distance of about 10 feet, before it reached this crack. Just below this crack a platform had been constructed on which she could lay her eggs and incubate. It was only a few inches thick, but seemed to answer its purpose exceedingly well. I do not know how it was constructed, as I did not remove it, but it was evidently made by the birds themselves. About 3 feet above the crack a ceiling had been put in by the birds, consisting of pieces of the stem of an aloe glued to the sides of the stem and covered with bits of wood, moss, &c. This ceiling appeared to be perfectly watertight, as it had been raining hard just previous to my visit to the nest, and yet the latter was perfectly dry inside. The finished nest of this second type is almost exactly like the first—namely, it forms a cage with a narrow opening, but it will be admitted that its construction requires an amount of sagacity on the part of our bird which is almost unparalleled.

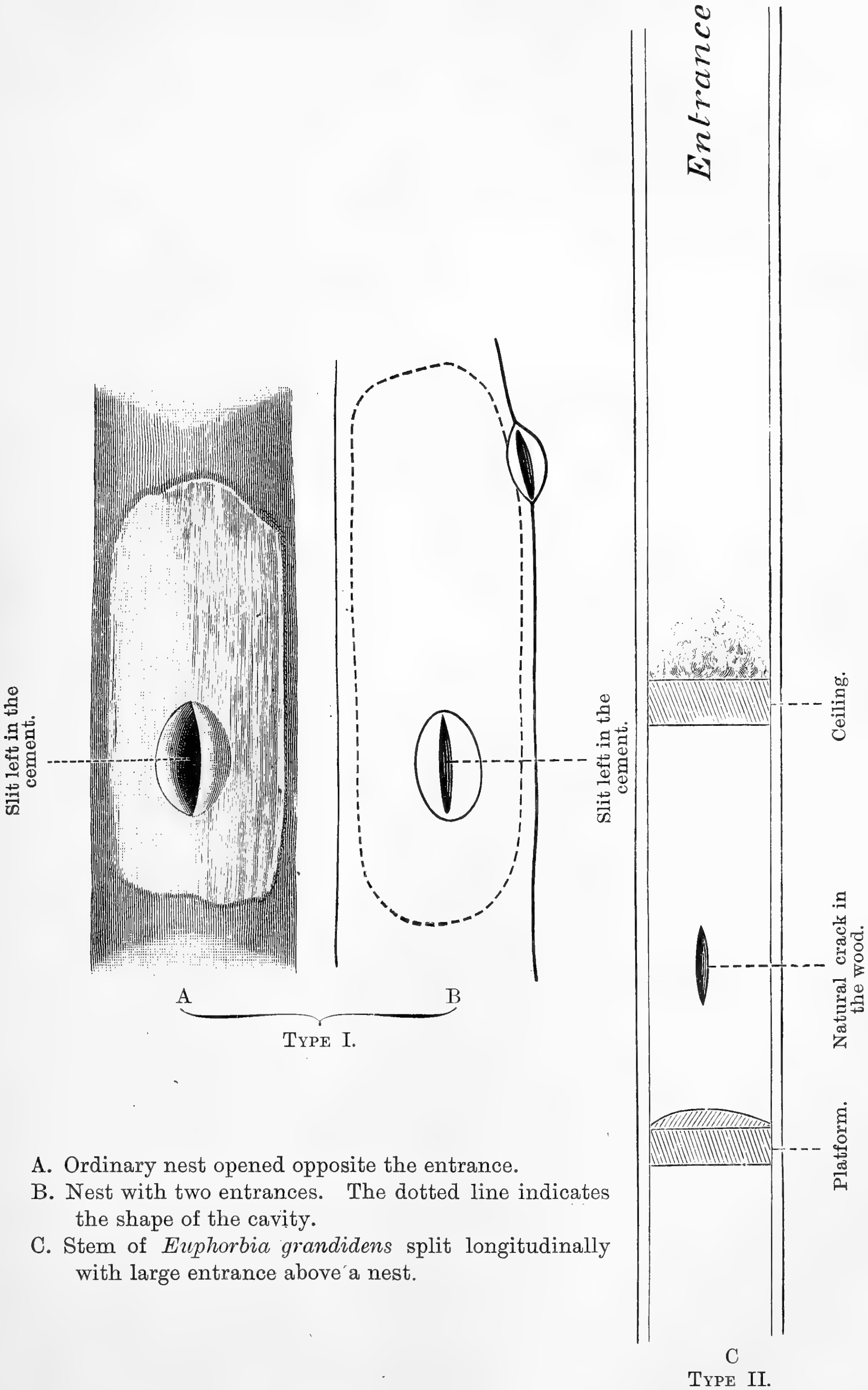
The female shortly after entering the nest begins to moult. Sometimes she goes through the moulting process so vigorously that at one stage she is almost naked, while in other cases she does not lose the majority of her old feathers until after she has left the nest. The female is, especially when she has lost many of her old feathers before the new ones have appeared, unable to fly, but otherwise she is by no means helpless and weak. She is usually very fat while she is in her prison, as the male bird brings her food every few minutes. As a rule when any danger approaches the nest, the female climbs up in the nest as far away as possible from the entrance, and there she keeps perfectly quiet until the danger is passed. I have noticed the same behaviour in the young ones. The imprisoned birds, therefore, in the first place rely for protection on the fact that the nest is not easily recognised as such, but I have noticed that the birds can give a good account of themselves with their strong beaks when actually attacked.

I may mention that if the hollow of the tree passes a long distance below the slit through which the food is passed, it is either filled up with soil, bits of wood, &c., or, as stated before, a platform is put in. The result aimed at is always the same—namely, the female must always, when sitting, be able to reach the slit with her beak. This, no doubt, facilitates the feeding process, and besides, it enables her to deal a surprise blow to any snake or small mammal which might try to force its way into the nest.

The time during which the female is imprisoned I estimate at about seven to eight weeks. It is certainly not less than six weeks. The eggs are laid near Grahamstown at the end of December or beginning of January. There are usually three, but in one case four young birds were found in one nest, so that evidently the number varies. The eggs are pure white.

The question naturally arises as to who closes the nest. Is it done by the male or by the female, or have they both a share in it? Further, What is the material with which the nest is closed up in the ordinary cases? For a long time I held with Livingstone and Mrs. Barber that the male imprisons the female, and unfortunately even now I cannot decide this question from direct observation of the building operations. But when I handed the female belonging to the first nest I received this year to our present taxidermist, Mr. M. Irniger, he called my attention to the fact that her beak was smeared pretty well all over with the same cement which was used to close up the entrance in the nests belonging to type No. 1, and to fasten the pieces of aloe stems to the walls of the nest belonging to type No. 2, in order to form the lower portion of the ceiling as described before. It was evident, therefore, that the female had access to this cement, whatever its nature and origin might be.

As all the nests which had come under my observation were remarkably clean, and as sweet smelling as a bird's nest can possibly be, I had often thought that the female might use her own excrements as a cement, but as the latter was so very unlike ordinary excrements of birds, I had not given serious attention to this supposition, and believed what I had been told by some people, that she throws her excrements with some violence through the slit which



A. Ordinary nest opened opposite the entrance.
B. Nest with two entrances. The dotted line indicates the shape of the cavity.
C. Stem of *Euphorbia grandidens* split longitudinally with large entrance above a nest.

DIAGRAMMATIC REPRESENTATION OF THREE NESTS OF *Tockus melanoleucus*, Licht.

remains open, although I could not imagine how she managed it. But as the female to which I referred had her beak covered with it, some of her excrements were taken out of her anus for comparison. They looked very different from any other excrements of birds I have seen. They felt sticky to the touch, and when dry they presented exactly the same appearance as the cement with which I am very familiar, except, of course, that there were no bits of wood embedded in it. I feel now almost convinced that the female constructs her own prison, and I begin to doubt whether the male bird has any essential share in it. However, as only the lowest portion of the ceiling in the nest belonging to type No. 2 could have been constructed by the female, the upper loose portions must evidently have been put in by the male, and it must therefore be left to further observations to decide whether he also uses his excrements in the same manner as the female does, since this case shows, at all events, that he must take some interest in the construction of the nest.

There is not very much room in a nest when the female is alone, and one can easily imagine that it would be a very tight fit if she was to occupy it with three or four nearly full-grown young ones; besides, the supply of food for three or four such large birds might even overtax the strength of the most devoted father of such a family. The question therefore arises, Does the female leave the nest before the young ones are quite capable of taking care of themselves? and if she does so we have further to ask whether the nest is closed up again, and by whom this is done? The only nest which arrived late in the season last year was the one found in the Kap River Valley, near Clumber. It was brought to me about the 10th of February by Mr. W. Webb. Unfortunately he had removed the cement to prevent it from being broken on the journey, but he was positive that no bird had escaped from it, as he had carefully closed up the entrance again. When opened, the nest was found to contain a nearly full-grown young bird. As Mr. Webb is known to be a trustworthy man, I had no hesitation in concluding from his statements that the female left the nest some time before the young one was fully developed and helped the male to feed it, and that the entrance was closed up after her exit in the usual manner, most probably by the young bird. This conclusion was strikingly confirmed by a nest which I received this year on January 19th. It was perfectly intact; no bird could possibly have left it on the journey to Grahamstown, but when it was opened it was found to contain only two young birds which were still far from the stage at which they would be able to fly. The female had left the nest, but the entrance was plastered up again in the ordinary fashion. Thus it is proved that the nest may be perfectly closed and yet two birds may be seen flying to the nest—namely, the male and the female—and this may explain the statements which I have had from trustworthy observers that they have actually noticed two birds flying to the same nest, and which were supposed by some to be two males. There is still plenty of scope for further investigations on the nesting habits of the hornbill, but I hope the short account of it which I have given may prove not to be without interest.

COMPARISON OF EVAPORATION RESULTS IN NEW SOUTH WALES AND SOUTH AFRICA.

By Garwood Alston.

(Read June, 1895.)

My object this evening is twofold : first to place before the Society some data which I think will be interesting, and next to draw attention to a service which, I take the liberty of suggesting, is very poorly supported by the Executive of the day, and which has even been more poorly treated in past years. I allude to what is here called the Meteorological Commission. This might be a misnomer perhaps if, as I should like to see, an Office were established taking over, not only the duties of the present Commission, but with instructions to record all natural facts as they become known in Geology, Botany, Climatic differences and kindred subjects, and, for my present purpose, more especially to record what becomes of that part of our natural heritage which takes the form of rain.

Not venturing to suggest a suitable name for a problematical Office, I will now pass a few remarks on this Report for 1893 by the Government Astronomer of New South Wales, which was laid on your table at your last meeting. I was particularly struck by its title ; Mr. Russell boldly and plainly calls it 'Rain, River, and Evaporation Observations,' and, at my request, your Secretary kindly lent me the volume for perusal.

The scope of the Report is most quickly gathered from a glance at the four maps at the end of the book. The first of them gives the mean monthly rainfall for each area, comprised between two ordinary parallels of latitude and longitude at single degree intervals, with a supplementary diagram in an upper corner showing the comparative rainfall for each year since 1870. The second map shows the comparative total rainfalls for 1893 in a rather peculiar but perfectly intelligible form, and the third gives monthly comparisons for the same period, both referring the data to the same areas as in the first case.

It is to the fourth map I wish to direct especial notice to-night ; it gives in a simple, graphic form the rise, fall, and duration of floods in the western rivers of the Colony, the Murray, the mysterious Darling, and their tributaries, and is, with its descriptive and numerical context in the body of the Report, the local record of what is a most important branch of knowledge in any country, whether applied to the determination of the strength of levees or dykes, or in deciding as to the volume of water available for storage.

In addition to the voluminous data respecting rainfall, &c., from which the maps have been constructed, the Report gives a few tabular statements of "Evaporation Results," as they are called, at different stations, and I purpose making comparisons between some of these results and some that I obtained a few years since at Van Wyks Vley. The observations from which these "results" have been deduced were with one exception taken in evaporation tanks, 4 feet in diameter, 3 feet in depth, and sunk into the ground to within an inch of their upper rims. Measurements were made to the top of a rod of brass (rising from a glass float), by the aid of a "contact-gauge" reading to the thousandth part of an inch.

Mr. Russell points out that the evaporation from the tank at Lake George, which is at the margin of a large sheet of water, might be expected to be less than that at any of the other stations, and justifies the "expectation" in a short comparative table. There is here a slight apparent anomaly, for the gauge at Sydney "with the waters of the harbour on three sides of it" shows a loss of 34 inches against 29 inches from the Lake George tank, but this is partly, perhaps sufficiently, explained by the differences in mean shade temperatures, that at Sydney being 62·9°, against that at Lake George only 57·4°. Some part of the difference is, however, possibly due to the difference of elevation above the sea level.

Lake George, at an elevation above sea level of 2,267 feet, is the one exceptional station at which measurements of loss have been taken on a large water surface, and from these measurements it is found that the lake loses from 50 to 60 per cent. more than the tank does. The experiments have been conducted over a period of eight years, and Mr. Russell arrives at the important conclusion that—"We must then, I think, assume that the evaporation at Lake George in a dry year, when the lake receives no drainage, is the best guide to the amount lost from evaporation, *plus* spray carried away by the wind."

Percolation from the bottom of the lake is not taken into account "for two reasons," says the author; "first, there is as yet no data, and, secondly, the lake has been full for so many centuries that percolation seems improbable."

I am, with all respect to Mr. Russell, inclined to challenge the value of this last assumption, and, on the other hand, I should like to be assured that no underground drainage enters the lake in dry seasons, for I understand the admitted drainage in wet seasons to mean underground drainage; without reasonable certainty on these points a valuable factor in making comparisons is missing.

I will now sketch the steps taken to distinguish evaporation from percolation at Van Wyks Vley. The reservoir was completed about December, 1883, and very soon after took water; the resident engineer, Mr. J. E. McNellan, under Mr. J. G. Gamble, then Hydraulic Engineer to the Colony, began to register the depths of water on the 23rd of January, 1884, and kept the record until the 28th of October of that year, when I made a survey of the area (at level of sill 33 acres), then flooded, with the water 3 inches above the sill upon which the discharge pipe rests. After this date I often supplemented Mr. McNellan's observations with others taken by myself, using the same measuring-rod and position, and we continued this record until the 17th of June, 1885, after which date water was used for irrigation purposes. The point from which measurements have throughout been taken is that reached by passing a rod, vertically held, close up to the centre of the discharge valve and down to the stone sill upon which it rests. The rod was of mahogany, painted and divided to hundredths of a foot. It will at once be seen that measurements taken in this way cannot be too critically compared with the tank observations taken in New South Wales, and the second decimal places I use in the tables which I will annex to this paper are only useful in so far as they assist in checking and balancing total results.

The data given in Table I. were gathered in a period of unusual drought, the rainfall for the whole period of nearly eighteen months, including two rainy seasons, being only $\left.\begin{matrix}4{\cdot}20\\+3{\cdot}88\end{matrix}\right\}$ 8·08 inches, and the results reached may safely be taken to represent the maximum vertical loss by evaporation, percolation, and waste in spray taken together that is ever likely to be experienced at Van Wyks Vley. These data are not, however, to be relied upon as indicating the present rate of loss, for several reasons. When I made the little survey before alluded to I determined the depth of the original water table, underlying the dam, with reference to the point from which the depth of water within the dam is measured, and I found it to be about 7 feet below that point. In constructing the dam the contractor carried his excavations in search of material (within the dam) nearly down to the level of this water table, and, during the whole of the first year, soakage through the thin crust left was sufficient to cause little whirlpools to show themselves on the surface of the water, indicating a very rapid escape from the dam into the natural water-bearing strata. Doubtless the like loss took place all over the then surface of the dam. On the other hand, the water table thus became permanently raised, and it is no longer possible for so large a proportionate quantity to escape from the dam. This was, I think, the chief cause of abnormal loss during the period; some little effect may be attributed to water consumed by stock, but this could only have been visible during the periods of low water, and later observations led me to the conclusion that, with a larger area of water exposed, there is doubtless a larger volume of water lost but a less diminution in depth as measured in the dam.

A little consideration will show that it would have been useless to keep a record in the form thus far adopted after water was distributed for irrigation; close measurements *were* however kept by myself until May, 1890, and the results given by the seasons 1887–8—when we had an initial depth of 13·2 feet on March 7th, 1887, and an area of nearly 2,000 morgen under water—give a clue to the different rates of loss from large or small areas. The loss during the twelve months March to March, 1887–8, is rather less than that shown from January to December, 1887, in annexure 2; the difference is about one-tenth of a foot. These measurements are those which show the least loss, vertically measured, of any taken during the 6½ years' work, while the mean area flooded has not, at any time, been nearly approached.

This result is much greater than that obtained by Mr. Russell at Lake George, for deducting my constant (considered later on) for percolation, there still remains the remarkable difference of Lake George giving up only 41 inches, against 66 lost by Van Wyks Vley, and it is this discrepancy which led me to suggest a doubt as to the freedom from percolation outwards or drainage inwards in the case of Lake George; there is, of course, the possibility that they may neutralise each other's action.

It being my duty to determine, each year, how much land it would be safe to place under irrigation, I found it advisable to determine the approximate rate of loss from percolation, and I had as data—

1. The minimum rates of total loss under different heads of water.

2. Special measurements, taken during the periods of minimum loss, which were compared with mean temperatures and also with differences between wet and dry bulb measurements.

From these data curves were constructed in the hope of getting at the actual loss by evaporation during these short periods. There was not more discordance in the results than could be fairly attributed to the roughness of my measurements of depths (100-foot intervals), and I accepted a loss of 1·70 inches per month as the most probable loss from percolation only, this loss being that calculated for an assumed mean depth of water of 6 feet at the end of July.

I had a second means of approximating this loss. I had at an early period noticed that for two or three days after a rapid rise of water in the dam there was a curiously rapid fall, and this I found to be owing to local loss about the perimeter of the flooded area, and, knowing the comparative depths of water in wells on three sides of the dam, I constructed curves of escapement sections and used the rapid losses following on a rise of water in calculating the coefficients of escape for different depths. On the whole I found this method to give me nearly the same results as those gained by the other method; the means giving a fraction over 18 inches loss per annum.

With respect to the measurements after the great catch in 1887, I find that between March 7th, the day on which the water attained its maximum height of 13·2 feet, and March 24th, when the next rain fell, I reported to Government that "the loss of 0·42 feet in 17 days at this season is below my tabular rate for lesser depths, which is as it should be." This loss of 0·42 includes the rapid fall I have before spoken of, and I have not now data at hand which would enable me to state its value, but even the 0·42 is only at the rate of 8·89 inches per 30 days against a mean of 10·10 inches for the two years tabulated; but the probability is that at least 1 inch dropped within the first two days, which would bring the monthly rate down to 8 inches.

At a later date, June 25th, I reported a loss of four inches in 35 days, or at the rate of 3·42 inches per 30 days, and this at a time when I had fully 500 morgen of land under irrigation. Here, again, the corrected limit would show less than the mean for the two years tabulated, but my diaries in which detailed observations are noted are still at Van Wyks Vley.

I much regret that I have not access to the data upon which I made my ultimate determination as to the loss by percolation. I had hoped that I should be able to show that it cannot be much less than 20 inches per annum, but I am afraid that I must ask you to believe that the evaporation curves persistently refused to account for the balance of loss that I now ascribe to the effect of percolation; and that, in regard to the continuance of that rate of loss for some years to come, which I think probable. I thoroughly examined the bed of the dam in 1891, and found so slight a film of silt that I am convinced that but little practical obstruction was opposed to the escape of water after an eight years' deposit had accumulated. There is, I should state, one exceptional point in respect to silt. The canal which leads water from the Carnarvon River into the dam has practically refilled the excavations, made by the contractor, with the heavy silt resulting from the first cutting of the gully now so noticeable where the stream enters the reservoir. The water, having reached hard rock, will not continue this action at so rapid a rate in future.

In further confirmation of the general correctness of the results of my investigations I can only state that having given—(1) The depth of water stored, (2) Assumed the nearly invariable rate of percolation, (3) Deduced the variable but seasonable rate of evaporation for different depths, I was able to determine how much land could be cultivated during each season without, in any single instance, disappointing the tenants under my charge as to their supply of water for irrigation.

I trust I have shown that I have established a reasonable distinction between losses from evaporation and percolation in this one particular instance. I have now the humiliating suggestion to make that my determinations are utterly worthless, except on the spot where they were made, for the simple reason that no observations of a like nature have hitherto been publicly recorded within this Colony.

The Government Astronomer of New South Wales gives to his Colony, not only the rates of evaporation from open tanks judiciously placed, but he collates these rates with others deduced from observations taken on a natural lake untrammelled by artificial bounds, and he raises his gift to almost royal proportions by giving the records, in his fourth map, of the rise, fall, and duration of floods in all the watercourses draining the drier districts of the country which employs him. From these last records, and knowing the local rates of evaporation, engineers can determine, within reasonable limits, losses by percolation proper to any soil crossed by those particular rivers.

Evaporation, which is primarily a friend to man, becomes a foe, but one that may be honestly met, in storage matters. Percolation, in some soils, is a very fiend to encounter in like works, albeit a true friend, left to itself, in the natural disposal of rainfall.

I have touched to-night but very imperfectly upon one theme only; but there are other subjects demanding even closer attention. What posterity may do for themselves does not intimately concern us; what they will say of us will be much the same as we may justly say of our predecessors, viz., that they have left us very much in the dark on many subjects on which they should have enlightened us. The officers of vessels visiting or passing us are taught and know more about the bed of the oceans washing our coast-line, their currents, winds, and temperatures than we know, despite the efforts of the Educational Department of the land we live in.

How many of us could, offhand, give a fair description of the geological formations, climatic peculiarities, variations in soils, or class the herbage or artificial productions underlying a line drawn haphazard across the map of South Africa? It will be justly said that no single individual can want to know all these things, but I urge that the individual who does want to acquire any knowledge of the kind, relating to any part of the country, should be enabled to acquire that knowledge without having to apply to specialists on the different subjects, or to wade, knee-deep, through Blue-books, of the contents of which no general index has ever yet been compiled.

Annexed will be found tables of comparisons and curves illustrating those used in investigating losses and determining expenditure, and to these I have added notes which make them self-explanatory as far as the data I have on hand permit me to make them.

I.

1884–5.	Intervals in days.	Total fall during interval.	Rate per day inches.	Rate per month of 30 days.
Jan. 23–Feb. 20 ...	28	10·68	0·381	11·43
Feb. 20–Mar. 30 ...	39	11·40	0·292	8·76
Mar. 30–May 6 ...	37	8·04	0·217	6·51
May 6–June 12 ...	37	4·44	0·120	3·60
June 12–July 12 ...	30	3·24	0·108	3·24
July 12–Aug. 31 ...	50	6·60	0·132	3·96
Aug. 31–Sept. 30 ...	30	6·12	0·204	6·12
Sept. 30–Oct. 28 ...	28	9·48	0·338	10·16
Oct. 28–Nov. 30 ...	33	14·16	0·429	12·87
Nov. 30–Dec. 31 ...	31	14·16	0·457	13·71
Dec. 31–Jan. 23 ...	23	10·44	0·454	13·62
Jan. 23–Feb. 25 ...	33	11·88	0·360	10·80
Feb. 25–Mar. 30 ...	33	12·48	0·378	11·34
Mar. 30–April 30 ...	31	10·80	0·349	10·47
April 30–May 31 ...	31	3·84	0·124	3·72
May 31–June 17 ...	17	1·32	0·078	2·33

During the above period there was no expenditure of water, the discharge valve only being lifted now and then to see that it was in working order. Cattle drank freely at the dam, but there were but few on the estate.

II.

1887.		Intervals in days.	Total fall during interval.	Rate per day inches.	Rate per month of 30 days.
Jan. 1–Feb. 20 ...		50	25·20	0·504	15·12
Mar. 5–Mar. 25 ...		19	5·28	0·278	8·34
Mar. 26–April 1 ...		6	1·20	0·200	6·00
April 2–May 1 ...		28	4·66	0·163	4·89
May 3–May 17	Time of great expenditure in irrigation.	14	1·68	0·120	3·60
May 20–June 25		36	6·12	0·170	5·10
June 25–July 2		7	0.60	0·086	2·58
July 2–July 25		23	2·28	0·099	2·97
July 25–Sept. 10		47	8·04	0·171	5·13
Sept. 10–Nov. 19		70	24·24	0·346	10·38
Nov. 20–Dec. 31 ...		41	13·08	0·319	9·57

The above table is framed from a report sent to the Government, February 29, 1888, in which simple measurements are recorded. Corrections are needed for the periods during which water was actually running into the dam; thus from February 20th to March 5th no fall whatever is shown. The total value of this correction does not exceed + 6 inches. On the other hand rather more than a foot must be subtracted from the total for water used in irrigation. The loss from evaporation and percolation is then 7·30 feet, or about one foot less than in 1884.

III.

AUSTRALIAN		
Station.	Time.	Rate.
Lake George average ...	8 years' evap. only ...	40 inches
,, *tank* ,, ...	4 ,, ,, ...	28 ,,
Dubbo ,, ,, ...	6 ,, ,, ...	60½ ,,
Hay ,, ,, ...	8 ,, ,, ...	40 ,,
Sydney ,, ,, ...	8 ,, ,, ...	36 ,,
Walgett ,, ,, ...	8 ,, ,, ...	55 ,,

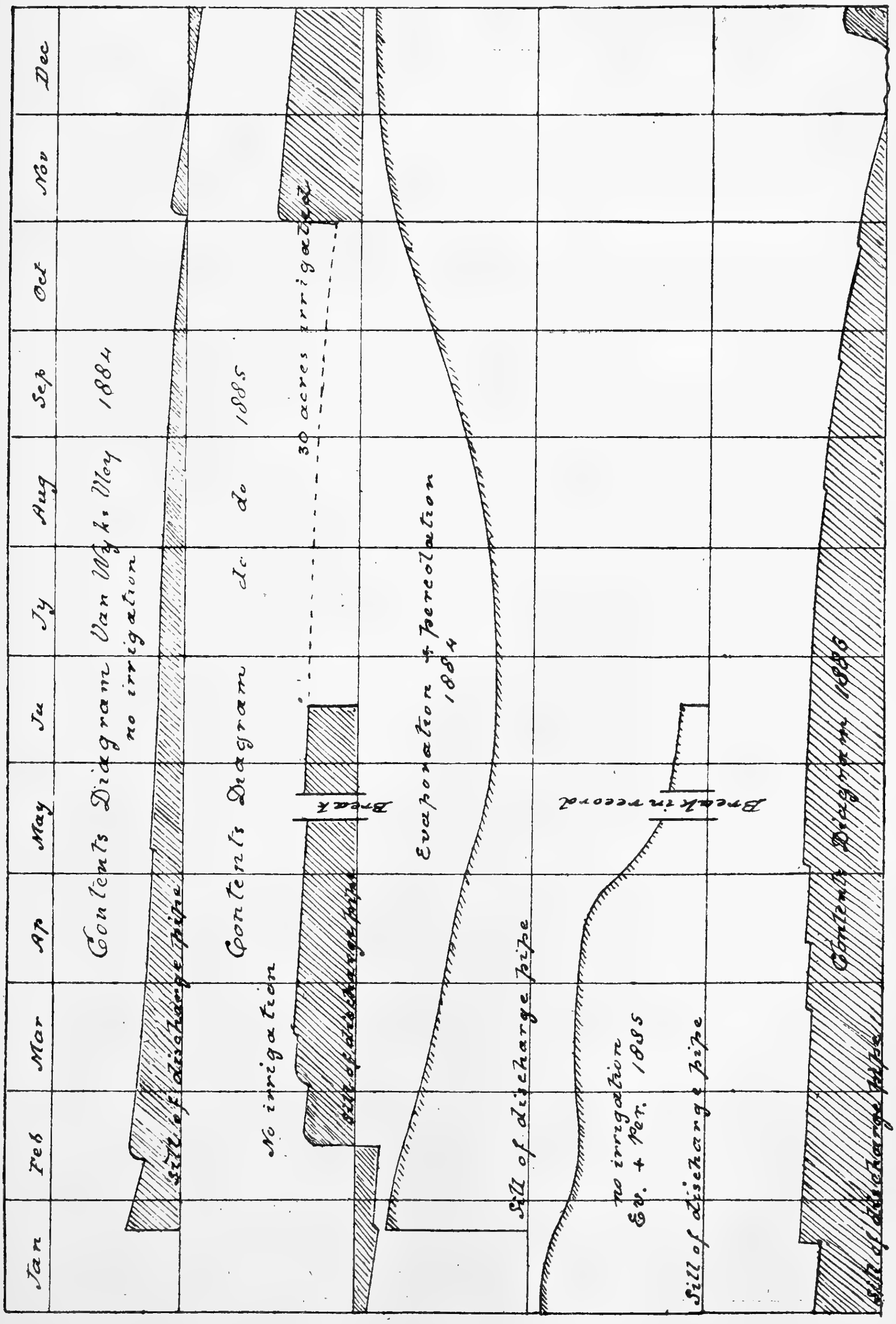
VAN WYKS VLEY.

Period, January, 1884, June, 1885—	
Evaporation and soakage together	94 inches
Ditto, ditto, 1887—	
Evaporation, soakage, and irrigation, 600 morgen	$92\frac{1}{2}$

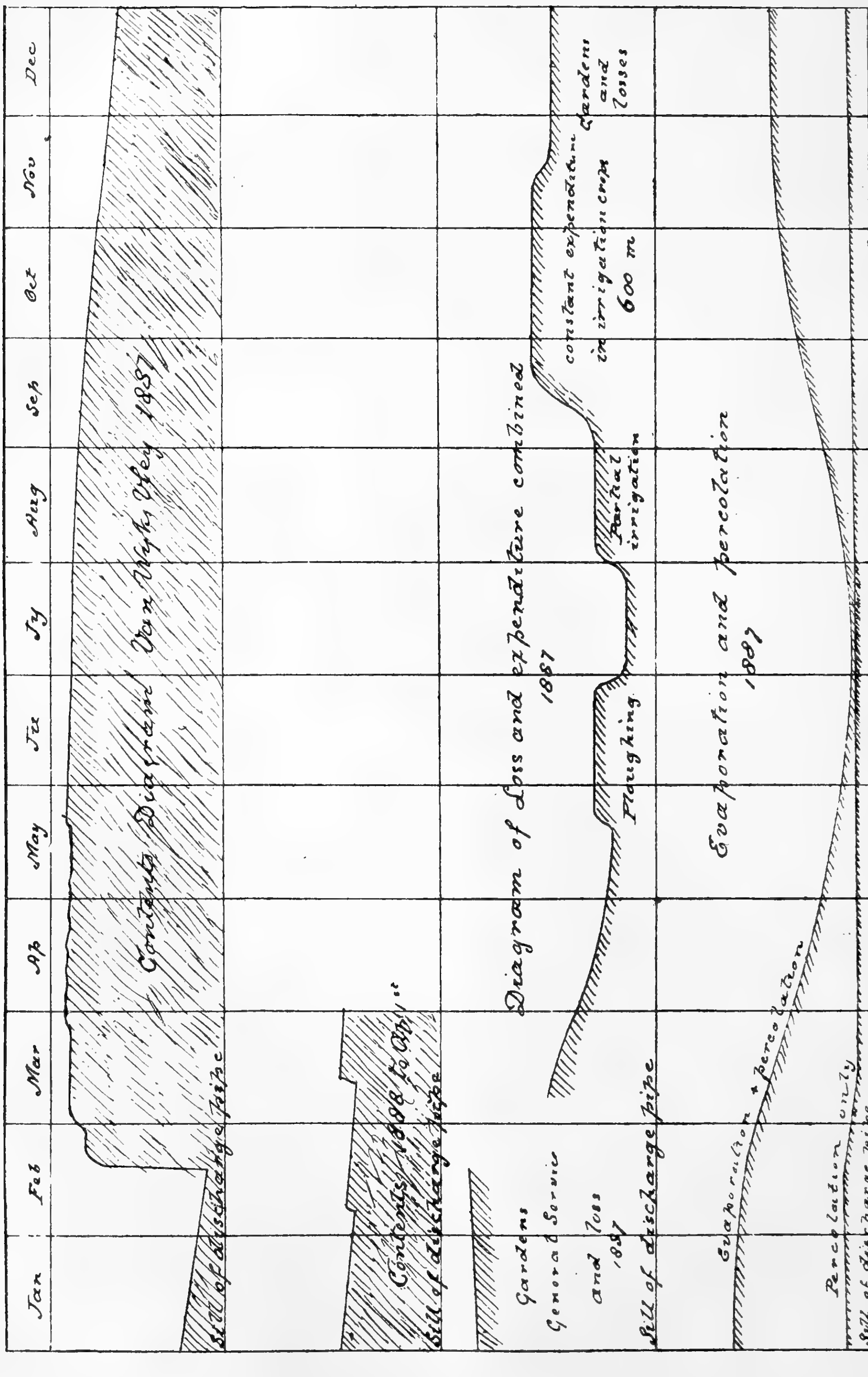
The above data (Australian) are to nearest whole numbers.

The Cape data for 1884–5 are, as stated in the paper read this evening, extravagant. The data for correction of the observations for 1887 are not at hand; the nearest approximation I can make to net loss by infiltration and evaporation combined is 76 inches.

V


Jan
Feb
Mar
Ap
May
Ju
Jy
Aug
Sep
Oct
Nov
Dec
Contents Diagram Van Wyk's Vley 1884
no irrigation
Sill of discharge pipe
Contents Diagram do 1885
No irrigation
30 acres irrigated
Break
Sill of discharge pipe
Evaporation + percolation 1884
Sill of discharge pipe
no irrigation
Ev. + Per. 1885
Break in record
Sill of discharge pipe
Contents Diagram 1885
Sill of discharge pipe

V.


Jan
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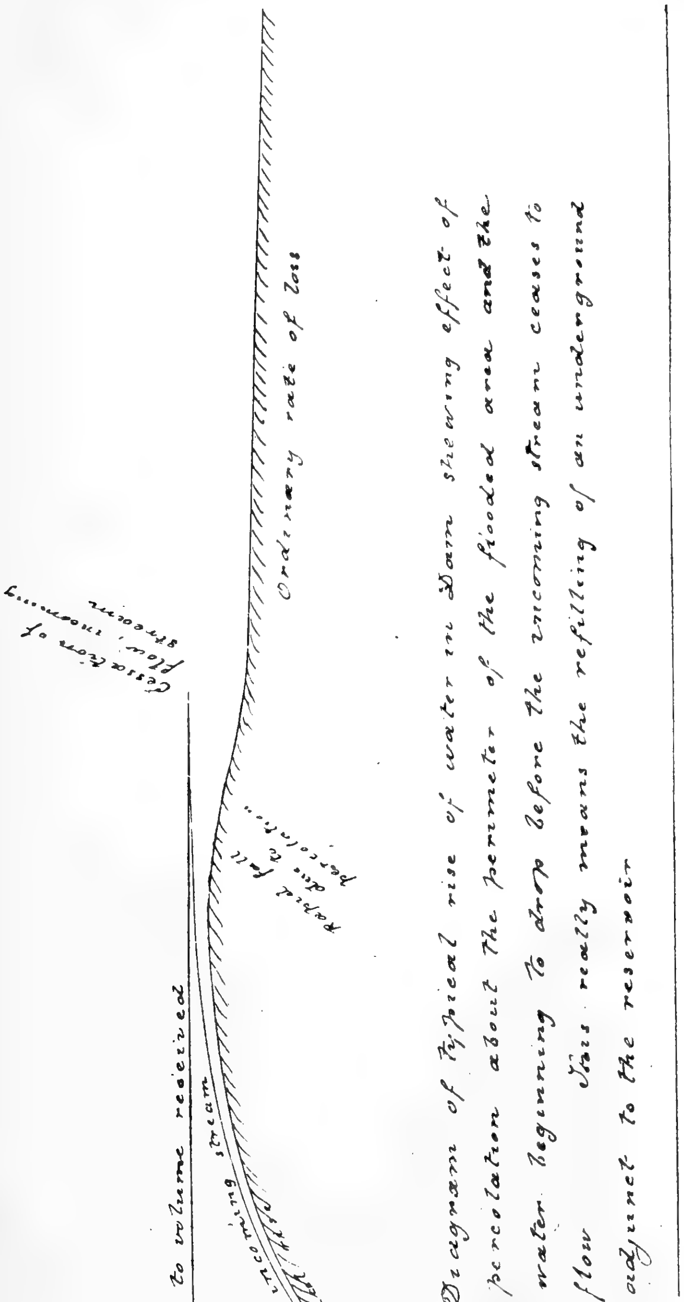
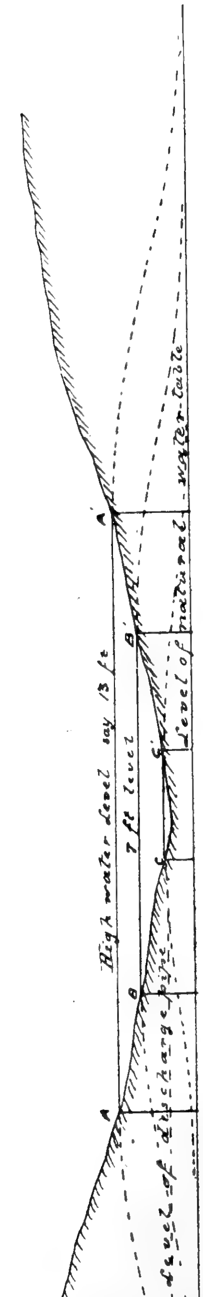
Contents Diagram Van Wyk's Vley 1887
Sill of discharge pipe
Sill of discharge pipe
Diagram of Loss and expenditure combined 1887
Gardens General Service and loss 1887
Sill of discharge pipe
Ploughing
Partial irrigation
constant expenditure in irrigation crops 600 m
Gardens and losses
Evaporation and percolation 1887
Evaporation + percolation
Percolation only
Sill of discharge pipe

VI.



VII.



Section showing effect of percolation, at different depths of water, on the soil under and about the flooded areas. The escapement sections are measured by the perpendiculars multiplied into the perimeters.

OCCURRENCE OF BLIND INSECTS IN SOUTH AFRICA.

By A. Raffray.

(Read October 30, 1895.)

In his presidential address, Dr. Marloth has expressed a regret that caves in South Africa have not been explored with a view to the discovery of such blind and bleached *Arthropoda* as are so peculiar a feature of the subterranean fauna of Europe and North America.

Probably Dr. Marloth's attention was not called to the fact that a French naturalist, Mons. E. Simon, an arachnologist of worldwide repute came to South Africa in 1892 and explored three caves in the Transvaal: one in the Pretoria district and two in Waterberg and Zoutspansberg. The result of his investigations has been published in the 'Annales de la Société Entomologique de France,' 1894, p. 64.

Mons. Simon has found in these caves some examples of the classes and orders *Thysanoura*, *Myriopoda*, *Arachnida*, and *Coleoptera.*

In the order Coleoptera he found—1. *Eurychora Simoni*, Fairm., a new species belonging to a genus peculiarly abundant in South Africa. This species has normal eyes, but it is light brown instead of black, and the colour thus resembles that of subterranean forms. 2. *Plagyopyga cyclogona.* This species was probably an occasional visitor to the cave.

In the class *Arachnida* he found—1. A *Loxosceles*, which he declares to be identical with the European species *L. speluncarum*, Duf., and which, I presume, inhabits European caves; this spider, however, is not blind. 2. A new genus, *Phyxelida makapensis*, Sim., belonging to a family which, hitherto, was not known to have cave-inhabiting representatives; this spider has also minute eyes.

The other *Arthropoda* have not yet been identified.

With the exception of *Loxosceles speluncarum*, these Arthropoda cannot be said to belong to a subterranean fauna.

I should, however, state that animals living in caves are not necessarily always blind or bleached in colour, more especially in the caves of tropical or subtropical countries.

Some years ago Mons. E. Simon explored some caves in the Philippine Islands, and his discoveries, which were much more numerous there than in South Africa, have been published in the

'Annales de la Société Entomologique de France,' 1892, p. 27. Two Coleoptera belonging to the family *Pselaphidæ* were examined by me and proved not to belong to a cavern-inhabiting form: one, *Tmesiphorus Simoni*, Raffr., has very large eyes, is dark in colour, and closely allied to a species abounding in the forests of Singapore; the second one, *Batrisus cavicola*, Raffr., shows relationship with some Australian forms, but the eyes are very small. It is the first time that a species of the very large genus *Batrisus* has been found in caves.

It is worthy of note that one of the insects found in the caves of the Pyrénées, in France, *Machærites Mariæ*, which has in all respects a subterranean facies, has well-developed, although small eyes, while in the female the eyes are exceedingly small and irregular, varying even in the same specimen. This peculiarity is in accordance with the fact that in many insects the eyes are smaller in the female than in the male.

Caves are not, however, the only localities where blind and bleached insects have been discovered. In the order *Coleoptera*, *Anillus*; *Scotodipnus*, *Reicheia* in the *Carabidæ*; *Apteranillus*, *Micrillus*, *Scotodytes* in the *Staphylinidæ*; *Amaurops* in the *Pselaphidæ*; *Raymondia*, *Crypharis*, and I believe *Troglorhynchus* in the *Curculionidæ*, as well as some others, have been found in Europe under big stones deeply embedded in the ground. I have myself discovered some of these very species in such a position in the South of France and in Algeria. With the exception of one *Anillus*, found in California, these insects seemed until quite lately to be confined to Europe. The difficulty of detecting these minute species may perhaps account for their not being recorded from other parts of the world, and my supposition seems to be justified by the discovery made by myself in Cape Town, and also in the neighbourhood of Cape Town (Newlands), of a *Scotodipnus* and a *Reicheia* belonging to the so-called subterranean genera.

Scotodipnus capensis, Pér., is very closely allied to its congener known from the South of France, Italy, and Corsica; it is an entirely blind insect, of pale, transparent colour, amber-like almost. It is found under stones at the foot of the Lion's Rump, near Cape Town, in the month of January. When the stone is turned over the insect is not detected at once, but if the muddy ground has remained attached to the under side of the stone, after a short exposition to the rays of the sun or to the daylight, *Scotodipnus*, who seems uneasy and disturbed by the heat, and possibly also by the light affecting its nervous system through the translucid teguments of the body, begins to move rather quickly and can then be detected. This insect seems very rare; I found only two or three specimens last year, and four or five this year.

The second species, *Reicheia promontorii*, Pér., belongs to a genus known to occur in the South of France, Sicily, Algeria, Styria, Herzegovinia, and Carynthia, in caves. I found this new South African species at Newlands on the slopes of the Devil's Peak, in sifting dead oak-leaves; it was fairly abundant.

Reicheia promontorii is not entirely blind; close to the insertion of antennæ is a small, black protuberance, which under a high magnifying power proves to contain a very small and rudimentary eye consisting of only one very convex facet, the diameter of which is $\frac{3}{100}$ of a millimetre. The colour is darker than *Scotodipnus*, but still amber-like and not darker than in most of the true subterranean, cave-inhabiting beetles. I kept it alive so as to ascertain whether it was blind or not. Placed on a sheet of white paper, surrounded by a small barrier which it would have been very easy for the insect to surmount, *Reicheia* went straight forward, and quickly, until the antennæ came in contact with the obstacles; it would then stop, the antennæ vibrating quickly to try and ascertain what the barrier was. It would then go literally always in touch with the obstacle, as if it was hoping to find an aperture by means of which it would escape. This goes to show that the rudimentary eye is of very little use, if of any use at all.

It is now proved that subterranean forms occur in South Africa, and the wish so judiciously expressed by Dr. Marloth has been, or was already, partly fulfilled.

It is of interest to find that these subterranean insects show such a decided affinity to the European ones.

It cannot be said that *Scotodipnus* and *Reicheia*, through a special *modus vivendi*, similar to that obtaining in Europe, have been affected in their evolution, because both species have been found together with other minute beetles, decidedly peculiar to the Cape and quite characteristic of a fauna which is perhaps one of the best defined and most isolated, so far as we now know—and a good deal is known—in the world.

In South Europe and Algeria, so far as my experience goes, these insects live by themselves under very big stones where no other insects are found; at the Cape they are found under comparatively small stones and together with other insects.

This peculiarity of an isolated Cape entomological fauna has been already proved many times, and the best proof of it is afforded by the entomological collections of the South African Museum, which—I have no hesitation in saying it—are, so far as South Africa is concerned, the best and most extensive in the world.

I.—S. VELORUM.
II.—LIGHT CURVE OF S. VELORUM.
III.—GRAPHICAL DETERMINATION OF THE ORBIT OF AN ALGOL VARIABLE.

By Alexander William Roberts.

(Read October 30, 1895.)

I.—*S. Velorum.*

This remarkable variable was discovered at the Cape Observatory by Mr. C. Ray Woods when comparing photographic plates taken on the nights of March 18, 1893, and January 20, 1894.

Dr. Gill was good enough to telegraph to me its variation immediately on its discovery, but it was not till the night of the 1st of February, 1894, that the interesting nature of its variation was manifest here. The minimum which took place on that night was also observed at the Royal Observatory, and the determination of the period and type of variation was fully confirmed by the Lovedale observations.

Since then S. Velorum has been regularly observed both at the Cape Observatory and at Lovedale; at the former place by photography, and at the latter by the usual method of eye determinations of brightness. In this respect that photographic and visual measures have been carried on concurrently, the observations of S. Velorum are unique. No other variable has been systematically observed by photography, and it is to the credit and honour of the Cape Observatory that in this as well as in many another line of investigation, it has led the way,—and kept the lead. When we consider the traditions, the instrumental equipment, and the personnel of the Cape Observatory, it is probably no exaggeration to say that the series of measures initiated and carried on there, of S. Velorum, will be to variable star astronomy what the photographs of the comet of 1882 were to sidereal photography.

It is of course true that isolated photographs of variables have been taken at Arequipa, Harvard, and Mount Hamilton, and recently a series of measures by photography of β Persei was made at the Lick Observatory to test the relative accuracy of photographic and eye estimates. But the method adopted (though perhaps in a way necessitated by the brightness of β Persei) was not one calculated to produce the best results, viz., Polaris, a star in another part of the sky, was photographed alongside β Persei for comparison.

In Dr. Gill's photographs of S. Velorum the comparison stars are those *in the same field*, and are consequently all photographed under the same conditions of atmospheric absorption and instrumental adjustments.

Further, the same nine comparison stars that are imprinted on the photographic plates are also adopted at Lovedale as standard stars for the eye estimates of S. Velorum, and this mutual co-operation and agreement as to the standard stars to which all changes in the variable will be referred, cannot but have an important bearing on the final determination of its variation.

Especially will it have a direct bearing on the important question of the velocity of light of different wave lengths; that is if wave lengths which mainly operate in producing the sensation of vision are different from those that leave their impress on the photographic plate.

S. Velorum also is the first variable of its class discovered by photography, and the second Algol variable—as the class to which S. Velorum belongs is called—discovered in the Southern Hemisphere. Indeed the ceaseless activity in this branch of astronomy has only resulted in the discovery of fourteen Algol variables, of which four are in the Southern Hemisphere.

This star, therefore, has no ordinary claims upon our attention, and the purport of the present paper is to state as far as has been ascertained from eye estimates alone the chief features of its variation and their probable explanation.

II.—*Light Curve of S. Velorum.*

During 5 days 7 hours S. Velorum remains constantly a 7·75 magnitude star. An ordinary opera-glass will show it distinctly during this period of constancy. At the end of this period it begins to decline in brightness, slowly at first, and then with ever-increasing rapidity. As it passes the 9th magnitude, the limit of vision in a one-inch telescope, its rate of descent is one-tenth of a magnitude in eight minutes. When the variable, however, reaches magnitude 9·25 it comes to a sudden halt. For the next six and a half hours it remains constant at this magnitude.

At the end of this time it suddenly and rapidly begins to ascend again. As it increases in brightness the rate of increase slows down, till, when it nears its normal magnitude, its rate is so slow as to render it extremely difficult to say when the increasing phase ceases.

On reaching magnitude 7·75 the constant period sets in, and once more for 5 days and 7 hours S. Velorum is like the great majority of stars, unvarying, unchanging. At the end of the 5 days and 7 hours, the descending phase begins again, and for another fifteen hours—four hours descending, six and a half hours at its minimum, and four and a half hours ascending—the star is a variable. It is to be noticed that the increasing period is somewhat longer than the decreasing, indicating slight eccentricity.

When observations have been secured over a long period of time it is possible to determine with great exactness the total period of variation, that is the time from any point on, say, the descending curve to a similar point on the next descending curve. The usual method adopted is to compare the light curves at the beginning and end of the series.

In determining the period of S. Velorum from the Lovedale measures, the method adopted was to reduce the various observations at minimum to an expression of the form,

$$\text{Mag.} = \alpha + \beta t + \gamma t^2 + \delta t^3$$

where α, β, γ, δ, &c., are constants for each minimum. From the numerical values of these constants for different minima the period is readily obtained.

The resulting period was:

5 days 22 hrs. 24 mins. 22 secs. $\pm$ 2 secs.

Having secured our data, the next step is to interpret them. The simple explanation of such variation as we have described is to consider it due to eclipse. S. Velorum is a close binary star, the two components revolving round one another in the period already given.

Inasmuch as that during 6½ hours the light from the system is constantly at 9·25 magnitude, the light of one of the stars must be completely eclipsed during this period; that is, the central star is a large, faint star round which a brighter, but smaller, companion revolves in a little less than six days. Such another system have we on a much grander scale in Procyon, only here the existence of the great non-luminous globe round which Procyon revolves is only made evident through the perturbations of Procyon.

The magnitude during the constant period (7·75) when compared with the magnitude at minimum (9·25) gives us the relative brightness of the two stars. For:

let m = light ratio between two magnitudes.
l_1 = light of central dark star.
l_2 = light of bright satellite.

then:

$$(9{\cdot}25 - 7{\cdot}75) \log. m. = \log. \frac{l_1 + l_2}{l_1}$$

A solution of this equation gives the ratio of the light of the companion to the central star as 4 : 1.

Then again we notice that while it takes only 4 hours for the secondary star to pass from simple contact to total eclipse, it takes nearly $10\frac{1}{2}$ hours to pass behind the larger star ; that is, the diameter of the central star is $2\frac{1}{2}$ times greater than that of its companion. And we have seen that it is four times fainter.

Further, as the time of passing across the primary is $10\frac{1}{2}$ hours, and the whole period 142·4 hours, we have a relation between the diameter of either star and the major axis of the orbit, or rather with the diameter of the orbit, for any data on which we could rest a determination of eccentricity is exceedingly uncertain. The distance between the two stars is probably not much greater than twice the diameter of the central star, a contiguity utterly unknown in the solar system. The tidal action and interaction in such a system must be enormous.

So far we have proceeded on the safe foothold of ascertained data. An assumption as to the mass of S. Velorum would yield the dimensions of the system expressed in terms of the sun's distance from the earth. Such an assumption would, however, practically be a mere guess. Indeed all we can say concerning the absolute size of the S. Velorum system is that its semi-diameter cannot be greater than 10,000,000 miles or less than 1,000,000 miles.

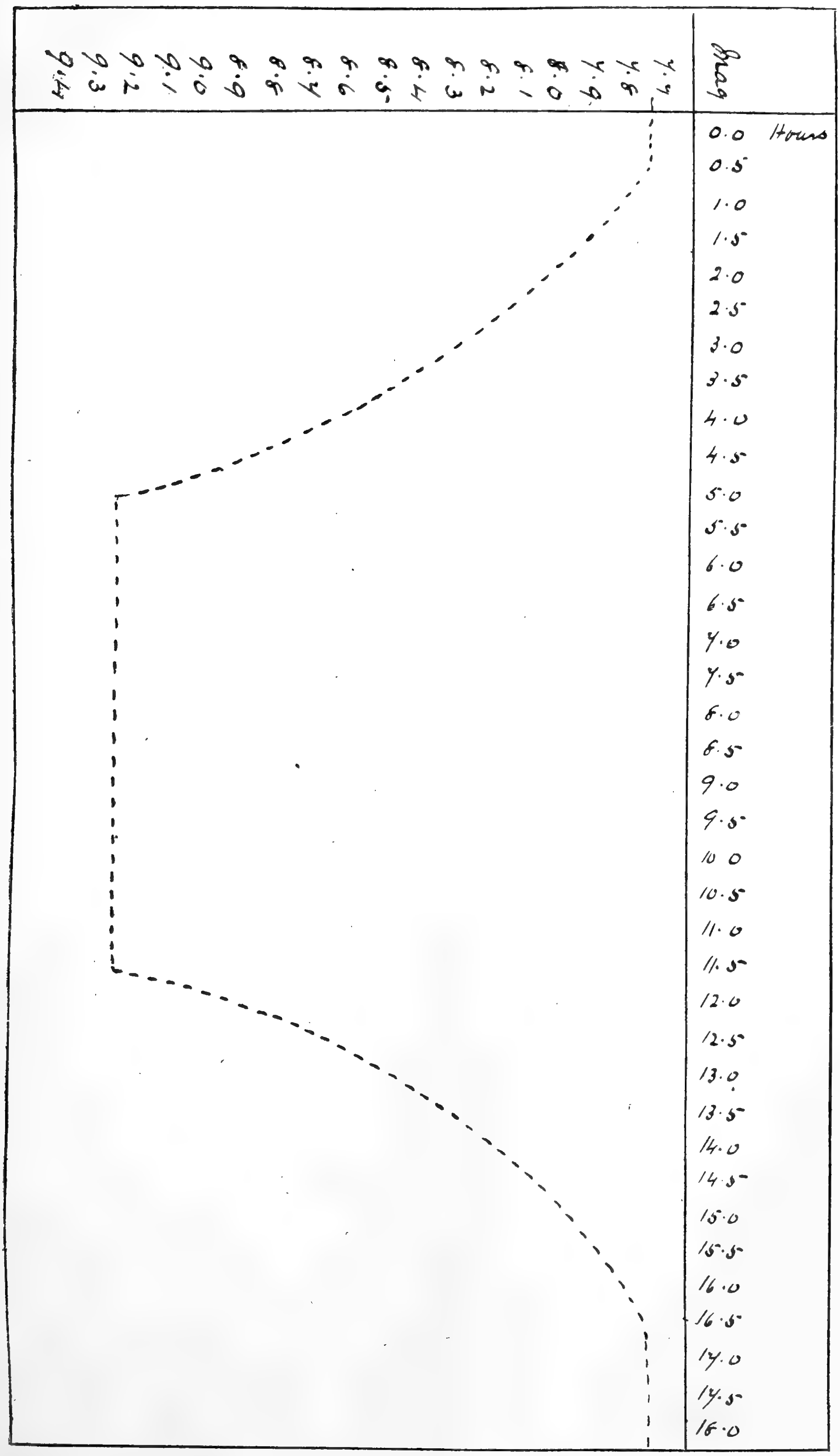
A spectroscopic examination of the star's light would give an absolute determination of the dimensions of the system were it a bright one. At present, however, it is impossible to tell the motion in the line of sight of 8th and 9th magnitude stars. But when we remember the progress that has been made in spectroscopic science during the past fifty years, we are warranted in the confident hope and belief that before a few more decades have passed away we shall be able to deal with motion in the line of sight of even 9th magnitude stars.

It may be mentioned that observations here of S. Velorum during the next few months will be directed specially to the determination, if possible, of a secondary minimum.

As the companion passes behind the central star we have the minimum phase described in this paper, but when the companion crosses the line of sight in front of the primary star it will be projected on the primary star, and we will have, theoretically, a secondary minimum.

Whether this minimum can be measured is another matter. It means only a fall from 7·75 mag. to 7·81 mag., a difference of 0·06 magnitudes, and the amount of difference in intensity that a practised eye can distinguish is, according to Dr. Gould, 0·06 mag.

II.—*Light Curve of S. Velorum.*



I think, however, differences even smaller than this can be distinguished, especially when the star is well situated as regards comparison stars. My own probable error for observations of S. Velorum is 0·05 mag., and I think this, with every precaution against error, could be reduced to 0·03 mag.; if so, it will be possible to determine the secondary minimum of S. Velorum.

To this paper as addenda are given:

(1) The light curve of S. Velorum during its varying phase (p. 27).

(2) A graphical solution of the orbit of an Algol variable.

III.—*Graphical Method of Determining the Orbit of an Algol Variable.*

Five elements determine the form and position of the orbit of a close binary star whose period is known, viz.:

(1) The time of Periastron passage.

(2) The angle between the line of Apsides and the line of Nodes.

(3) The position angle of the line of Nodes.

(4) The inclination of the orbit.

(5) The eccentricity of the orbit.

When, however, the inclination of the system equals, or nearly equals, 90°, the projection of the orbit becomes a straight line, and only three elements remain to be determined, viz.:

(1) The time of Periastron passage.

(2) The angle between the line of sight and the line of Apsides in the real orbit.

(3) The eccentricity of the orbit.

In an orbit of this nature there will be eclipse of either component as the stars pass through the line of sight. In the case of a bright primary star with a non-luminous satellite—as Algol—or in the case of an almost non-luminous central star and bright companion—as S. Velorum—there will be actual visible eclipse at only one of the passages through the line of sight. In some stars, however, there are two minimum phases, and it is with stars of this class that this portion of the paper deals.

Let A B C D (p. 30) be the orbit of a close binary whose inclination to the plane of projection is 90°. Let γ be the centre of the primary star whose circumference is indicated by the unbroken circular line round γ.

When the companion passes through A and C, eclipse will take place, the relative duration of which will depend upon the eccentricity of the orbit, and the position of its apsidal line with reference to the line of sight.

If the duration of eclipse at A is longer than that at C, then the periastron passage is nearer C than A.

Again, if the periastron passage takes place on the side towards B, rather than towards D, the time between the two minima at A and C will be shorter than the time between the two minima at C and A.

Thus we are able to determine the quadrant in which periastron passage lies.

Let: t_1 = duration of minimum at A.
t_2 = duration of minimum at C.
p_1 = time between min. at A and min. at C.
p_2 = time between min. at C and min. at A.

Then as the fundamental law of motion round a centre of force is that equal areas are described in equal times:

$$(1)\quad \frac{\text{Area of segment A B C}}{\text{Area of segment C D A}} = \frac{p_1}{p_2}$$

$$(2)\quad \frac{\text{Area of sector } \beta\, \alpha\, \gamma}{\text{Area of sector } \gamma\, \delta\, \varepsilon} = \frac{t_1}{t_2}$$

We have, therefore, graphically to describe an ellipse so that the line A C will divide it in the required ratio, and that also the area of the two sectors $\beta\, \alpha\, \gamma$ and $\gamma\, \delta\, \varepsilon$ will be to one another as the duration of minima at A and C.

When this is done roughly on a small scale, it may be made more and more to correspond with the required conditions by drawing the ellipse on a larger scale.

Absolute agreement can be attained by differentiating the well-known formula for angular motion round a centre of force, but as the purport of this short addendum is rather to indicate in a general way the relation between variation of light and orbital movement, I shall not trouble the Society with it; but the investigation is one of more than common interest.

The ellipse having been obtained graphically:

(1) The relation between the major and minor axes will determine the eccentricity.

(2) The angle between the line of Apsides and the line of sight can be measured by a protractor.

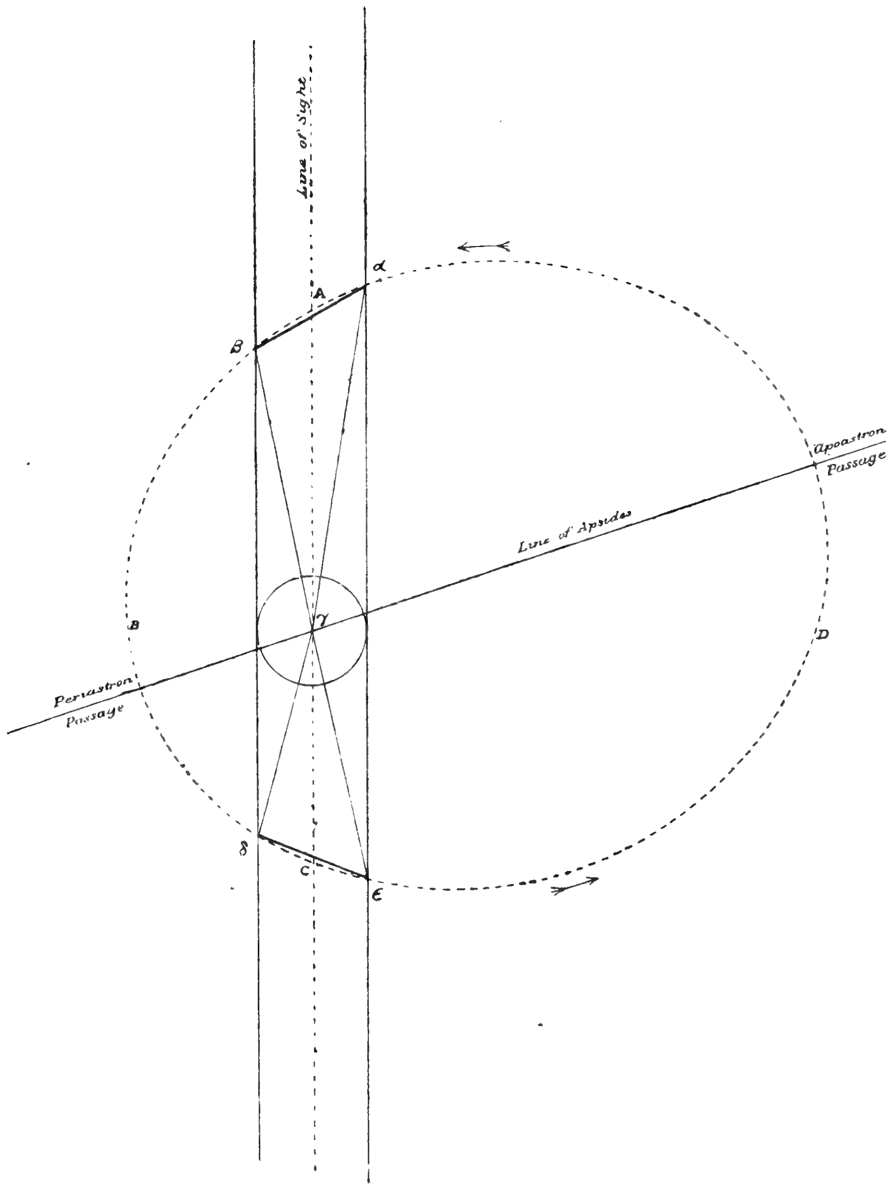
(3) Let this angle = θ

$$\tan \frac{\theta}{2} = \sqrt{\frac{1 + \varepsilon}{1 - \varepsilon}} \tan \frac{x}{2}$$

$$x - \varepsilon \sin x = mt$$

$$T = \frac{mt\,(p_1 + p_2)}{360^\circ}$$

From which the time of passing periastron, can be readily determined.



TYPICAL ORBIT OF AN ALGOL VARIABLE.

MORPHOLOGICAL AND BIOLOGICAL OBSERVATIONS ON SOUTH AFRICAN PLANTS.

By Dr. S. Schönland.

(Read March 25, 1896.)

1. *A case of Peloria in a S. A. orchid (Disa patula ?).*

No order of plants exhibits such marvellous differences in the shape of their flowers as orchids do, and yet their structure is surprisingly uniform. In most orchids (and in *all* S. A. orchids) the flower is composed of three sepals, three petals alternating with the sepals, one stamen, and it has further a trimerous pistil. Of the three stigmata which one would expect, two are usually confluent and the third forms a peculiar structure called the rostellum. In these orchids the single stamen is always placed opposite the odd sepal, and the latter is originally always placed opposite the axis from which the flower springs.* There are a number of reasons, some of which will be found in the introduction to Mr. H. Bolus's 'Orchids of the Cape Peninsula,' why we may ascribe theoretically to the orchid flower two alternating trimerous whorls of stamens, of which only one stamen is actually represented in most orchids, namely, the odd one of the outer whorl, while a few orchids only, such as the species of *Cypripedium*, possess the two lateral stamens of the inner whorl.

A great many plants which normally exhibit irregular flowers sometimes produce regular or "peloric" flowers, and it is a peculiarity of these peloria that they frequently have the structure which one has theoretically ascribed to the normal irregular flower. I was, therefore, greatly interested when I found amongst some flowers of a *Disa* (*D. patula ?*), which Mr. R. Schlechter collected last year near Humansdorp, one which had exactly the same diagram as the one which had been theoretically constructed for orchids generally by Charles Darwin and others. Peloria amongst orchids are very common, and (as Mr. Bolus informs me) even in South Africa, but such a theoretically nearly perfect case has not been put on record from this part of the world, and I may, therefore, be allowed to

* The diagram on p. 76 in Bolus's 'Orchids of the Cape Peninsula' ought to be reversed, in accordance with the usual practice of having at the top in such a diagram the parts nearest the parent axis.

describe it briefly. In justice to Mr. Schlechter I must mention that he recognised the peloric nature of the flowers handed to me, and that he asked me to investigate them.

In the genus *Disa* "the sepals * are nearly equal in length, free; the odd one usually posticous, more rarely anticous, galeate, vaulted or nearly flat, spurred, saccate, or umbonate." In the flower which I am describing they were nearly equal in size, all of them were hooded and saccate (Plate I, Fig. 1 D), the odd one was anticous. "The petals [in this genus] are very various in shape, usually much smaller than the sepals." In our flower they were small linear structures (Fig. 1 C), concave on their inner sides, all of them were again of about the same size, and a "labellum" was, therefore, not observable. There was a distinct column which was free from the foliar structures just mentioned. It bore three stamens of equal size and proportions (Fig. 1 A st), alternating with the petals. Alternating with these, and therefore opposite the petals, there followed three more or less cuneate structures, which I take to be staminodes (Fig. 1 A st′). Although no pollen was, even in its initial stages, formed in them, their appearance would have reminded any botanist at once of stamens, and I think that my interpretation of these structures will not be challenged. In the centre of the column a rounded triangular protuberance could be distinguished. It was somewhat depressed in the centre and raised slightly towards the three corners of the triangle. These latter alternated with the structures which I have called staminodes, and I have no hesitation in considering the three raised portions of the central part of the flower as stigmata (Fig. 1 A stg). It will be seen at once when glancing at my sketch of this flower (fig. 1 A), which represents it with all parts spread out, that if my interpretation of its various parts is correct, it has the theoretical structure of an orchid flower. As all three stigmata are equally developed, a rostellum is, of course, absent. Whether they could have become functionally active is not in my power to decide, especially as the flower was still young, and a normal flower of corresponding age would probably not have been ready yet to discharge its pollen, even if circumstances had been favourable. It will be noticed in my sketch that the pollen sacs were tailed at the lower end, and it is perhaps worthy of mention that pollen was contained even in these tails. There was no sign of the eventual formation of caudicles, and none of the stigmata showed any peculiarity indicating the formation of the glands normally formed on the rostellum, the function of which is to provide a sticky substance for the removal of the pollinia by the agency of insects.

* The passages in inverted commas are taken from Mr. H. Bolus's 'Orchids of the Cape Peninsula,' p. 134.

The question naturally arises whether the flower I have described represents a case of atavism, a reversal to an original type. I will, however, not venture on any speculation on this subject, for on the two spikes which I had at my disposal there were some flowers which resembled the one which I have described, but were not quite so regular, and did not possess any staminodes, but there were also several with a different structure. They had a floral envelope composed of two alternating whorls, each composed of two hooded and saccate structures similar to the sepals of the flower first described; they had four stamens equally well developed as the stamens of the first flower, and they had (I believe) two stigmata.* Here we have, therefore, orchidaceous flowers which are dimerous right through. I think it right to put these cases on record, but I do not feel justified in drawing any conclusions from the facts which I have ascertained.

2. *The structure of the flower and the method of pollination in Crassula canescens*, Schult.

The following observations were made on plants grown in my garden at Grahamstown, within about half a mile from a spot where the species is growing in its wild state.

Crassula canescens, Schult., belongs to the section *Globulea* which is characterised in Harvey and Sonder's 'Flora Capensis' as having panduriform petals which bear an oblong or ovate fleshy "gland" immediately behind the blunt apex. I do not know what has led to the belief that the knob-like structures on the petals are glands, but I may state at once that they are not excretory organs, and for want of a better term I will call them "epipetalous knobs." I have reason to believe that in the other species of *Cassula* § *Globulea* these knobs are in structure and function similar to those of *C. canescens*.†

The peduncle of *Crassula canescens* is scape-like, and bears a few densely capitate cymules. The appearance of the epipetalous knobs, which are white, announces the time when the flowers are ready to be fertilised; before this time they are, with the rest of the corolla, enclosed by the calyx. As soon as this stage is reached the flowers are plentifully visited by a hymenopterous insect (*Synagris emarginata*, Sauss. ?) ‡ A dissection of the flower does not show any appreciable quantity of nectar, but when covering up a cluster of flowers

* I could not be quite sure about their number.

† This is certainly the case in *C. radicans*, Haw, *C. cultrata*, L., and *C. obvallata*, L. As regards structure of flower, insect visitors, and fertilisation, my remarks on *C. canescens* apply also to these species, as I was able to ascertain after writing the above account.

‡ Mr. L. Péringuey, who kindly tried to identify the insect for me, could not state its name positively as I could only send him a female.

with muslin for about a week I found afterwards a fairly copious supply of nectar in all flowers which had reached the stage above mentioned, and at the same time I noticed that the epipetalous knobs did not show any secretion whatever. Furthermore, by means of anatomical investigation I could not demonstrate in them any tissue that resembled the well-known excreting tissues of other vegetable glands. The nectar inside the flowers appeared to have been secreted by the small scale-like bodies, which in this plant, as in the majority of crassulaceous plants, are found at the bases of the carpels on their outsides. It seemed to me, therefore, certain that the above-mentioned insects came to the flowers for the purpose of sucking nectar, and it seemed, further, most probable that they were the means of effecting the pollination of the plant. I may mention that no other insect was observed visiting the flowers, and that *Synagris emarginata* (?) seemed to prefer *C. canescens* although, I believe, it occasionally also visited (after exhausting all flowers of the *Crassula*) flowers of mignonette,* which were growing in profusion close by. The five egg-shaped epipetalous knobs of each flower are, as stated above, seated behind the portions of the petals which appear to be their true apices, and when they have made their appearance it looks as if the flower had opened. However, as a matter of fact, *the flower never opens.* To explain this more clearly I must give a short description of a petal, which will, moreover, help to explain some of the remarks which I have to make further on. It can easily be seen that each petal is thickest along the median line (Plate I, Fig. 2 A), and that it flattens out towards both its sides—one might almost say that it has a kind of midrib with broad wings. In making a median longitudinal section (Plate I, Fig. 2 C) through a petal it will be observed that the "epipetalous knob" forms the natural continuation of this midrib, and thus forms the true apex of the petal. The small, thin projection of the petal at the base of the epipetalous knob, which has hitherto been considered the apex of the petal, has, therefore, probably to be considered of the nature of a ligula,† but as I have not studied carefully the development of the petals I do not wish to insist too strongly on this interpretation. What concerns us here are two points—namely (1) each epipetalous knob is firmly connected with the thickest portion of the petal, and thus a lateral pressure on it, if sufficiently strong, will move the whole petal, and (2) the projecting thin portions of the

* I have since observed the same insect sucking nectar from the flowers of a *Euphorbia* at a time (May, '97) when no species of *Crassula* § *Globulea* was in flower.

† Similar ligular structures are found in *Boraginaceæ* where they frequently have the same function as in *Crassula* § *Globulea*.

petals close the entrance to the flower completely, and no access to it can be gained unless the petals are pushed apart and they themselves bent. Now it is by no means easy to push the petals apart, for we find that they are closely interlocked as they stand very close together, and are, moreover, imbricate (Plate I, Fig. 2 H p), but in addition to this they are closely surrounded by the comparatively thick sepals which have to be pushed aside at the same time. We can understand now that the entrance to the flowers is completely barred to small insects and all insects which have only soft mouth-parts. But a middle-sized hymenopterous insect, such as *Synagris emarginata*, with its wedge-shaped, hard mouth-parts, has no difficulty in gaining access to the flower. To these wedge-shaped, hard mouth-parts the epipetalous knobs form excellent points of resistance when the insect wants to prise a flower open and suck the nectar contained in it by means of its soft mouth-parts enclosed in the former. This is, as far as I can make out, their whole purpose in the economy of the flower.

The sepals and petals together form an elastic structure, so that the flower closes again immediately the insect has left it, and the same process has to be gone through again if another insect wants to gain access to the nectar.

Turning now to the sexual organs of the flower, we find that both anthers and stigmata are in the line which the mouth organs of the insect have to traverse to reach the nectar-producing glands (Plate I, Fig. 2 G gl). When examining the stigmata of a flower which shows the epipetalous knobs boldly, but in which the anthers have not opened yet, we frequently find germinating pollen-grains on them. Thus the stigmata are ready to receive pollen before the anthers of the same flower have discharged theirs. *The flower is protogynous.* Pollen germinating on the stigmata at this stage must have been brought from some other flower by the visiting insects, and *these insects*, therefore, *effect cross-fertilisation.* When the anthers open the pollen remains attached to them, but from their position it can be inferred that visiting insects cannot fail to brush some of it on their heads and carry it to the stigmata of the next flower which they visit. The stigmata remain receptive for a considerable period, and if the pollen of a flower is not removed part of it is deposited on the stigmata of the same flower. In flowers which were protected from insect visitors by a covering of muslin I found repeatedly large numbers of germinating pollen grains on the stigmata, and although I did not carry the experiment so far as to see whether these flowers would produce ripe seed, I think it is not far-fetched to conclude from the fact just mentioned that *self-fertilisation* is also possible.

3. *On some points in the morphology of Aizoaceæ.*

a. The inflorescences of some species of *Mesembrianthemum.*

In a number of species of *Mesembrianthemum* the flowers are borne singly at the ends of vegetative shoots. This (judging from the illustrations in De Candolle's 'Plantes Grasses') is, for instance, the case in *M. spectabile*, *M. felinum*, *M. longistylum* and *M. glaucum.* The same appears to be the case in *M. lateriflorum*, only here the flowers appear at the end of short lateral branches bearing only two foliage leaves. In all these species the leaves have a decussate arrangement. In *M. brachiatum* and other species the leaves are also placed in pairs opposite one another, but the uppermost pair have branches in their axils which, after producing a pair of leaves, end in a flower. Thus a typical *dichasium* is the result. The two leaves preceding each flower can be considered as prophylls, and further branching often takes place with the same result, and thus the dichasial formation of the inflorescence is continued.

In some other species, such as *M. cordifolium* (Plate II, E) *M. helianthoides*, *M. viridiflorum*, *M. crystallinum* and *M. angulatum*, the inflorescences appear at first sight to be very different from the simple cases just cited, but on careful examination it will easily be found that the formation of their inflorescences is essentially the same. It is certainly so in their youngest stages, except that the corresponding branches are not equally strong from the first, and only later on their behaviour becomes different.

In *M. cordifolium*, which I have examined in the live state, there are two equally well-developed branches formed in the axils of the two leaves preceding the terminal flower of a vegetative shoot. Each of these bears two leaves and ends in a flower. In the axil of each of these leaves a bud is formed, but only one of them developes strongly at first, and its axis places itself into the prolongation of its parent axis, throwing the terminal flower (Plate II, E II) aside. Thus a sympodium, or false axis, is formed, and as the favoured side-branches proceed alternately from the right and left side of the relative main axis the inflorescence is, if we only take these branches into consideration, a *cicinnus*, but it is not quite pure, as the opposite branches also develop later on and produce a flower after forming two leaves, and thus a true dichasium is formed, which, however, through the formation of the sympodium, is obscured. There is no term in the English language to adequately represent this form of inflorescence; in German it is called a "dichasium mit wickel-tendenz." *M. helianthoides* appears to agree in the points just mentioned with *M. cordifolium.*

The cases hitherto mentioned will assist us in understanding the inflorescence of *M. angulatum*, which is even more complicated. This plant is a common weed in Grahamstown gardens. The seedling of *M. angulatum* produces a richly branched axis in which the leaves are decussate, but as soon as flowers are produced the leaves instead of being opposite appear to be alternate with divergence $\frac{1}{2}$. On the flowering branches we notice that the flowers are lateral (Plate II, D, I, II, III) and without bracts. We further see that every second leaf is opposite a flower (Plate II, D, β, &c.), and that, as a rule, the alternate leaf bears two branches in its axil (Plate II, D, a, &c.), the upper one being more strongly developed than the lower one. This latter we recognise as an accessory shoot, while the more strongly developed one may be regarded as the normal shoot of this leaf. The second leaf (Plate II, D, β, β', &c.) bears in its axil a shoot in a similar state of development as the accessory shoot of the first leaf, and we may, therefore, without inquiring further at present, also regard it as an accessory shoot, while the axis of its normal axillary shoot has, as in *M. cordifolium*, placed itself into the prolongation of its parent axis and formed a sympodium. We thus see that here also the flowers are really terminal, and have only been thrown aside by the strong growth of a lateral axis. That this is not mere theory can easily be seen when the youngest parts of an inflorescence are examined. But in any case the inflorescence must be considered a true cicinuus if we leave the accessory shoots and the free lateral shoots out of account. In a cicinuus we must find that the branches composing it are produced alternately to the right and left of the main axis. In Plate II, A, in which I have represented the ground plan of part of the inflorescence of our plant, this will be clearly seen to be the case. In this diagram I have called the lower leaf of the two placed below each flower a, a', a'', &c., the upper ones being marked β, β', β'', &c. The organs seated on the sympodium are drawn black throughout, organs on normal "free" branches are outlined and those on accessory shoots are indicated by dotted lines. The size and shape of the sepals give us a ready means, even when they are full grown, to determine the order in which they have been formed. It can easily be seen that they are arranged in a spiral with a divergence of $\frac{2}{5}$. Taking any of the flowers (I in Plate II, A) as a starting-point, and looking at it by facing sepal No. 2 through the axis of the flower, we find leaf β on the right. This leaf has a shoot in its axil bearing two leaves, a' and β', and terminating in flower II. Looking now through the centre of this flower at its second sepal, we find the next upper leaf, β', to our left, and thus the sympodium is continued by the shoot on the left side. Examining after this the shoot terminating in flower III, we find that the shoot continuing the sympodium is to our right, and the next one is to the left of its relative main axis, &c. By glancing at the sketch of an inflorescence (Plate II, D) and at the diagram which we have just considered, it will be seen that all flowers on the sympodium occupy one side of it (the upper side) but are arranged in a zigzag line, separated horizontally by an angle of 90°, while all β leaves occupy the lower side and are arranged similarly as the flowers. While we can thus trace a cicinuus with a sympodial axis composed of the shoots of β leaves starting from β of the first flower, we must not lose sight of the fact that, as in *M. cordifolium*, α also has an axillary shoot, which grows according to the same rules as the β shoot, and that thus the total inflorescence is again a dichasium, but as its axis cannot place itself into the prolongation of the parent axis it appears in its true colour as a lateral branch of the latter, but also developes according to the same laws as the axis on which it is seated. However, it will be seen that the branching from this shoot is much poorer than from β, and thus here also the inflorescence is a "dichasium mit wickeltendenz." I said before that between each normal shoot and its bract an accessory shoot may arise, and I have to add that, when it developes properly, its growth proceeds also on the same lines as the normal shoots.

It is a well-known fact that, as a rule, in dichasia corresponding shoots are antidromous. I know no clearer example illustrating this rule than *M. angulatum*. We will consider the shoots in the axils of α and β (Plate II, A). In the axil of the former we have a shoot bearing two leaves, α' and β', and the flower IIα. As the leaves are opposite one another we cannot decide at first whether we have to connect them by a right or left spiral, but if we look at the sepals we see that these are arranged in a right spiral.* We also notice that if we try to pass from α' to β' and then to the first sepal by the shortest way, we have to turn in the same direction in which the sepals are arranged—we have to traverse a right spiral. On the other hand, we find that the leaves on the shoot in the axil of β can be seen to be arranged in a left spiral if we include the sepals of the flower IIβ. By looking at the sepals of flowers I and IIβ we see that they are also antidromous, the sepals of I being arranged in a right spiral, those of IIβ in a left spiral, and by comparing succeeding flowers on the sympodium we find that succeeding flowers of the

* A spiral which turns in the same direction as the hands of a watch is called by botanists a right spiral. A left spiral of course turns in the opposite direction.

sympodium are always antidromous, whereas the flower terminating the ill-developed "free" shoot is homodromous with the flower terminating its relative main axis. The result of the arrangements which I have described is such that all organs of the plant which require light get a maximum of it. Given the same forms of stems, leaves, and flowers, and the well-known straggling habit of *M. angulatum*, I doubt whether any other combination of these parts could secure to them more advantageous positions than they occupy in nature. A fuller consideration of this point, which is of the very greatest importance, I will leave for the present but hope to revert to it in some future paper.

b. The development of the flower in *Mesembrianthemum angulatum.*

There is nothing remarkable in the structure of the flower of this plant, except that the placentation remains permanently axile, whereas, as is well known, in a great many species of *Mesembrianthemum* the placentation, though originally axile, becomes parietal in the fully developed flower. My reason for studying the development of the flower of *M. angulatum* was chiefly to form an opinion of my own on the origin of the so-called petals in the genus. The result agreed entirely with the facts found by Payer and Hagen. The very numerous so-called petals and the stamens arise together from five protuberances or "primordia" (Plate II, B pr) after the sepals have made their appearance. These split up by a series of radial and concentric divisions, and the outer of them become the petals, whereas the inner ones develop into stamens (Plate II, C st). Strictly speaking, therefore, the so-called "petals" are staminodia, and the genus *Mesembrianthemum* is to be regarded as apetalous, as is now usually done by botanists. In our case the three outermost rows of serial structures resulting from the five primordia of the androccium develop into staminodes (Plate II, C st′), and as there are usually 30 radial series formed, their total theoretical number is 90. I counted 82 in one flower. As is usual in structures arising in close proximity to one another, some succumb to the pressure exercised by the others, and thus the smaller actual number may be accounted for. Altogether there are usually eight structures in each radial series—this would leave five for the real stamens, and their total theoretical number would be about 150.

The staminodes soon flatten out and overlap, but even in a full-grown flower one cannot help being struck with the similarity between the filaments of the proper stamens and the staminodes, and this similarity is greatest where the two adjoin, and from this fact one might also be led to the conclusion that the so-called "petals" are stamens without anthers, or in other words staminodes, which, however, through the study of the development of the flower, becomes an absolute fact, and thus justifies us in uniting *Mesembrianthemum* with other truly apetalous plants, such as *Aizoon*, *Galenia*, &c., into one natural order, the *Aizoaceæ*.

c. The inflorescence of *Galenia spathulata*, Fenzl.

Galenia spathulata is a more or less prostrate herb which is also a common weed in Grahamstown gardens. When examining its flowering region, it appears at first sight as if here the universal axillary branching of flowering plants did not obtain. If we examine a strongly developed shoot, it appears as if its branches arise by the side of the leaves, and that, therefore, they are without bracts. But by comparing it with the inflorescence of *Mesembrianthemum angulatum*, we find that we have to deal here with a similar inflorescence, although it is different in some details. In *M. angulatum* we may assume that the β leaf adheres to its axillary shoot for some distance, and that in this way the ordinary decussate arrangement of leaves in the species of *Mesembrianthemum* is altered into the alternate arrangement which we meet with in its inflorescence. We may further assume that the axis of its axillary shoot adheres to the axis of its parent shoot up to this point. If, on the other hand, both α and β adhered to the axis of their axillary shoots for some distance while the axis of the parent shoot (bearing flower I) remained short, we should have an inflorescence exactly the same as that of *Galenia spathulata*. Here again the shoot in the axil of β is favoured in growth, and, throwing the terminal flower aside, places itself into the prolongation of the parent shoot. It will now be seen why the free shoot in the axil of α' is found by the side of β and separated from it by a angle of 90°, while α' is found as the first leaf *on* this free shoot. The ground plan of this inflorescence is exactly the same as in *M. angulatum*, and even the further complication in the latter, namely, the formation of accessory shoots in the axils of both α and β occurs not infrequently. Thus we find a further common feature between *Galenia* and *Mesembrianthemum* in the fact that even in these highly complicated inflorescences the design, so to speak, is exactly the same.

Explanation of Figures :—

Plate I.—

Fig. 1.—*Disa* (*D. patula ?*).

A. Peloric flower (magnified), all parts spread out. s = sepal, p = petal, st = stamen, st′ = staminode, stg = stigma.

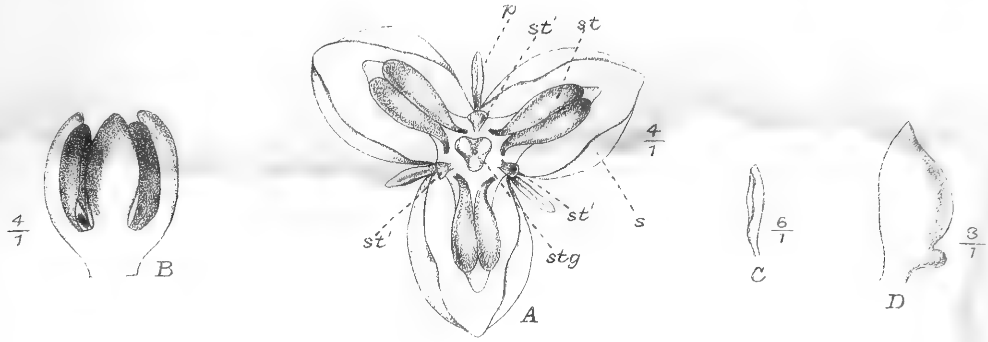


Fig. 1

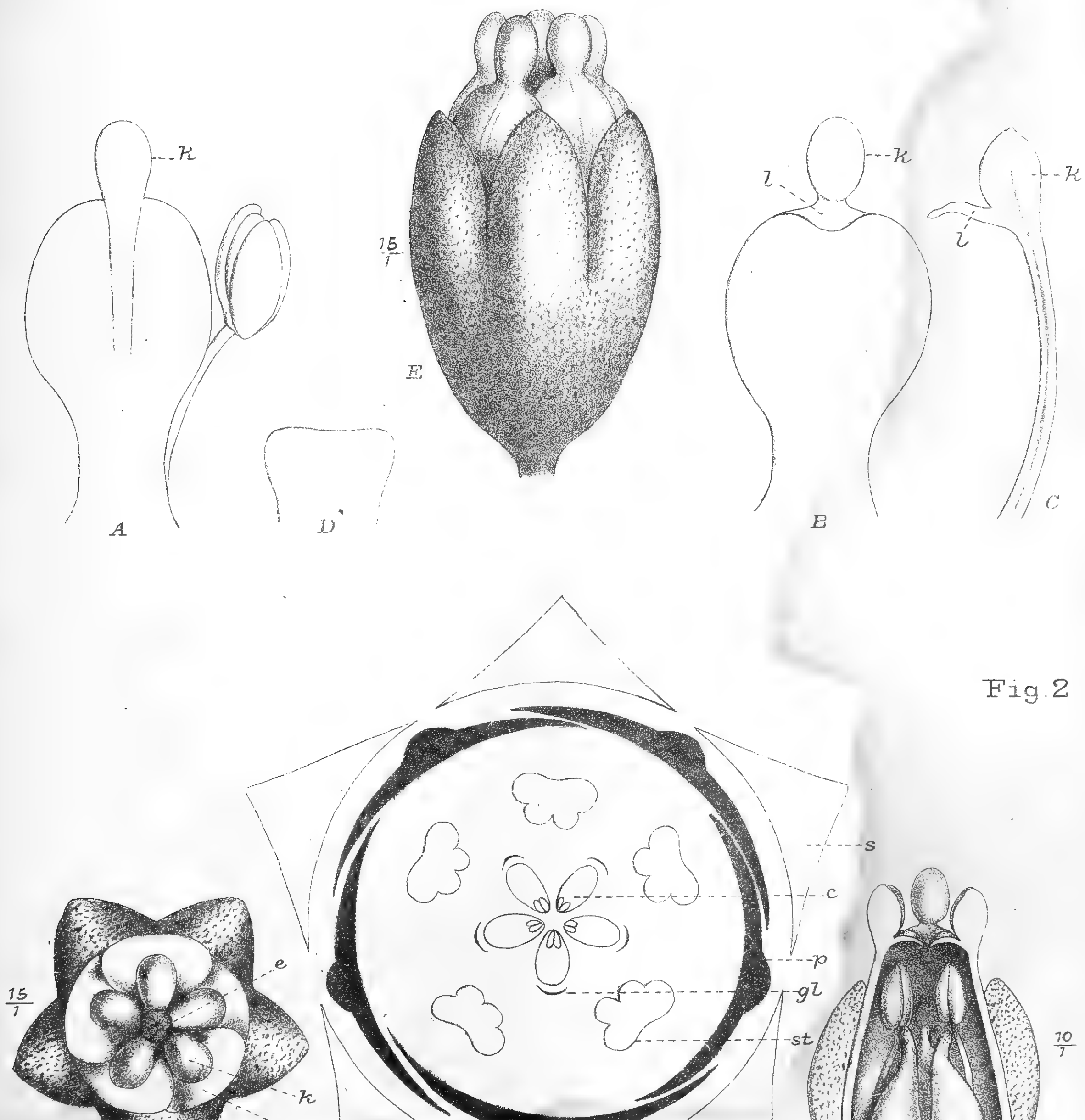


Fig. 2

S. Schönland del. West, Newman lith.

S. Schönland del.

West, Newman lith.

B. Column (magnified).

C. Petal (magnified).

D. Sepal (magnified).

FIG. 2.—*Crassula canescens*, Schult.

A. Outline of petal from the back with a stamen (magnified). k=epipetalous knob.

B. Outline of petal, front view (magnified). k=epipetalous knob, l=ligula.

C. Median longitudinal section of a petal (magnified).

D. Gland from the base of a carpel (magnified).

E. Flower (magnified).

F. Flower seen from above (magnified), e=entrance to the flower, k=an epipetalous knob, p=petal, s=sepal.

G. Flower with front portion removed (magnified), gl=nectar-gland at the base of a carpel.

H. Diagram of a flower, s=sepal, p=petal, st=stamen, c=carpel, gl=nectar-gland at the base of a carpel.

PLATE II.—

Mesembrianthemum angulatum, Thunb.

A. Ground plan of a flowering shoot, being a "dichasium mit wickeltendenz," I, II=flowers in which size, position, and order of appearance of the sepals are indicated. α, β, α', β' &c.=prophylls. The flowers on the sympodium are connected by an interrupted line. Flowers and leaves on the main sympodium are represented by thick black lines, those on the "free" branches are represented by thin double lines, those on accessory shoots by interrupted lines, σ=place in which the second sympodial axis of a "free" shoot is formed.

B. Very young flower (magnified), seen from above, S=one of the sepals which have been cut through, pr=one of the 5 primordia which give rise to the stamens and staminodes, g=protuberance on which the 5 carpels take their origin.

C. A flower in a subsequent stage showing the differentiation of the staminodes, st′, and stamens, st; these structures have not been all drawn.

D. Sketch of part of an inflorescence. Lettering and numbering the same as in A.

E. Sketch of a small portion of the inflorescence of *M. cordifolium*.

VARIATION OF LACAILLE 5861

By Alex. W. Roberts.

This star, the position of which is—

R.A. 14 h. 8 m. 10·2 s. (1875)
Dec. — 57° 16′ 12″

is a variable of an extremely rare type. Only one other star of the same nature of variations is known, namely, *U Pegasi* (Chandler 8598).

The peculiarity about these two stars is that their decreasing period is slightly shorter than the increasing period ; with all other variable stars the rise to maximum brightness is much more rapid than their fall to minimum. Both stars also vary in a remarkably short time, the period of L 5861, being 7 h. 16 m., and of *U Pegasi* 5 h. 22 m.

This is the shortest period known, and accordingly extreme rapid variation might be claimed as a second characteristic of this type. This may, however, be an accident, as the variation of some other short period variables falls not very far short of this, notably the southern variable, *S. Antliæ*, period 7 h. 56 m.

The slow rise to maximum is however so definite and unmistakeable a characteristic, that it must be taken as the main point of difference between these two stars and all the other short period variables, some 45 in number.

U Pegasi was discovered by Chandler, of Harvard, towards the close of last year ; L 5861 was discovered at Lovedale in April of this year. Since then it has been regularly observed, the number of observations made being considerably over 500.

The range of variation is very slight, only 0·4 magnitudes—an amount that to an untrained eye would be almost imperceptible.

As already said, the star goes through all its variations in seven hours and a quarter, passing in this time from its maximum brightness down to its minimum, and up again to its maximum. There is no halt at any stage, variation is constantly going on.

One naturally wonders as to the cause of such perplexing light variation. To any such inquiry unfortunately no definite answer can be given.

We can only assure ourselves of a series of negations.

1. *The light variation of L 5861 is not due to eclipse.*

If that were so there would be periods of rest, during which the light of the star would remain constant. But no such stationary periods have been observed.

2. *L 5861 cannot be a large star.*

If so the two possible theories of light variation, rotation and revolution, would not be tenable. The latter could not exist; two large bodies could not revolve round one another in six hours; the former would end in the disruption of the star.

3. *The light variation of L 5861 arises from some mechanical, not chemical source.*

The period of maxima and minima are of extreme regularity, and the limits or amplitude of variation is of a certain fixed latitude. With variables, where spectroscopic examination indicates chemical change synchronous with the light variations, regularity of period and of amplitude is wanting, as we might naturally expect.

No chemical changes through unstable combination of the constituents of the star's upper atmosphere could alternate with the precision of an observatory clock.

4. *The changes are not deep-seated.*

No body could, as a whole, alternate through extremes of light and shade in periods of six hours. The changes are consequently surface phenomena, probably tidal in their nature. An upper viscous shell covering a solid globe would, under tidal forces, generate by friction enough heat at high tide to cause the change of light observed on either L 5861 or U Pegasi.

The conditions of variation would be, in that case, two stars revolving round one other in close proximity in a period of twelve or fourteen hours. The mutual attractions of the two spheres would produce two giant tides in each star, which as they passed over the more solid nucleus underneath would generate heat, and so give rise to an increase of brightness.

An examination of the star's relative position might indicate a sensible parallax, and thus we might be able to compare its light with that of stars whose distance is known.

The whole subject of stellar variation is one of no common interest; and now that spectroscopic researches at Potsdam and Harvard have established a relationship between stellar variation and double stars, the interest is accentuated.

For the determination of the orbital movement of variable stars, the finest instruments, the most refined mechanism are required. For the determination of the light variation a good pair of eyes is all that is needed.

I have added this last sentence with the hope that some one in the Society may feel inclined to undertake work that now needs the full energies of half a dozen men to do it justice.

Six years ago the number of southern variables stood at:

Algol variables	0
Short period variables	4
Long period variables	10

These formed pleasant occupation for one man, and time enough and to spare to seek for more.

The numbers now are:

Algol variables	4
Short period variables	20
Long period variables	55

And when the results of that remarkable work the "Cape Durchmusterung" are published, these numbers will be largely increased.

There is thus need for more workers, and it is to be hoped that this appeal which I make on behalf of one of the most interesting sections of astronomical work will not go unanswered.

Addendum to note on New Variable in Centaurus.

I have just received a communication from Professor Pickering, Harvard, which has an important bearing on a conclusion come to in the paper on the new variable in Centaurus. I there state that I am loath to accept rapid variation as a characteristic of the new class of variables, as S. Antliæ varies in a period of 7 h. 47 m. Professor Pickering finds that S. Antliæ is of the same type as U Pegasi, and consequently of the same type as L 5861, the new variable star. His observations, which were made with the Harvard photometer, are very numerous, and apparently conclusive.

It is pleasant to find, instead of an anomaly, such complete agreement with what theory would lead one to expect; but of far more importance than this agreement is the outlook which these recent discoveries present. It needs little prevision to state that they cannot be exhaustive, but that instead, now that astronomers know what to look for, they are the first of a long series of such discoveries.

The three stars which belong to this type now are:

Star.	Period.	Variation.	Authority.
S. Antliæ	7 h. 47 m.	0·6 m.	Pickering
U Pegasi	5 h. 32 m.	0·6 m.	Chandler
L 5861	7 h. 16 m.	0·4 m.	Roberts

LATITUDE OF LOVEDALE.

By Alex. W. Roberts.

In the year 1889 a series of observations was made to determine the astronomical latitude of Lovedale, and although the present is somewhat remote from that at which the determination was made, the results may not be lacking in interest.

The stars chosen were:

α *Ceti*, *R.A.* 2 h. 56 m. 28·6 s. (1889)
Dec. + 3° 39′ 13·0″

and:

δ *Hydri*, *R.A.* 2 h. 19 m. 46·6 s. (1889)
Dec. − 69° 9′ 52·4″

These stars were extremely suitable for the purpose.

(1) They culminated, one north the other south, at nearly the same altitude, viz.:

α *Ceti*, 53° 34′
δ *Hydri*, 53° 37′

(2) They culminated also within half an hour of each other.

(3) Both stars are well-known standard stars.

The observations for latitude were taken with a sextant by the usual well-known method of circum-meridian altitudes, the corrections for first and second differences being rigorously applied.

The telescope of the sextant was a one-inch transit glass, specially fitted to the sextant for the operation. The light was reflected on to the vernier by a mirror from a bull's-eye lantern, care being taken to keep the light at the same angle of incidence. Indeed the lantern, reflector, and sextant were all rigidly fixed to a wooden stand, moving on altazimuth bearings that I had specially constructed for the purpose.

The observations, north and south, were made over the same portions of the sextant; thus the errors due to defective centering or unequal graduations mutually destroyed one another.

The times of meridian passage of both stars being less than half an hour, there was little chance of the instrumental adjustments altering seriously during the period covered by the observations, usually about an hour and a half.

There were seven determinations made, viz.:

Date.	No. of Observations. N.	S.	Resulting Lat.
1889. Nov. 16	11	17	— 32° 46′ 36·7″
19	10	18	37·5
23	8	10	31·9
25	7	18	31·4
26	9	11	31·5
27	8	11	37·5
28	8	6	34·0

The mean value of the latitude of Lovedale resulting from these observations is

$$— 32° 46′ 34·4″ \pm 1·9″$$

NOTES ON SOME EXPERIMENTS WITH THE ACTIVE PRINCIPLE OF MESEMBRIANTHEMUM TORTUOSUM, L.

By Isaac Meiring.

(Read September, 1896.)

This plant, which goes under the broad designation of "Hottentot's Kauwgoed," grows in the Karoo, the locality from which the supply under consideration was obtained being Fortuin, near Matjesfontein. Like many other Cape plants, it has great medicinal virtues ascribed to it, chief of which are its soporific influence on young children and its curative and quieting effect on them when suffering from acidity. It is alleged that for these purposes the plant is very widely used, the method of procedure being that one or two drops of the juice of the green plant is given to the child, who then enjoys a deep, quiet rest for several hours. This assured effect I ascribed to the alkaline nature of the juice, which is so great that it is said to be used for washing clothes when soap is not obtainable.*

In November, 1889, I procured a small supply of the plant, and which Professor McOwan kindly identified for me botanically, for the purpose of making an examination of it, and I found it to contain an alkaloidal principle which, when injected into a frog, soon produced a marked hypnotic effect. These experiments were then allowed to drop for several years, but since then some clinical experiments with a tincture of the dried plant proved that it had decided anodyne properties without concomitant bad effects. I have thought it might be interesting to bring this plant more prominently forward.

The method of isolating the Active Principle, after some preliminary experimenting, was as follows:

A strong decoction of the dried plant was made in water. After filtration this was concentrated to a convenient bulk, and acetate of lead was added to precipitate the tannin and other vegetable acids

* Since writing the above my attention has been drawn to the following:

"This species (*Mesembr. tort.*, L.), a native of the Karoo, appears to possess narcotic properties. The Hottentots, who know it by the name of 'Kauwgoed, are in the habit of chewing it, and become intoxicated, while the farmers use it in the form of a decoction or tincture as a good sedative" (Pappe. Flor. Cap. Med. Prodromus, 1868).

and inert organic matter. A voluminous precipitation took place. This was filtered off, and to the filtrate was added solution of subacetate of lead, when a further precipitation took place. It was again filtered. The precipitates so obtained were not examined further. The filtrate was rendered alkaline by the addition of liquid ammonia, when a third precipitate fell. This precipitate was preserved for later examination. The lead was removed from the filtrate by means of sulphuretted hydrogen. The liquid was then concentrated over a water-bath to a small quantity, rendered acid by the addition of dilute sulphuric acid, and Mayer's solution ($HgI_2 + 6KI$) was added until no further precipitation took place.

The precipitate was allowed to settle, and was washed with water. After suspending it in a little water, sulphuretted hydrogen was passed through it to precipitate the mercury, which was separated by filtration; the filtrate was rendered alkaline and shaken together with chloroform (3) and ether (1) in a suitable separator (ether alone from previous experiments not being considered a good solvent of the alkaloid). The chloroform solution containing the alkaloid, after separation, was removed and spontaneously evaporated to dryness in a capsule.

No crystals were visible in the residue, which was next dissolved in water with the addition of a drop of dilute sulphuric acid. A few drops of this solution were evaporated on a microscopic slide, when the sulphate of the alkaloid crystallised out.

The solution gave the following reactions:

With fixed Alkalies	No ppt.
With Picric Acid	Yellow Amorph. ppt.
With Tannic Acid	Ppt. sol. in H_2SO_4 insol. in Ammon.
With Phosphomolybdic Acid	Yellow Amorph. ppt.
Wagner's Sol. (KI + I)	Brown ppt.
With Dragendorf's Sol. (KI + Bi) ...	Ppt. sol. in H_2SO_4 insol. in Ammon.
With Mayer's Sol. ($HgI_2 + 6KI$) ...	Dense ppt.
With Merc. Perchl.	Cloudiness
With Gold Chloride	Cloudiness

These reactions indicate the principle to be an alkaloid.

The precipitate obtained after treatment with lead and ammonia was examined, but it was found to contain a trace only of possibly the same alkaloid.

To test the alkaloid physiologically one or two drops of its solution were injected under the skin of a frog. Within a few minutes an apparent effect is noticeable, such as hurried breathing, uneasiness, and a marked moistness of the skin. In about ten to twenty minutes' breathing only takes place at long intervals, and when the frog is placed on its back it cannot right itself. Reflex action seems to be marked and consciousness to be retained. After an interval of from four to eight hours entire recovery takes place, although in some cases they have died. This is an average case of a good many experiments. The effect on frogs seems so peculiar that it could almost be considered a test for the drug. On guineapigs the effect is slight even in doses ten times as much as for a frog, uneasiness and refusal of food being the only apparent effect. In two cases of experiment the one guineapig died twenty-four hours afterwards, the other one recovering altogether in that time.

In conclusion I wish to say that in 1894 I mentioned the above results, and gave a small quantity (all I had) of the plant to Dr. Rubenstein, then on his way to Germany. He writes to say that Dr. Fromm, in Freiburg, had found it to contain a chemical body capable of being crystallised (alkaloid or glucoside?), which, contrary to his (Dr. Rubenstein's) expectations, does not resemble curara, but rather morphine, but through want of material further research was impossible.

Although these notes do not pretend to be an exhaustive examination of the constituents of the plant, nor of the alkaloid itself, and this must be left to others better able to do so, still, should they have incited interest in original research in this direction, my object would have been attained.

September, 1896.

TRANSACTIONS

OF THE

SOUTH AFRICAN PHILOSOPHICAL SOCIETY.

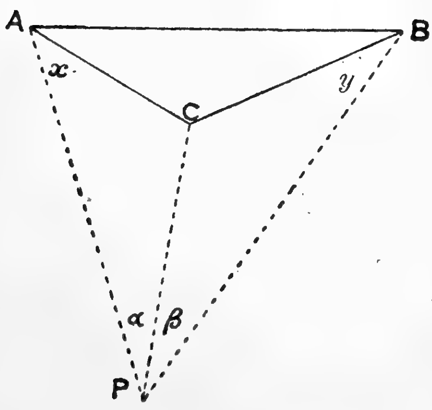
NOTE ON THE THREE-POINT, OR POTHENOT'S, PROBLEM.

By H. G. Fourcade.

(Read January 27, 1897.)

The ordinary methods of computation of the position of a point, given the angles subtended by three other points of known positions are chiefly :—

First method.



1. Compute the length and "angle of direction" of α from the co-ordinates of C and A.

2. Compute the length and angle of direction of β from C and B.

3. Put $PAC=x$, $PBC=y$. Then $\tan \frac{1}{2}(x-y)=\tan(z-45^\circ)\tan\frac{1}{2}(x+y)$ Where

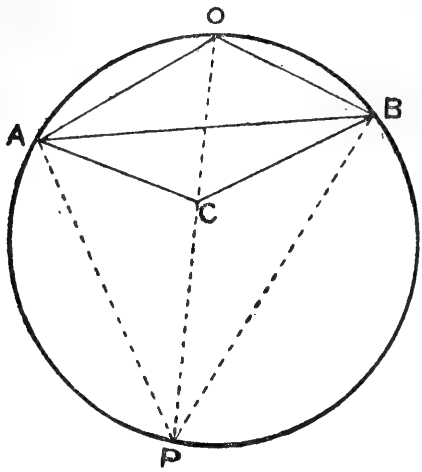
$$\tan z=\frac{a \sin \beta}{b \sin \alpha}$$

and

$$\frac{1}{2}(x+y)=180^\circ-\frac{1}{2}(\alpha+\beta+C).$$

4. Compute the co-ordinates of P either from triangle P C A or triangle P B C.

Second method.



1. Compute the length and angle of direction of C from the co-ordinates of A and B.

2. Compute the co-ordinates of O from the triangle O A B in which O A B $=\beta$ and O B A $=\alpha$.

3. Compute the angle of direction of O C from the co-ordinates of O and C.

4. Compute the co-ordinates of P either from triangle P O A or P B O.

Both these methods are avoided by many surveyors on account of their length. A shorter method will now be given, with a numerical example showing the arrangement of the computation.

Taking the middle point C for origin, put x' y' and x'' y'' for the co-ordinates of A and B. The equations to the circles (1) through A and C and containing the angle α (2) through C and B and containing the angle β are

$$\tan \alpha \left\{ y\,(y-y')+x\,(x-x') \right\} - xy' + yx' = 0$$
$$\tan \beta \left\{ y\,(y-y'')+x\,(x-x'') \right\} - yx'' + xy'' = 0$$

reducible to

$$y^2+x^2+Ay-Bx=0$$
$$y^2+x^2-Cy+Dx=0$$

Where

$$A=x' \cot \alpha - y' \quad B=y' \cot \alpha + x'$$
$$C=x'' \cot \beta + y'' \quad D=y'' \cot \beta - x''$$

Then

$$\frac{y}{x}=\frac{B+D}{A+C}=m$$

$$m^2x+x=B-mA$$

$$x=\frac{B-mA}{m^2+1} \quad y=mx$$

Example.

A	−1811·59	−1018·55	$y' = -1376{\cdot}55$	$x' = +406{\cdot}90$
B	+ 6·81	−930·26	$y'' = +441{\cdot}85$	$x'' = +495{\cdot}19$
C	− 435·04	−1425·45	0·00	0·00

$\alpha = 64{\cdot}7{\cdot}40$

$\beta = 20{\cdot}33{\cdot}20$

+9·685719	+9·685719	+0·425980	+0·425980
+2·609488	−3·138792	+2·694772	+2·645275
+2·295207	−2·824511	+3·120752	+3·071255
+197·34	−667·59	+1320·54	+1178·30
$-y'$ +1376·55	$+x'$ +406·90	$+y''$ +441·85	$-x''$ −495·19
A +1573·89	B −260·69	C +1762·39	D +683·11
A +3·196974	−2·662730	A +1573·89	B −260·69
m 9·102482	0·006906	+3336·28	+422·42
+2·299456	x −2·655824	2·625744	m 9·102482
$-m$A −199·28	9 102482	3·523262	m^2 8·204964
+B −260·69	y −1·758306	m^2+1	=1·01603
−459·97		y −57·32	x −452·71
		−435·04	−1425·45
	Co-ordinates of P :	−492·36	−1878·16

A check is afforded by the computation of the angles of direction P A and P B. P C is given by

$$\tan^{-1} m.$$

March, 1898.

AN INQUIRY INTO THE ORIGIN OF THE MUD RUSHES IN THE DE BEER'S MINE, KIMBERLEY; COVERING THE PERIOD JANUARY 1, 1894, TO DECEMBER 31, 1896.

By J. R. Sutton, B.A.

(Read March 31, 1897.)

To the ordinary risks to life and limb, from blasting, from skip and trolley accidents, from sudden and unexpected falls of ground, to which all mines are more or less liable, the De Beer's Diamond Mine at Kimberley has of late added the almost unique and unenviable distinction of mud rushes. It would scarcely be possible to convey, by a mere description, any idea of the appalling aspect in which death presents itself when the mud breaks loose. The tunnels and chambers near its point of exit are filled up almost at once; all the candles are extinguished by the rush of air, and in the black darkness men run for their lives. Behind them the mighty torrent tosses great boulders before it as though they were corks, and tears from their places timbers that took perhaps four or five men to lift into place. A person caught in the full flood of the rush will most likely be torn limb from limb. Those overtaken when its force is abating are perhaps only suffocated. Some who stand no chance of reaching the main tunnels in time to escape, perhaps rush, as a forlorn hope, into this or that blind offset. Here the mud may be dammed up by the compressed air, and if the relief party can clear the mud away in time they may be saved alive. In the interval—which may be a day or a week, according to the amount of mud—without food or light, the imprisonment is worse than death. Two out of three natives who were overtaken by a great rush of mud on May 26, 1896, were saved alive in this way after a confinement of 100 hours; but it is not to be wondered at that neither was quite sane when rescued.

The composition of the mud varies considerably. It may be scarcely more viscous than dirty water, or it may be as stiff as the cement used by masons, with, of course, any intermediate stage. Generally speaking, when the mud is thin the rush is not of great dimensions, and in many cases, possibly, only happens because a pocket of water near the casing of the mine has been cut into by the mining operations. The great rushes, on the other hand, are more often of thicker mud mixed up with large and small lumps of "blue ground" and "reef." On more than one occasion 1,000 linear feet of tunnel have been packed full in a very few moments with mud of this description, and it is this which so frightfully mangles the unfortunate body overtaken by its onset. The blue prints annexed show fairly well the area attacked by a typical mud rush; though not by any means the largest, they represent the last three of any noteworthy magnitude. Figs. 1 and 2 depict the circumstances of the double rush of September 9, 1896, on the 920 and 960 foot levels, causing the deaths of three natives; Fig. 3 depicts the rush of October 17, 1896, on the 1,000 foot level, in which six natives lost their lives; Fig. 4 represents the rush of November 12, 1896, on the 960 foot level, which was not attended with any fatality.* On Fig. 4 will be seen a cross tunnel which the mud failed to penetrate, though each end was blocked. On all these pictures the close lines drawn diagonally across the direction of the tunnels indicate the portion of the mine from which the diamondiferous rock was being excavated on that particular level when the rush of mud took place. The red line on Fig. 1 marks the junction of the blue ground and boundary rock. It occupies the same approximate position on all the levels.

The origin of the water in the mud is not very clearly understood. The belief has been general that it is directly due to the rainfall, and further, that a heavy rainfall is always followed after an interval of eight days by a mud rush. So much has this idea prevailed that any further attempt to get to the root of the matter has been deemed superfluous. It has even been said that a rainfall record is as good as a dated list of mud rushes. Now since none of the deep levels in the mine are free from the danger, and lives are certain to be lost so long as a firm grasp is not obtained of the physical agencies involved, it became very necessary to place this fact, if fact it should prove to be, on a sure footing. Accordingly a list of the dates on which mud rushes had taken place was compared with the rainfall of Kenilworth, the rain-gauge being about two miles in a direct line N.E. of the mine. It soon became apparent that, far from the mud rushes following hard upon the rain, a season of drought was, on the contrary, if anything, distinctly the more dangerous.

Table 1 gives the monthly rainfall for the three years; Table 2 the number of mud rushes in each month.

* According to the official returns the total number of deaths caused by mud rushes in the De Beer's Mine in the three years 1894–1896 is forty-five.

TABLE 1.—KENILWORTH RAINFALL.*

	1894	1895	1896	3 years
January	7·29 in.	·93 in.	1·48 in.	9·70 in.
February	5·35	3·53	·98	9·86
March	2·32	1·94	2·74	7·00
April	1·57	3·46	2·98	8·01
May	·93	1·30	2·25	4·48
June	·06	·00	·56	·62
July	—	·21	—	·21
August	·28	·00	·43	·71
September	·27	·02	·00	·29
October	·67	·08	·25	1·00
November	3·25	1·79	·98	6·02
December	2·52	2·34	8·42	13·28
Year	24·51 in.	15·60 in.	21·07 in.	61·18 in.

TABLE 2.—MUD RUSHES.

	1894	1895	1896	3 years
January	—	—	2	2
February	1	1	1	3
March	2	1	2	5
April	4	—	1	5
May	2	—	2	4
June	3	2	1	6
July	2	—	1	3
August	3	2	2	7
September	1	—	3	4
October	3	—	1	4
November	1	—	1	2
December	1	4	2	7
Year	23	10	19	52

Of the thirty-six months dealt with in these two tables, nineteen have a rainfall under one inch, and seventeen of upwards of one inch. In the former months there were twenty-nine mud rushes, and in the latter twenty-three. Or again, taking the totals in the three years of the six dry months (May to October), and the totals in the six wet months (November to April), in the former there were twenty-eight mud rushes and in the latter twenty-four.

* The Kimberley rainfall will not be quite the same. So far as this matter is concerned, however, the differences are unimportant.

While the rainfall theory has little support from these statistics, its insufficiency is quite demonstrated when the actual rainfall and mud-rush dates are put side by side. During the whole three years there were twenty-six instances of wet weather in which the rain exceeded ·5 inch per day. Six of these were followed within eight days by a mud rush, and twenty were not. It is to be noted, moreover, that this ratio is obtained after favouring the rainfall theory to the utmost; for example, if the mud should come within nine or ten days after the rain, or if the rain should not quite total ·5 inch, it is still counted in its favour. Again taking the date of each mud rush and putting it into one column or another, according as it was or was not preceded by a rainfall of not less than ·5 inch, we get nine instances in favour of the theory and forty-three against it; and this also after favouring the theory in every reasonable way. It may further be added that the heaviest rainfall of the whole period, *i.e.*, nearly $4\frac{1}{2}$ inches in the twenty-four hours ending 8 p.m. December 30, 1896 (of which nearly 3 inches fell in two hours) has not been followed by a mud rush.

But, it may be objected, is it not still possible that a mud rush is due directly to a heavy downpour of rain, even though nothing of the sort takes place within any specified period of time? Might not the water lie dormant until its chance came? To understand quite clearly all that can be said in favour of this argument necessitates an acquaintance with the rudiments of diamond-mining. But for the purpose in hand Fig. 5, representing a section of the mine through the main shaft, may prove sufficient—in essentials at any rate. The De Beer's Mine (like every true diamond mine) consists of a pipe, roughly circular in plan, extending for some unknown distance vertically downwards into the earth. At first it was excavated at the top, the whole of the diamond-bearing ground being taken right away, until such a depth was reached that the sides threatened to collapse upon the quarrymen. Then underground working was resorted to, so that what had hitherto been "diggings" became a mine.

As the ground from these underground workings is removed that from above eventually falls in, and hence it is necessary to start fresh levels in succession at greater depths in advance of the continuous crushing process. In the long run, for every load removed from below, an equal amount must settle down from above, and thus the depth of the old open quarry would go on continually increasing were it not that the boundary rock, commonly called "reef," is concurrently breaking away from the sides and falling into the hole. There is no doubt that the grinding of the different particles of this *débris* upon one another as they sink deeper and deeper must produce thousands of tons of fine material pre-eminently adapted for the formation of mud. Furthermore a heavy shower of rain will deposit thousands of tons of water in the great receiving funnel of the open mine. We have then what at first sight might appear to be all that is necessary to make the mud: plenty of *débris*, and a vast receiving surface for the water.

A very little consideration, however, will be sufficient to convince one that nothing short of a deluge could possibly convert the available materials into a viscous state. No sluits are allowed to discharge into the open mine, so that the precipitation is pretty equally distributed over the whole surface. What certainly happens then, is this: the rain percolates into the *débris* as it descends, and is absorbed by the top layers until they are saturated; and no layer below can take up any of the rain directly until the layers above can hold no more. In all probability six feet of *débris* could absorb quite that number of inches of rain. Afterwards the lower layers will absorb the moisture from the upper layers, by a simple drying-out process; but of course this process is the inverse of that required to produce mud. The rain having ceased, evaporation begins, the upper layers are dried up, and, in their turn, dry out the lower layers. It seems, then, that while there is nothing in the rainfall record to support the rainfall theory, neither is there any antecedent probability that rain could penetrate anything like a thousand feet of *débris* save in inappreciable quantities. This deduction may be further enforced by a little arithmetic. I have said that mud rushes filling up more than a thousand linear feet of tunnel are not unknown.* Combining this length with the average sectional area of the tunnels, say nearly 100 square feet, and remembering too that sundry large chutes and offsets are also filled up at the same time, we have, for a large rush, a cubic content of quite one hundred thousand feet, without taking account of what mud may be still left in the place from whence it came. Assuming that one-half is water, it follows that at least fifty thousand cubic feet of water have to be accounted for. Now the contour of the open mine is roughly twelve hundred feet in length by eleven hundred in breadth, or say a superficial area of about a million square feet. An inch of rain falling into the open mine would only represent eighty thousand cubic feet of water, whereas it is quite plain that at least this quantity would have to collect into one pocket, where every particle of it could act upon every other particle, before 50,000 cubic feet of

* A mud rush some years ago in the Kimberley Mine is said to have filled 3,000 linear feet of tunnel.

it could be forced at one swoop into the mine. Again, in the three years dealt with by this paper, sixty-one inches of rain fell (representing a volume of about five million cubic feet over the mine area), into the open mine. Of this the greater portion would be evaporated again almost immediately, particularly that falling in small showers. Then again the top *débris* could absorb an enormous quantity without being more than damped by the moisture. It would be hard to show a probability that anything like a million cubic feet of the five millions could eventually collect in dangerous quantities into pockets in the vicinity of the deep working levels. And yet there were fifty-three mud rushes in the same time, averaging perhaps ten thousand to twenty thousand cubic feet each in volume.

Since the rainfall over the open mine is manifestly inadequate to the task with which it has been burdened, the solid fact remains that the water which makes the *débris* formidable must flow into the mine from the sides. Now in sinking shafts and driving tunnels in the solid rock outside the mine various feeders of water have been struck, many of them quite sufficient for all the requirements of mud rushes. In the rock tunnel, for example, on the 1,200 foot level of the Kimberley Mine, is a feeder of water yielding perhaps five thousand gallons per hour. On the 1,520 foot level of the same mine is another (belonging doubtless to the same water system), not so large, but still important. Physical observations upon these during the last two years reveal little, if any, changes of temperature day after day. Their flow is constant whether the season be wet or dry. Their temperatures agree pretty closely with Lord Kelvin's theoretical estimate of increase according to depth within the interior of the earth. In short, they are unaffected by current meteorological conditions. These, then, indicate the water factor of a mud rush. An underground spring with a flow of only one hundred gallons per hour would, since it would penetrate the *débris* at one spot, soon supply enough water for the greatest of mud rushes, without any assistance from the local rainfall. The two large springs in the Kimberley Mine, just referred to, and indeed the largest springs in either that or the De Beer's Mine, are in the quartzite. And here it may not be out of place to mention that although the supply of top *débris* has always been ample, mud rushes never occurred until the level of the quartzite was reached.

Without recognising the rainfall, then, we have at hand abundant materials out of which the most highly finished mud rush may be constructed. But to the miners, white and black, it is perhaps cold comfort that the potentials of a horrible death instead of seeming to exist only after a heavy rain, are always hovering near, and that at any time the death-dealing mud may burst upon them from some unexpected quarter. It is consequently doubtful if they could be induced to limit their faith in the maleficence of the rain. The human mind intuitively seeks reasons, and is generally satisfied with the most convenient—specious or otherwise. Thus the "changes" of the moon still account satisfactorily for "changes" of the weather to the majority, because, although the relation seldom works out in practice, meteorologists have not yet been able to devise a simple and more convenient substitute. But whereas the numerous false doctrines of this type are of no consequence one way or the other, the same indifference is not to be encouraged towards what will be a standing menace to diamond producers until Moissan's laboratory supplants the mine. It is imperative, therefore, to ascertain whether any controllable agencies conspire to drive out the mud, or whether it rushes forth of its own accord so soon as a sufficient quantity has gathered together.

At the outset of this branch of the inquiry there was some difficulty, inasmuch as the mud-rush records were not of a scientific closeness of description. In fact, it is not to be expected that they should be. The primary intention of an overman's report to the mine manager is whether a given quantity of work has been done, and, if not, why not; for more than that the manager can satisfy himself by personal inspection. Thus many mud rushes, whose whole history and description would have been of the greatest value, are dismissed in a very few words: *e.g.*, "March 20th, 2nd Shift. Mud out into Main Drift. One set of timber out. Same level, south side No. 10, mud out to Main Tunnel"; "3/8/94 2nd Shift. Mud rush on 840, James & Co., in which four boys are caught and are undoubtedly dead, the mud being so fine, also a mud rush on 880 in same quarter immediately underneath closing 5 filling places"; and so on. Then again there was sometimes a doubt whether such a time as, say, "Feb. 20th, 3rd Shift," always referred to the shift beginning at 11 p.m. on the 20th, or to that ending at 7 a.m. on the 20th.* Nor was it always possible to determine from the wording of the reports whether a mud rush was of large or small dimensions. Still, for a preliminary inquiry such as this, it is not very likely that more precise terminology would have been of much greater utility.

* The mine is worked in "shifts" of eight hours each; the first shift begins at 7 a.m. and ends at 3 p.m.; the second begins at 3 p.m. and ends at 11 p.m.; the third begins at 11 p.m. and ends at 7 a.m.

Now, given a sufficient quantity of mud in the vicinity of the underground workings, what possible influences, over and above its own weight, could be conceived as likely to set it in motion? I can only think of three:—

1. Landslips due to undermining;
2. Earth tremors;
3. Changes of atmospheric pressure.

The first is not a matter that admits of scientific discussion. In the whole of South Africa there are, unfortunately, no instruments which would have enabled one to deal with the second; we are therefore restricted to the third.

In order to consider the matter as judicially as possible, I have thought it best to plot the barometer curve, from observations taken at 8 a.m., 2 p.m., and 8 p.m., daily, for the whole thirty-six months, irrespective of whether a mud rush occurred in any assigned month or not. The curve is a very open one—twenty inches of paper to one of mercury*—with the idea of accentuating the differences of pressure. On the day, and as near the time as could be ascertained, that a mud rush took place, *m* or *M* is written under the curve, a small letter or a capital being used according as the account seemed to warrant a small or large rush respectively. *W* indicates a rush of water. The arrow-heads attached to most of the letters indicate roughly from which end of the working area the mud came. The attached numbers show the depth of the level upon which the mud started. The vertical lines at the base of the diagram represent the rainfall—an inch of paper to an inch of rain. The horizontal lines through the barometer curve show the mean pressure of the month. The dots indicate the maximum shade temperatures of the day. It is important to remember that the mean of the pressures at 8 a.m., 2 p.m., and 8 p.m., is almost identical with the mean of the hourly values, and also that in general the maximum and minimum pressures will be higher and lower respectively than the crests and depressions of the curve.

A study of these curves leaves, I think, no room for doubt that changes of atmospheric pressure are the most potent of all extraneous causes tending to drive out the mud. Only a few mud rushes take place under a steady barometer, nearly all while the changes of pressure are rapid and the gradients steep. The greater number occur during the passage of a depression, and herein, though the analogy might be unduly pressed, remind one of the meteorological characteristics of choke-damp. Of the whole fifty-two mud rushes, twenty-five took place when the barometer was below the

* These dimensions have been considerably reduced in printing.

mean pressure of the month, thirteen when the pressure was distinctly above the mean, the other fourteen at about the mean. Many of the thirteen which took place when the barometer was relatively high were still under a depression. If we divide the mud rushes into two sets, large and small, we get the following result:—

TABLE 3.—DISTRIBUTION OF MUD RUSHES ON THE BAROMETRIC GRADIENT.

	Large Rushes.	Small Rushes.	Total Rushes.
On a downward slope	6	8	14
In the pit of a depression ...	8	4	12
On an upward slope............	8	1	9
Under a crest	4	4	8
Under a steady pressure	3	4	7
Uncertain	1	1	2
Total	30	22	52

At the same time some of those which are classed as under a steady pressure may yet have been subjected to great and sudden barometric changes, unobserved because of the great intervals separating the consecutive observations. This is a matter which could only be settled by a continuous barometric record, and, unfortunately, the photo-barograph of the station under my charge has not been running long enough to do so in every case. Certainly on April 30, 1896, although the barometer stood nearly at its normal levels at the standard observing hours, yet in between those times the changes were very great. On one other day, by a piece of bad luck, it happened that the photograph was spoiled by a temporary failure of the clock. I should not feel inclined, though, to put much faith in the statistics of Table 3, because much would depend on one's notion of the weight to be given to the descriptive terms, wherefore others adopting the same method might get somewhat different values in each class. It is safer to form a judgment upon the actual curves.

What seems to be a most significant fact is revealed by an analysis of the hourly distribution of these rushes: Fifty-one per cent. have taken place during the second shift, *i.e.*, between 3 p.m. and 11 p.m., twenty-seven per cent. between 7 a.m. and 3 p.m., and the remaining twenty-two per cent. between 11 p.m. and 7 a.m. In other words, the greater proportion come in the shift during which the barometer stands at the lowest point of its diurnal range. The diurnal range of temperature may possibly contribute something to this result, even as it seems, at times, to have modified the action of a barometric depression.

There are some indications of a lagging, on the part of the mud rushes, behind the changes of pressure, greater for large rushes than for small. This same lagging, if it certainly exist, could produce a rush of mud (which may have been started by a deep, but narrow, depression) right under, or even following upon the next advancing crest. The temperatures are apparently responsible for this anomaly. [See the mud rushes of April, 1894.]

Since we are unable to locate the spot where the mud is forming, it is difficult to formulate a statement which shall define the precise effect of atmospheric pressure upon it. The *débris* is clearly not pervious to the air, because, if it were, the mud would flow out in an almost uniform stream as fast as it could be formed. The only effect of a depression would be to quicken the flow, and of a crest to slacken it.

An explanation which seems to meet some of the difficulties is this: Suppose a stream of water to be percolating through the boundary rock into the *débris*. If there should be no outlet beneath, this would go on until the whole mass of *débris*, up to a certain level depending on its capillary attraction, would be quite saturated. But if the mass of wet *débris* be in communication, on its under side, with the atmosphere, will it run out? Not unless the algebraic sum of the forces within the mass downwards is greater than the pressure of the atmosphere against it, upwards. It is conceivable that when the head of mud is great the mud may burst its bounds irrespective of the state of the barometer.* But when the head of mud is not great—and apparently this is so in most cases—the normal *spring* of the air (Boyle's term is convenient) will detain the mud in a state of equilibrium. The power of the air to support a limited head of fluid is of course quite familiar to any one acquainted with the structure of a mercurial barometer. Should the analogy not be obvious the following simple experiment, if carefully performed, will perhaps make it so. Take a rough iron pot open only at the top, pack it with earth, and add water until it can absorb no more. Shake it well and stand it to settle. Drain off any water lying on the top, and then invert the pot. In general the mud will remain in the pot. If now a small hole be gently pierced through the bottom of the pot so as to admit

* One would infer that if the head of mud were alone responsible, the mud below would be simply squeezed out by the excess above until the equilibrium was restored.

the air, a lot of the mud will instantly burst out of the mouth of the pot.

Suppose now a given mass of mine *débris* to be saturated, and to be held in equilibrium by the atmosphere at mean pressure. The effect of an increase of pressure would be simply to check the percolation of water from the rock. On the other hand, a decrease of pressure by diminishing the conservative forces, would tend to set free the mud. The barometer curves do, I think, support this view.

That every depression is not accompanied by a rush of mud may be due either to a lack of mud for the time being, or to something blocking the exit, or to the fact that, in a well-ventilated mine, with upcast and downcast shafts, a surface barometric depression may not necessarily indicate a decrease of pressure in the working places. Let us consider how the surface temperatures might be expected to act. Though the data are not yet sufficient for a rigid mathematical analysis, their general tendency will be, perhaps, obvious enough. So long as the surface air is warmer than the air in the working places, there will be, as a rule, equilibrium in the shafts and tunnels; but immediately the temperature of the surface air falls below that of the working places the equilibrium will be disturbed. The warm air from below will rise in the upcast shaft, and the colder surface air will flow down the downcast shaft (in the present instance the Rock Shaft) to take its place. As a consequence a current of air will be created, its strength varying in proportion to the difference of temperatures. The downcast current of cold air will be warmed as it descends, chiefly by conduction from the heated chambers, and hence it will not in general penetrate directly into the offsets and working places. On the contrary it will flow rapidly past their entrances along such tunnels as permit of its free ingress and egress. The important point to be borne in mind, however, is that the flow of the current past the offsets and working places will lower the pressures within them by suction—an operation the principle of which has been utilised in the anemometers of Dines and Hagemann.* There are not any data upon which one could base even a guess as to the amount of diminution of pressure such a process could be expected to produce. At some future time I hope to be able to take systematic observations of the air currents in the Kimberley Mines, and this part of the question may then, it may be, receive some sort of solution. Meanwhile it seems clear that the general tendency of the temperatures is to modify the pressures:

* These anemometers, however, project into the air; the mouths of the working places are more often than not flush with the tunnels.

counteracting, to a certain extent, the maximum effect of the normal decrease of pressure during the afternoon, and assisting or impeding atmospheric depressions. A low temperature and a shallow depression might even reduce the pressures underground quite as much as a deeper depression with a normal temperature. Moreover, since it frequently happens that after a deep depression the temperature gradient may be falling as rapidly as the pressure gradient is rising, so it may happen that the maximum effect underground may not be felt until some time after the passage of the centre of the depression. I am not saying that it is so, but that the curves give colour to the idea.*

The Kimberley Mine some time ago suffered with mud rushes quite as dangerous as those now troubling the De Beer's Mine. I have not been able to ascertain whether they also were sensitive to atmospheric changes, for the simple reason that the last took place shortly after my barometer record began. An attempt was made by the management of the mines to cope with the Kimberley mud, by driving a tunnel right round the mine near the junction of the black shale and melaphyre (some 700 feet above the working places), with the idea of catching the "surface water" which flowed into the *débris* at that spot. Curiously enough there have been very few, if any, mud rushes in the Kimberley Mine since this tunnel was made. And it is therefore intended to make a tunnel at the same depth round the De Beer's Mine. But it is to be noted that the 1,000 foot level in the Kimberley Mine was well advanced, and the 1,200 foot level opened, at the same time as the water tunnel was made, and that both these levels tapped a quantity of water which, in all probability, came straight from the quartzite. This by being led away to the pumps could do nothing towards mud-making. If the water above the melaphyre is responsible for the mud, there is no apparent reason why mud rushes should not have taken place above the quartzite level—which they did not. By one of those remarkable coincidences, which *will* happen, after a systematic attack had been made on the "surface water" in the De Beer's Mine sometime during 1895, the number of mud rushes fell off considerably. And the General Manager's report to the annual meeting of shareholders

* It would be hazardous, at this early stage, to assert that the changes of pressure act directly in bringing about a mud rush. The whole diminution of power when surface pressure and temperature fall together would not at any time be more than one-fiftieth of that keeping the mud in equilibrium. It is quite possible that the pressure changes may act in some indirect way. Thus, for example, to take a simple illustration, an engine driver is powerless of himself to move his engine a single inch, but he can easily set free forces that will move it miles.

towards the end of that year contained this statement: "*Mud Rushes:* These have been much less frequent than during the previous year, owing to the surface water having been taken up. For many months no mud rushes of a serious nature have occurred." Nevertheless it will show how little effect this high-level water produces, that in the month of December, 1895, there was more mud than ever before, or since, and in the following year (1896) there was almost as much as in 1894 before the high-level water was interfered with.

It may be expected that the tunnel which is to be driven round the rock, on the 1,000 foot level, between the blue ground and quartzite, will give better results, and capture a lot of water that is really dangerous. Yet it is doubtful at the best if anything but a temporary security can be gained thus. Deeper levels are certain to reintroduce the elements of mischief. Personally I am inclined to think that variations of current meteorological conditions ought not to be neglected at any time. I have recommended to the directors of the De Beer's Company the free use of recording aneroid barometers indicating on a very open scale, and these instruments may shortly be provided. I have further ventured to suggest that if traffic in the dangerous places could be stopped for about a minute (so as to eliminate artificial eddies in the air) three times a day, and observations taken of the behaviour of two candle-flames, one near the roof and the other near the floor of the tunnels, it might be possible to foretell a rush of mud. The Society will judge of the chances of success. The idea is that, as a rule, the heated air from the drilling and filling places should rise and flow out under the roof of the tunnel, cold air flowing in along the floor to take its place. The candle-flames ought therefore to be deflected accordingly. But should a volume of mud be advancing from its place within the bowels of the *débris*, the imprisoned air lying between it and the miners being pushed rapidly on before, might be expected to deflect both candle-flames outward. The wet and dry bulb thermometers might also furnish some useful additional data. Of course if any information could be gleaned in this manner, a very rapid judgment would be essential as to the proximity of the danger.

Fig.1.

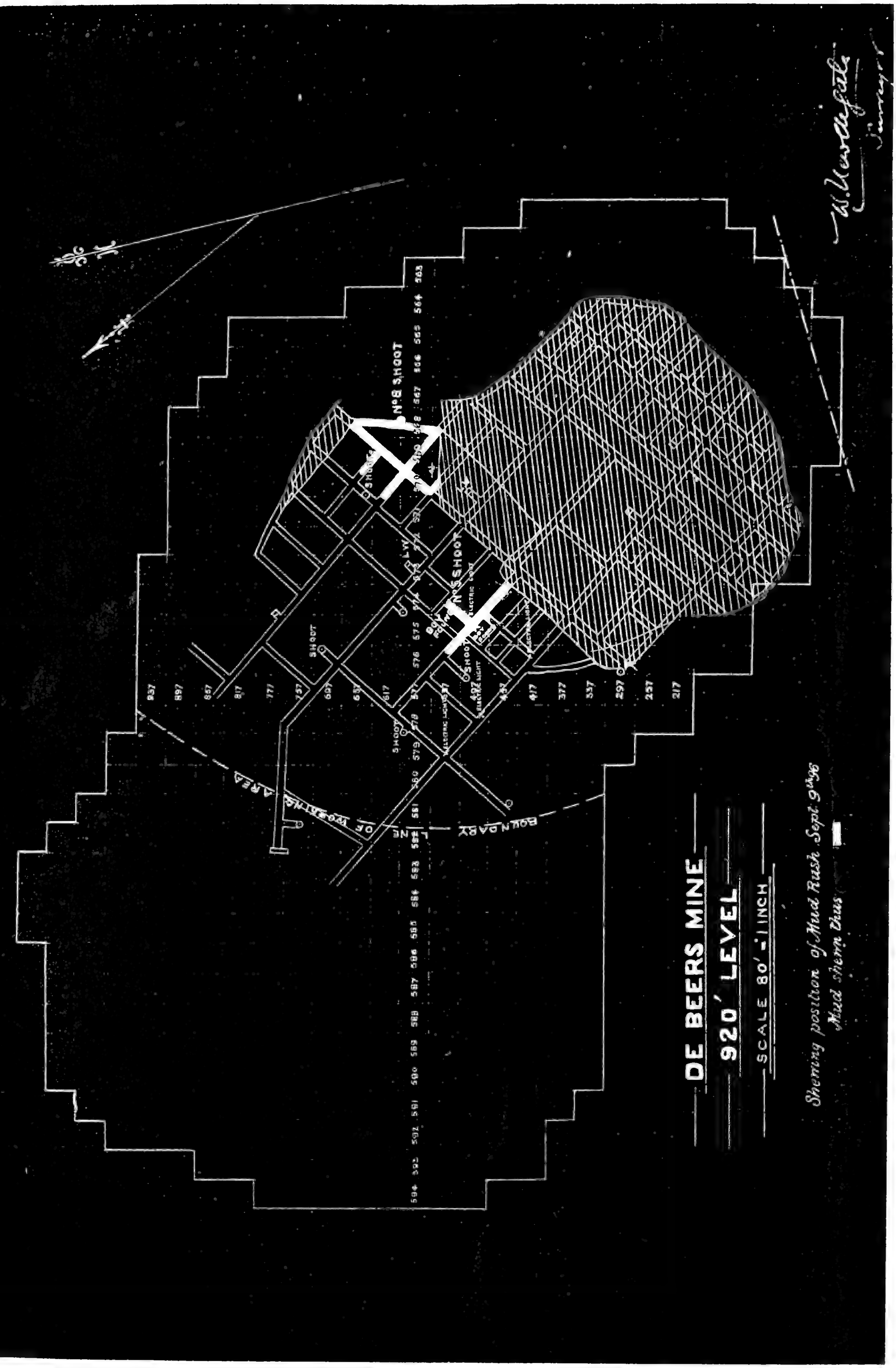

DE BEERS MINE
920' LEVEL
SCALE 80' = 1 INCH
Shewing position of Mud Rush Sept. 9th 96
Mud shewn thus
Nº 8 SHOOT
Nº 5 SHOOT
BOUNDARY LINE OF WORKING AREA

Fig. 2.

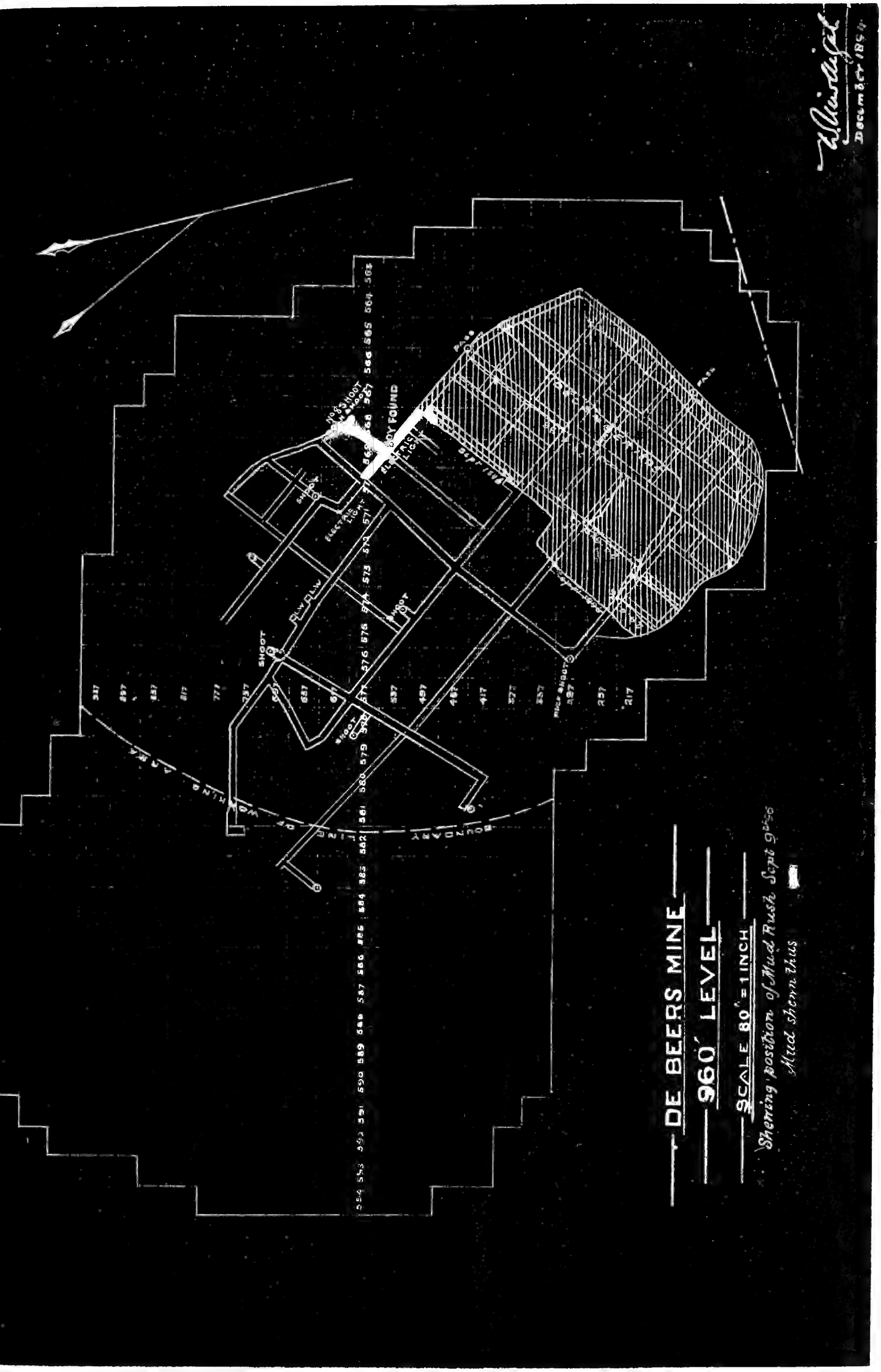

DE BEERS MINE
960' LEVEL
SCALE 80' = 1 INCH
Shewing position of Mud Rush Sept 9th 96
Mud shewn thus
BOUNDARY LINE OF WORKING AREA
BODY FOUND
ELECTRIC LIGHT
SHOOT
PASS

Fig. 3.

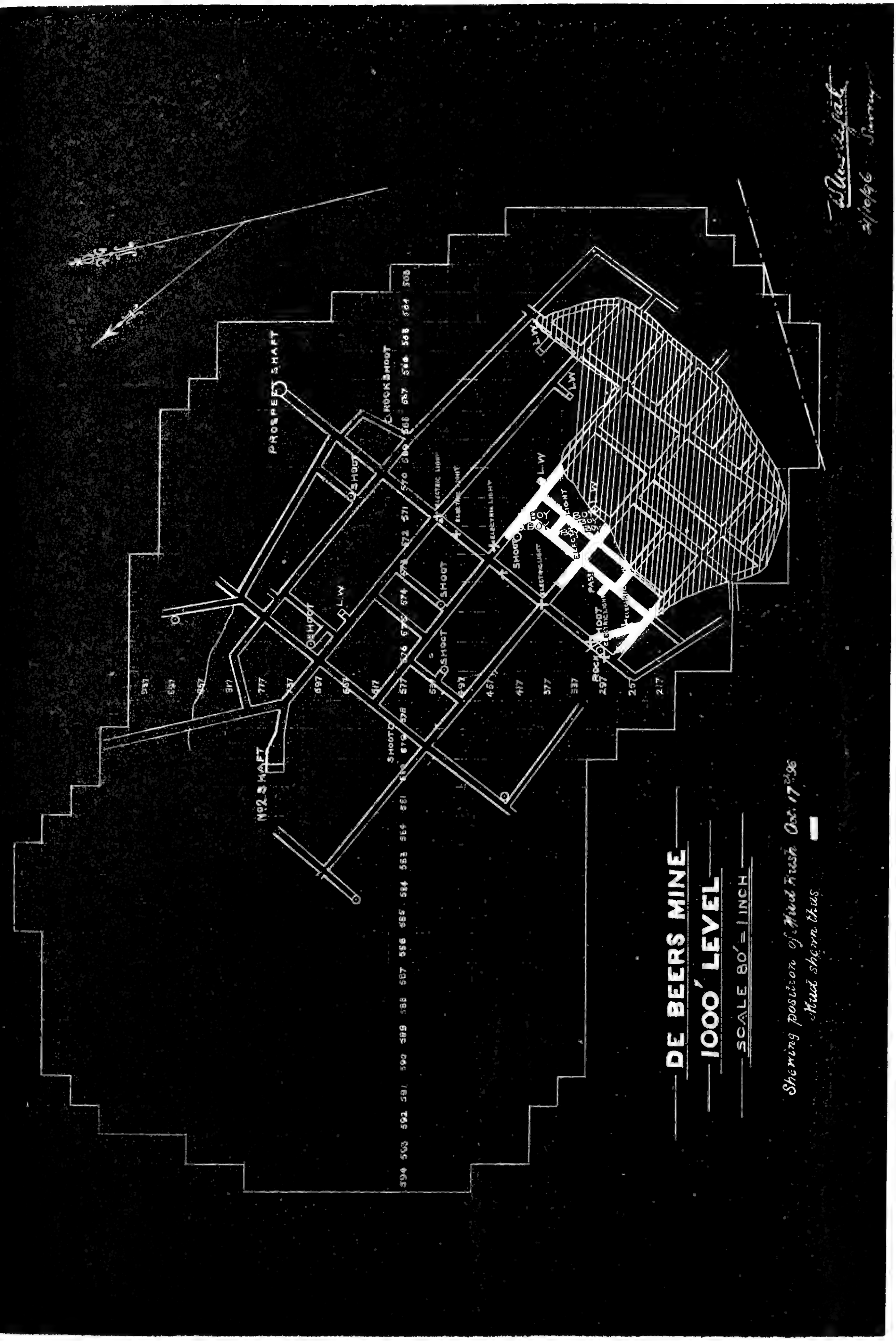
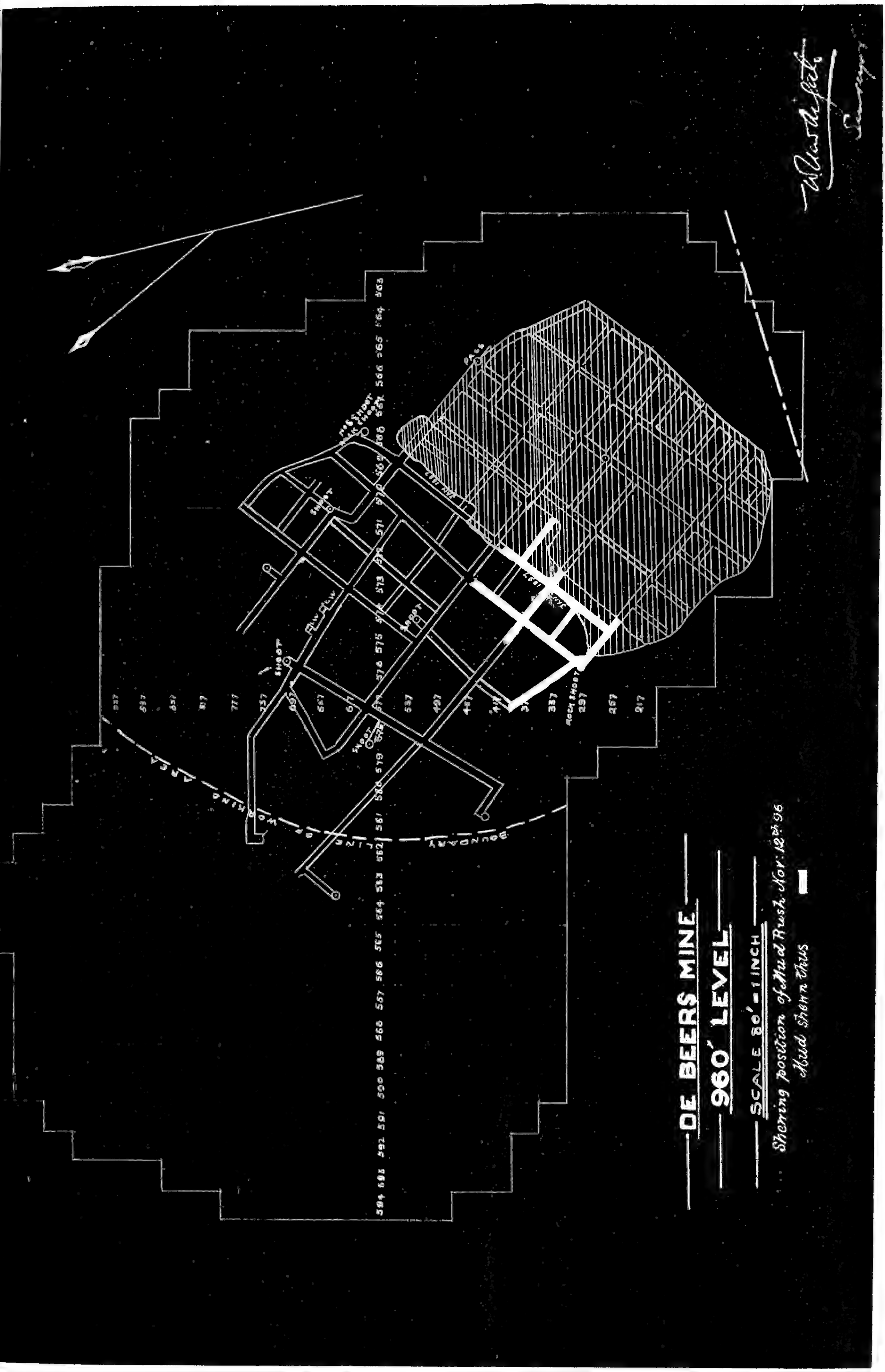

DE BEERS MINE
1000' LEVEL
SCALE 80' = 1 INCH
Shewing position of Mud Rush Oct. 17th 96
Mud shewn thus
PROSPECT SHAFT
No 2 SHAFT
ROCKSHOOT

Fig. 4.



DE BEERS MINE
960' LEVEL
SCALE 80' = 1 INCH
Shewing position of Mud Rush Nov: 12th 96
Mud shewn thus
BOUNDARY LINE OF WORKING AREA

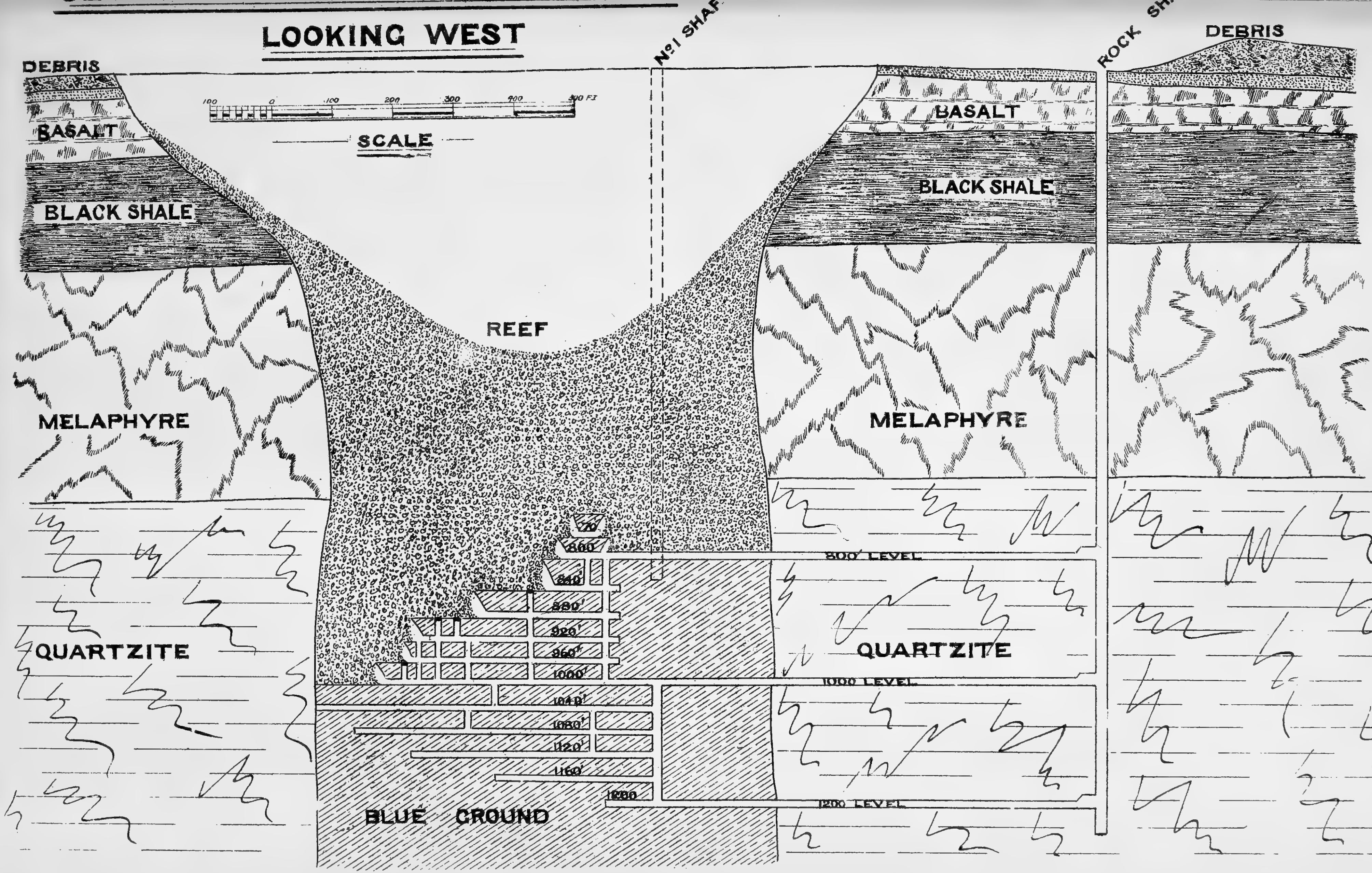

LOOKING WEST
DEBRIS
BASALT
BLACK SHALE
MELAPHYRE
QUARTZITE
SCALE
100 0 100 200 300 400 500 FT
REEF
No1 SHAFT
ROCK SHAFT
DEBRIS
BASALT
BLACK SHALE
MELAPHYRE
QUARTZITE
800' LEVEL
1000 LEVEL
1200 LEVEL
760'
800
840'
880'
920'
960'
1000'
1040'
1080'
1120'
1160'
1200
BLUE GROUND

Fig 5.

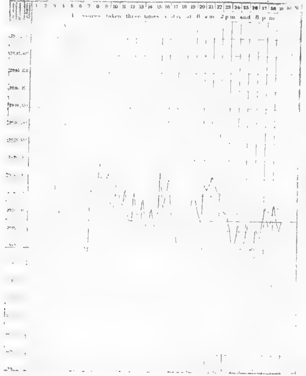
1896

94.

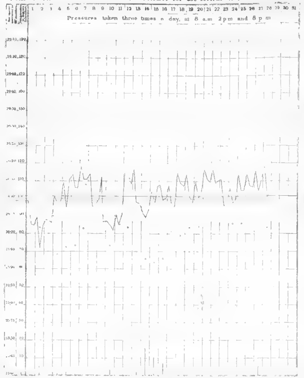
PSSURE and TEMPERATURE CHART for the Month of June 1894.

Barometer correction	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Pressures taken three times a day, at 8 a.m. 2 p.m. and 8 p.m.																														
26·5																															
26·50																															
26·45																															

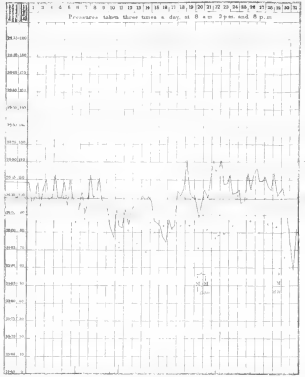
PRESSURE and TEMPERATURE CHART for the Month of January 1894



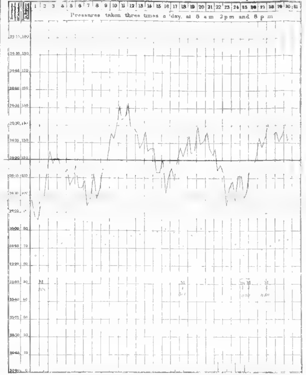
PRESSURE and TEMPERATURE CHART for the Month of February 1894



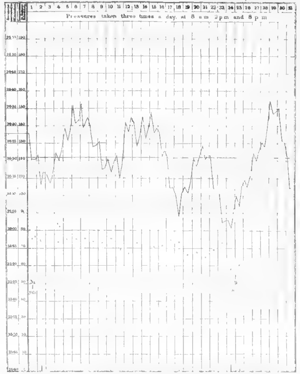
PRESSURE and TEMPERATURE CHART for the Month of March 1894



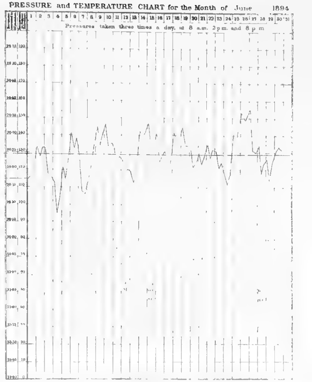
PRESSURE and TEMPERATURE CHART for the Month of April 1894



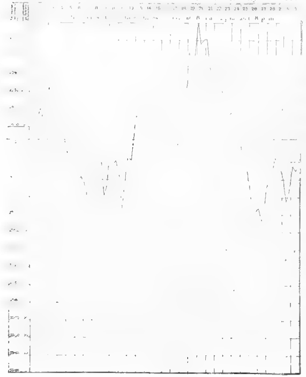
PRESSURE and TEMPERATURE CHART for the Month of May 1894



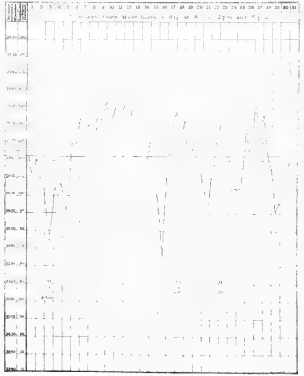
PRESSURE and TEMPERATURE CHART for the Month of June 1894



PRESSURE and TEMPERATURE CHART for the Month of July 1894



PRESSURE and TEMPERATURE CHART for the Month of August 1894



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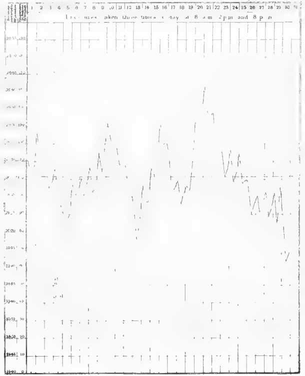
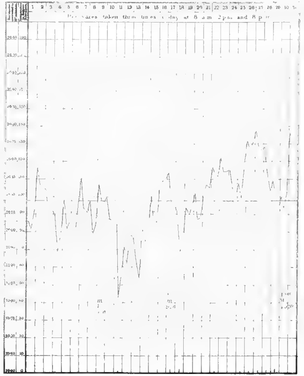
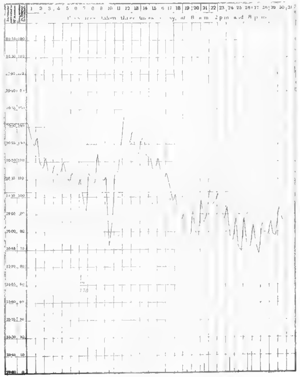


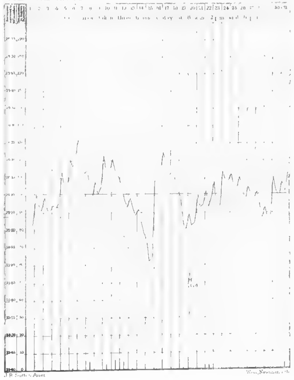
PRESSURE and TEMPERATURE CHART for the Month of October 1894



PRESSURE and TEMPERATURE CHART for the Month of November 1894

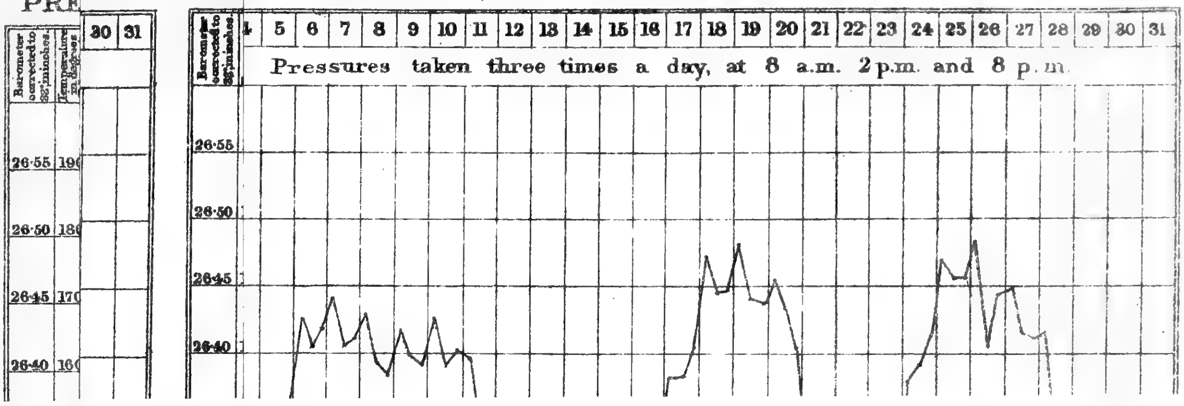


PRESSURE and TEMPERATURE CHART for the Month of December 1894

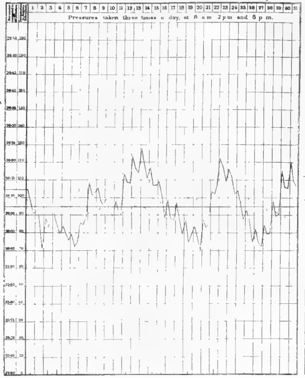


The continuous curve shews the atmospheric pressure from observations taken three times daily
The dots shew the maximum temperature of the day
The vertical lines at the base of the diagrams represent the amount of rain the distance from one horizontal scale line to the next above indicating one inch.

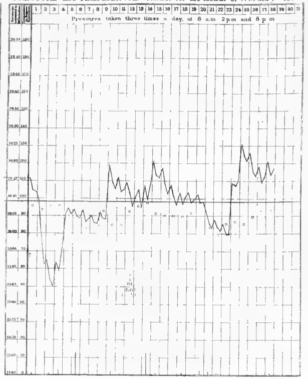
PRE 895. PRand TEMPERATURE CHART for the Month of June 1895.



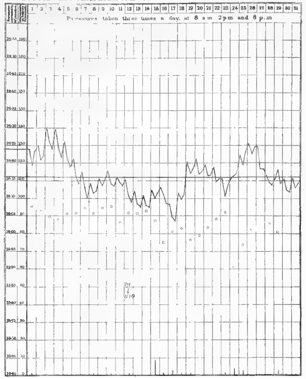
PRESSURE and TEMPERATURE CHART for the Month of January 1895



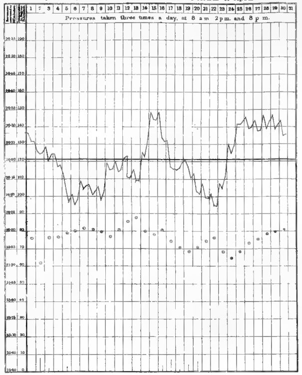
PRESSURE and TEMPERATURE CHART for the Month of February 1895



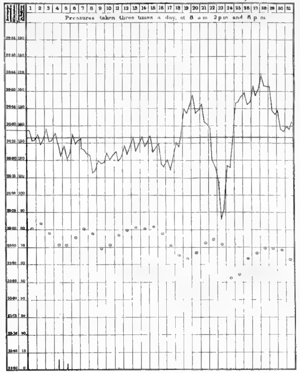
PRESSURE and TEMPERATURE CHART for the Month of March 1895



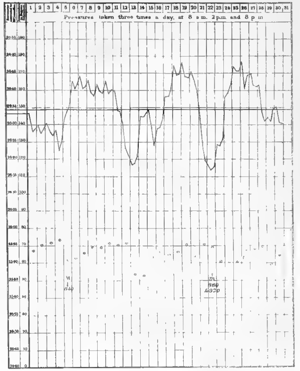
PRESSURE and TEMPERATURE CHART for the Month of April 1895



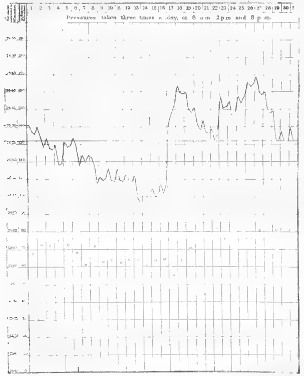
PRESSURE and TEMPERATURE CHART for the Month of May 1895



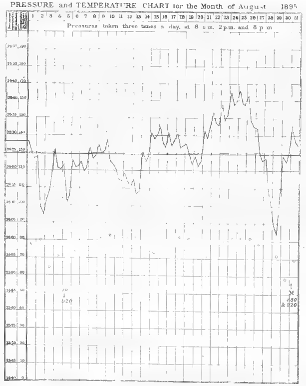
PRESSURE and TEMPERATURE CHART for the Month of June 1895.



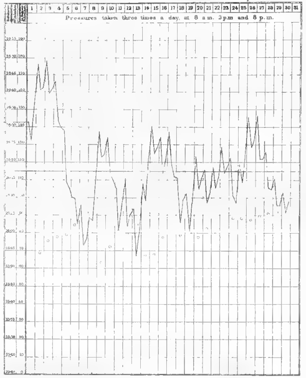
PRESSURE and TEMPERATURE CHART for the Month of July 1895



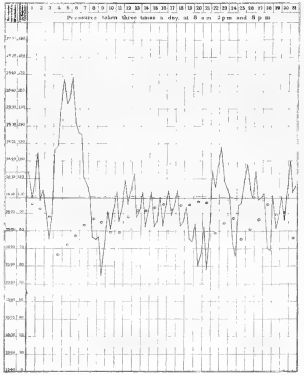
PRESSURE and TEMPERATURE CHART for the Month of August 1895



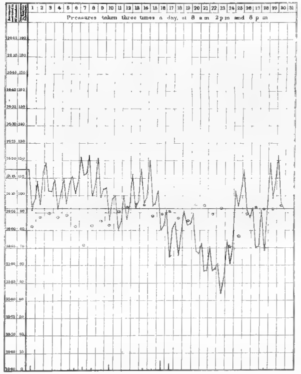
PRESSURE and TEMPERATURE CHART for the Month of September 1895



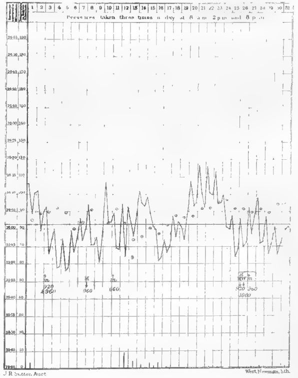
PRESSURE and TEMPERATURE CHART for the Month of October 1895.



PRESSURE and TEMPERATURE CHART for the Month of November 1895.



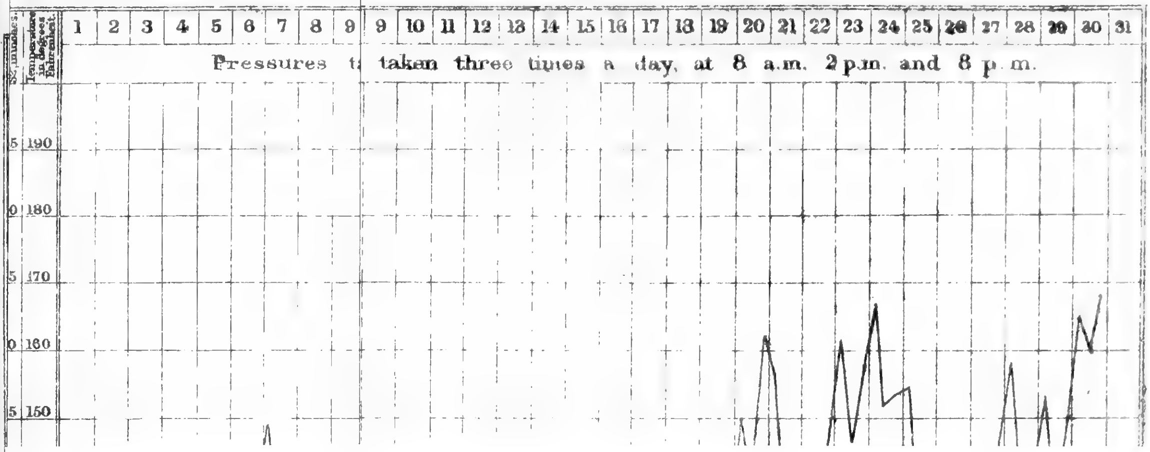
PRESSURE and TEMPERATURE CHART for the Month of December 1895.



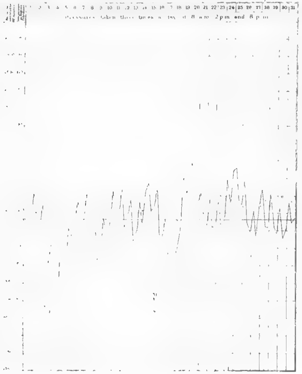
J. R. Sutton, Auct. West, Newman, lith.

The continuous curve shews the atmospheric pressure from observations taken three times daily.
The dots shew the maximum temperature of the day.
The vertical lines at the base of the diagrams represent the amount of rain: the distance from one horizontal scale-line to the next above indicating one inch.

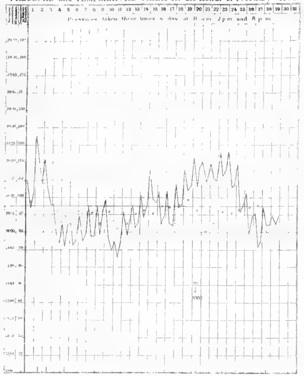
RESSURE and TEMPEIERATURE CHART for the Month of June 1896.



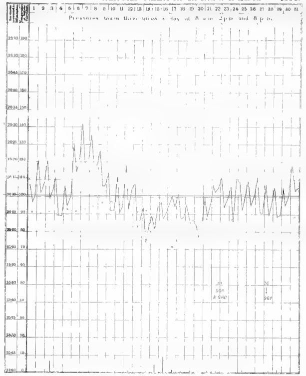
PRESSURE and TEMPERATURE CHART for the Month of January 1896.



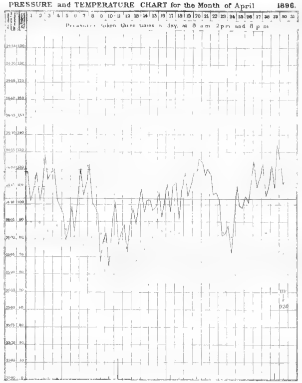
PRESSURE and TEMPERATURE CHART for the Month of February 1896.



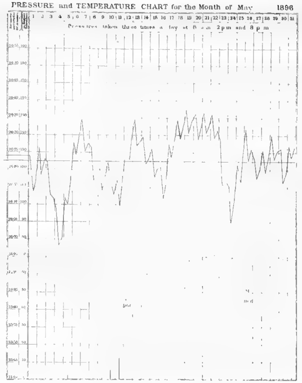
PRESSURE and TEMPERATURE CHART for the Month of March 1896.



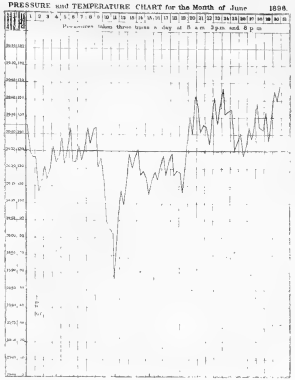
PRESSURE and TEMPERATURE CHART for the Month of April 1896.



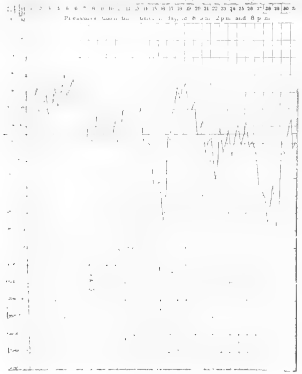
PRESSURE and TEMPERATURE CHART for the Month of May 1896.



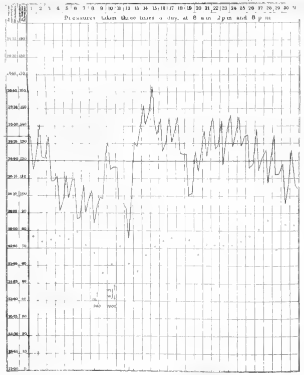
PRESSURE and TEMPERATURE CHART for the Month of June 1896.



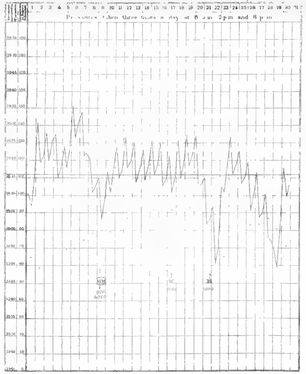
PRESSURE and TEMPERATURE CHART for the Month of July 1896.



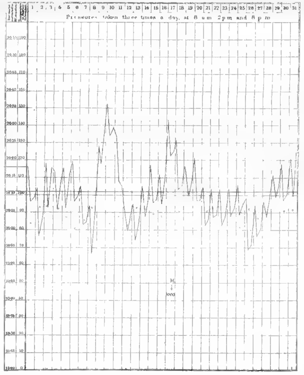
PRESSURE and TEMPERATURE CHART for the Month of August 1896.



PRESSURE and TEMPERATURE CHART for the Month of September 1896.



PRESSURE and TEMPERATURE CHART for the Month of October 1896.



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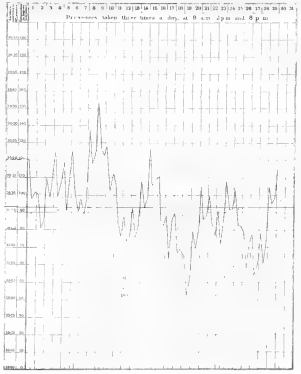
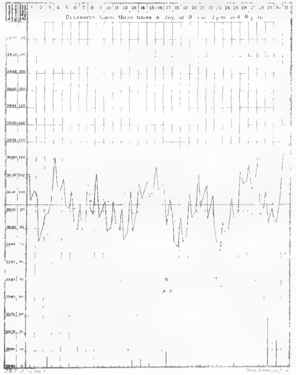


PRESSURE and TEMPERATURE CHART for the Month of December 1896.



The continuous curve shews the atmospheric pressure from observations taken three times daily.
The dots shew the maximum temperature of the day.
The vertical lines at the base of the diagrams represent the amount of rain, the distance from the horizontal scale-line to the next above indicating one inch.

NOTE.

The above paper was written in March, 1897. The De Beers Mine was delightfully free from mud from the end of 1896 to June, 1897, in spite of torrential rains, and hopes were entertained that mud rushes had come to an end. In June, however, they began afresh, on a larger scale than ever, and have occurred at pretty frequent intervals throughout the winter drought. The mud rush of July 16th last (in which two lives were lost—one a white man, the other a native—while several were saved after some days' imprisonment in a blind offset) is perhaps the largest on record; four levels were more or less blocked, the rush of mud proper being succeeded by that of a body of water estimated at from two to three million gallons.

Since the paper was written I have been able to compare the mud rushes of 1894 in the Kimberley Mine with the atmospheric conditions of the same year. The barometric factor is there, but the temperature factor seems to be quite absent. This is doubtless due to the lesser velocity of the air-current in the Kimberley, compared with that in the De Beers Mine. J. R. S.

OBSERVATIONS ON THE MORPHOLOGY AND CONDITIONS OF GROWTH OF A FUNGUS PARASITIC ON LOCUSTS IN SOUTH AFRICA.

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(Read October, 1897.)

In March, 1896, I had an opportunity of examining some locusts brought from Richmond, in Natal, by Mr. Arnold Cooper to the Bacteriological Institute, Grahamstown, where I was at that time medical officer. These locusts Mr. Cooper found dying and dead in great numbers in a maize-field, many of them attached to the maize stalks in a dying condition. On closely examining them he found that they were all attacked by a fungoid growth, and on a microscopic examination of the tissues of the dead locusts, he found the mycelium of the fungus penetrating the tissues and growing in them. The locust was the large red variety (*Acridium purpuriferum*, Walk.) which had not appeared in these regions for more than thirty years, and which was lamentably destructive both from its numbers and voracity. Recognising the importance of this observation Mr. Cooper, accredited by the Government of Natal, brought a supply of dead locusts to the Bacteriological Institute for further examination. But at this time several observers in various parts of South Africa observed and recorded the presence of the fungus on dead or dying locusts. My part in this investigation was therefore the observation of the modes of growth and the morphology of this fungus.

Appearance of the Dead Locusts.

On the dead locusts the fungus appeared as a grey or buff-coloured fur, in patches about the depression between the thorax and the abdomen, and the joints between the legs and body, and the line of the tracheal stigmata of the abdomen. The growth had a velvety appearance and was in all cases very short. On dissecting and teasing out the connective tissue beneath the integument and examining this microscopically the mycelium of the fungus and round or ovoid conidia were abundantly seen. I found precisely the same appearances in other diseased locusts which were sent to us for investigation from King William's Town in May, 1896, thus showing that the fungus was spread over a large area of South Africa.

Cultivation Experiments.

I now made an attempt to get a pure cultivation of the fungus, using as a medium for growth *sloped glycerine-agar* of the ordinary composition. I inoculated the medium with a platinum loop rubbed over with the teased connective tissue in which the mycelium was found. In twenty-four hours, at a temperature of 30° C., small yellowish translucent islets were visible on the surface of the medium; they had a radiate appearance and cog-wheel-like edges; in thirty-six hours they had increased in all directions, forming small circular patches, one-fourth of an inch in diameter, and a slight velvety growth was visible both aerially and into the substance of the medium. Growth in all directions was now vigorous over the surface of the medium, and the aerial growth, and that into the substance of the medium also increased; in forty-eight hours the velvety aerial growth could be seen dotted over abundantly with dark points which on a microscopic examination were found to be spore cases. After this reproductive effort the formation of spore cases apparently ceased but vegetative growth of the aerial filaments continued until the surface was covered with a thick filamentous grey mycelial growth; the strength of this aerial growth evidently depended to a large extent on the nutritive pabulum; for on less nourishing media, such as potato, it was far less abundant and slower in development. I noticed in growing it on potato that the growth continued for some time short and scanty, resembling in appearance that on the integument of the locust, and then the growth suddenly became vigorous and abundant. This increase of vitality I took to be due to self-sown spores growing on the decayed tissues of the earlier fungoid growth, thus obtaining a more suitable pabulum as will afterwards be seen.

Microscopic Examination on Growth of Medium.

On examining the edges of the growing islet of fungus it was seen with a low power to be composed of the interlacing filaments of a fungus; the mycelium was composed of filaments branching alternately; the filaments being formed of elongated cells with no other differentiation of structure; the protoplasm in some of the filaments was clear and homogeneous, in others very granular, with large vacuoles scattered through the protoplasm of the cell; experience showed that this granuality and vacuolation was an accompaniment of active growth. Wherever active growth, either vegetative or sexual, went on there the growing cell showed granularity of protoplasm; a faint yellowish colouring of the protoplasm was often seen in these conditions. Such was the appearance of the filaments twenty-four hours after inoculation; but after forty-eight hours very considerable differentiation of structure was apparent. Then a form of asexual reproduction made its appearance, rapid segmentation of the filaments taking place, followed by the throwing off of buds. This gemmation takes place on the filaments growing along the surface of the medium, on the perforating and on the aerial filaments. The formation of conidia is preceded by the rapid segmentation of the terminal mycelial filaments which at the same time show granularity, pigmentation, and vacuolation of the protoplasm. Once the process of segmentation begins, it goes on with the most extraordinary energy; buds are thrown off in all directions and on separating reproduce the process. The conidia thrown off are ovoid or circular in contour, and of varying sizes, some being small, not measuring much more in diameter than a white blood corpuscle, while others are from three to six times larger. The margins show a double contour, this appearance being no doubt due to a thin cell wall; the enclosed protoplasm is often vacuolated and irregularly granular; what appears to be a nucleus is often seen, the protoplasm of which is darker and more homogeneous. These separated conidia repeat the vegetative cycle with great rapidity either by budding or by elongating; a process being pushed out by the cell wall which takes part in the prolongation. It appeared to me that the initial division nearly always began with the nucleus when that was visible, the cell then elongating, and a septum forming which separated the new from the germinating cell. Actual gemmation, however, often seemed to take place, portions of protruded protoplasm being cut off by constriction of the cell wall. The new cells and buds could be separated with great ease from the germinating cell and then they immediately reproduce the same process; in this way from a single cell long filaments were formed which branched alternatively, the branches often forming conidia and throwing them off. Such is the vital process of the formation of mycelium as is found on the surface of the nutritive medium and the filaments which, penetrating root-like into the medium, show the same characters and formation. These penetrating filaments, however, always ceased to invade the medium deeper than $\frac{1}{4}$ to $\frac{1}{3}$ of an inch. This stoppage of growth probably points to the necessity of considerable oxygenation as requisite to the vital process.

The aerial growth, however, which begins in the same way and goes through the processes above described, soon takes on a true sexual process of reproduction; that is to say, the protoplasm of two separated individual cells unites and rapid segmentation of the protoplasm of the conjugating cell takes place, an oospore being formed. The manner in which I have observed this process to take place is as follows:—

This reproductive function is established about forty-eight hours after the mycelial growth has begun on the surface of the nutritive medium. An aerial filament is observed branching, one of the short branches being very granular and terminating in a large granular conidium; from the division of the stem another branch, the protoplasm of which is usually clear, and which may or may not be terminated with an enlargement or globular swelling, runs up and approaches the conidium, which it touches, and the protoplasm of the two cells in contact intermingles. The process, however, may very likely be more promiscuous, and I have seen appearances which make me suspect that terminal conidia were fertilised from cells or conidia of neighbouring filaments with which they came in contact.

When fertilised the oospore and its sporophore grow with great rapidity, the sporophore shooting up and outstripping the fertilising branch. The oospore developes a thick cell wall, which assumes a dark or brownish colour, and the protoplasm, which can be seen rapidly segmenting, also takes on a golden yellowish colour. The size of the oospore increases rapidly, and its cell wall becomes thickened; the sporophore also increases in thickness out of proportion to the mycelium branch from which it springs; with its growth it forces itself up into the oospore, forming a secondary globular enlargement or capitellum.

Further Development of the Oospore.

After fertilisation the oospore rapidly increases in size, the wall thickens, and the enclosed protoplasm becomes densely and finely granular and of a yellowish colour; then segmentation makes its appearance, the enclosed protoplasm apparently resolving itself by condensation at numerous spots into numerous globular masses. These became more defined in shape, and, losing their circular contour, appeared ovoid or ellipsoidal. These ovoid light brown bodies are the spores, and these individually now increase in size, causing the rupture of the spore cyst. The spore cyst ruptures with violence, as the cyst wall has by this time become dry and elastic; this is shown by the fact that the ruptured wall curls back after splitting. The spores are thus thrown broadcast over the surrounding area; from the appearance of the ruptured cyst wall it is evident that it is at the time of rupture composed of two layers, the outer fine and transparent, the inner thick and pigmented; the capitellum stands out conspicuously from the floor of the ruptured spore cyst.

The Spores.

These, as I have said, are ovoid or ellipsoidal bodies of light brown colour, and semi-transparent, the pigmentation is evidently chiefly in the cell wall; many of them appear more pointed at one end than at the other, and there is also a want of bilateral symmetry, in the majority, one side being the more flattened; their sizes equal the diameter of a red blood corpuscle in length and one-half or one-third as broad. I have calculated that there are often as many as 200 spores in a single spore cyst. When in the space covered by a square surface of one-quarter of an inch of the fungus growing on nutrient medium I have counted as many as 100 spore cysts the enormous fecundity of the fungus may be imagined; 20,000 spores being produced in this area, or 320,000 to the square inch.

Development of the Spores.

The spores when they reach maturity, and are ejected from the spore cyst, are ovoid or boat-shaped in contour. For examining the development of the spores I used a fine film of gelatine pressed between two cover glasses separated to the extent of the thickness of a cover glass; a rim of Canada Balsam round the edges of the cover glasses made a closed cell which could be fixed to a glass slide. The development of the spores shown in the gelatine could then be easily watched from day to day under the microscope. Observation showed that at ordinary temperature in twelve hours the ovoid spores had become much larger and had lost the ovoid form and become circular. In twenty-four hours further a still greater increase in size had occurred and the spores had begun to sprout; in twenty-four hours further the sprouts had greatly increased in length and showed the characteristic alternate branching and the segmentation of the mycelium. Examined with a high power the spores at the end of the first twenty-four hours were not distinguishable from the conidia of the fungus; the cell walls had become thin and the protoplasm from being homogeneous had become granular and vacuolated. The vegetative process was from this stage exactly as I have described it in the case of the vegetative conidia; sprouting, elongation of the sprout, and branching of the mycelium thus formed taking place; thus the growth was as given above: first the formation of mycelium, then the throwing off of conidia, finally the formation of spores by sexual reproduction. The cycle from spore to spore occupied, at room temperature, about five to six days. There may possibly have been some phases of the reproductive process which I may have overlooked, either from inaccuracy of observation or inexperience in working microscopically with fungi. But I may here state that I made repeated experiments with the fungi from many separate cultivations, so that I over and over again clearly made out and verified the phenomena above described by numerous separate observations on many different occasions.

Suitability of Media for Growth of the Fungus.

As I have said, the primary cultivation experiments were made on glycerine-agar peptone, and that medium was always found very suitable; but the fungus grew well on many other media, such as gelatine peptone, sugar agar, a solid medium made with crushed locusts: in fact, on all nitrogenous solid media it grew well. On bread paste and on potato it grew slowly at first, but after the lapse of a fortnight the growth suddenly became fairly luxuriant. I have stated above the cause to which I attribute this phenomenon. In nitrogenous fluid media, such as beef bouillon, a bouillon made from dead locusts, &c., it grew most vigorously; gradually filling the upper part of the tube with a fine flocculent growth, which close to the surface became a dense felted network. Only the asexual forms of growth took place in the fluid, but these were produced with the greatest exuberance, conidia being thrown off and mycelium being formed in all directions. When the growth came to the surface aerial filaments were formed with the production of spores in the way above described. The more vigorous growth close to the surface supports what I stated above with regard to the growth in solid media that the appearance of air is necessary for active growth.

In media made from non-nitrogenous substance, such as starch and sugar, the growth was not nearly so abundant, and soon ceased. In comparing tubes of bouillon and tubes of strong starch and sugar solution sown with fungus spores on the same day, after a week's growth this difference was very remarkable: in the nitrogenous tube the growth being vigorous and abundant, in the non-nitrogenous it being feeble and scanty. Besides, on microscopic examination, the mycelium in the carbohydrate solution was very pale, extremely vacuolated, and the granularity of the protoplasm was absent, and also in the older mycelium there was marked fatty degeneration of the protoplasm, large yellow globules of oil being abundant in the cells, the protoplasm of which was collapsed. It would thus appear that the fungus is one which needs nitrogenous matter for its healthy growth. From the foregoing considerations, the ease with which the fungus grows on various media, at ordinary room temperature, and also from the following experiment it would seem that there is reason to believe that the fungus may be saprophytic over a wide area in South Africa. The ease with which it can be cultivated makes it difficult for me to believe otherwise.

Resistance of the Fungus to Drying and to Heat.

I took the felted pellicle of growing fungus from a tube of beef bouillon and dried it thoroughly *in vacuo* over sulphuric acid. After the interval of a month I broke up the flinty mass thus produced, and on sowing particles of it on glycerine-agar, the characteristic fungus growth was produced. The exposure to moisture or dry heat over 150° F., however, quickly killed the fungus whether dried or not.

Inoculation of Healthy Locusts, &c., with the Fungus.

I obtained some healthy locusts from the surrounding district, and inoculated them by rubbing the connective tissue of locusts dead from fungus disease over them, and others I inoculated with the cultivated fungus. Within a week a considerable proportion of the locusts, both those inoculated with the cultivated fungus and those inoculated from the locusts dead of fungus disease, showed symptoms of illness, and a large proportion, about 40 per cent. died. These dead inoculated locusts showed the characteristic mycelium and conidia in their tissues, thus proving the identity of the cultivated fungus with that found in the original dead locusts. The greyish growth which I above described as appearing on the locusts brought from Natal, was also apparent in several of the inoculated locusts. This surface growth I found to possess the true sexual mode of reproduction, and showed the characteristic spores.

I fed some healthy locusts on the cultivated fungus, and some of these also died showing the characteristic appearances, but whether in the process of feeding some spores got on the surface of the locusts and grew from there, or whether the infective process spread from the alimentary canal I do not know. The process of infection from locust to locust is probably by the ovoid spores which get into the tracheal stigmata and then begin to sprout, penetrating into the connective tissues surrounding the tracheal tubes, and there forming the vegetative mycelium and conidia. I did not, however, microscopically demonstrate the actual presence of the spores in the trachea. There can however be, in my opinion, no hesitation in affirming the identity of the growth inside the locust with the cultivated fungus.

I also inoculated the large green grasshopper (*Phymateus leprosus*, Fab.) so commonly found on garden sub-tropical plants, with the cultivated fungus, and this insect also contracted the mycosis and died. I found mycelium in its tissues and the conidia; also it was very interesting to find that its excreta after being discharged in a few days became covered with a luxuriant mouldy growth, from which I was able on glycerine-agar to cultivate the characteristic fungus afresh. I was unable at the time to pursue my experiments further in this direction, but the one case is sufficient evidence to show that the mycosis is not confined to the locust species. The fact also that I found the characteristic mycelium and the spores in locusts sent from King William's Town in May, 1896, and that the fungus grows so freely on albuminoid and decaying animal matter would lead us to suppose that a careful search would demonstrate that this fungus in certain seasons is fairly widespread in South Africa, and that it attacks from year to year, during the warm season, locusts and other allied insects. But whether the fungus is carried to these parts by the swarms of locusts, or whether it is saprophytic on decaying albuminoid matter throughout these regions and then attacks the locusts which arrive in these parts, is a matter for further investigation.

Classification.

I was at first inclined to believe that the fungus belonged to the class *Entomophhoreæ* with which it has, as will be seen, many strong resemblances, but it has also several characters in common with the *Mucorini*, so that my limited experience will not allow me to say that it is not closely connected with the latter class.

Pathogenicity.

Sufficient evidence has been given to show that the fungus is pathogenic. But what we know of the pathogenicity of this class of parasites does not encourage me to believe that through this agency destruction of locusts will take place on an extensive scale. When I brought the fact of the ease with which the fungus could be cultivated to Dr. Edington's notice, he suggested that it should be sent out in small tubes of glycerine-agar to districts where locusts were abundant and destructive. Large numbers of such tubes were distributed throughout Cape Colony during the latter half of 1896, and, as will be seen from Dr. Edington's report of the Bacteriological Institute for 1896, very favourable accounts were returned of the pathogenic action of the fungus on swarms of locusts in certain districts. But in spite of this positive evidence I do not think that sufficient data for a positive induction as to the value of the fungus in destroying locusts in large numbers have been collected; it is doubtful, in my opinion, whether this method of spreading a pathogenic mycosis can compete with the usual methods of destroying locusts *en masse.*

The general bearing of the evidence as to the life-history of the fungus which I have laid out above, would be to show that we have here to do with a fungus saprophitic on decaying animal or vegetable matter, which occasionally becomes parasitic on and pathogenic to locusts and other allied insects in South Africa, and which has probably acted in this way for an indefinite time in the past, though it has for the first time in 1896 been brought under actual observation.

APPENDIX.

REPORT ON THE DISEASE AMONGST LOCUSTS IN NATAL CAUSED BY A FUNGUS *EMPUSA ACRIDII.*

By Arnold W. Cooper, F.R.M.S.

In the month of February last (1896) specimens of locusts, which had died from disease, were sent to me for examination by Mr. Willie Nicholson, of Thedden, near Richmond. The locusts were covered with a fungoid growth which resembled Muscardine. The fungus is now determined as belonging to the Order *Entomophoreæ*, Genus *Empusa;* the species is probably a new one, and it is proposed to name it *Acridii.*

Microscopial examination showed that the locusts, now identified as *Acridium purpuriferum,* had died from this fungus disease, which nearly resembles Muscardine, which broke out amongst the silkworms in Southern Europe many years ago, and threatened the destruction of the silkworm industry in the countries affected by it. It was found that a careful removal of the dead silkworms was the most ready method of checking the ravages of the disease, thus showing that the infection or contagion spread.

Experiments made here with the locusts showed that the local fungus disease was easily communicated from the dead locusts to healthy ones, and death ensued in five or six days ; the experiments were on a small scale only, but repeated satisfactory results showed me that there was little doubt of the value of the discovery.

Specimens of the diseased locusts were forwarded, by his Excellency the Governor, to Cape Town, and a report upon them was made by M. Péringuey, of the Museum, in which he recommended that I should set to work in earnest to endeavour to spread the disease, and also stated that it was the best satisfactory announcement he had been able to make for the last seven years regarding the destruction of locusts by natural enemies.

Early in April I proceeded to Cape Town, to confer with M. Péringuey on this subject; on my arrival there I found that the Agricultural Department of the Cape Colony had arranged for the resources of the Bacteriological Institute at Graham's Town to be placed at the service of the Natal Government, for the purpose of research into the disease. At the request of the Cape Government, and authorised by Sir John Robinson, I left Cape Town after making the necessary investigations there, and arrived at Graham's Town on the 23rd of April. Before leaving Cape Town I had telegraphed to Richmond for suitable material for the investigation, which arrived at Graham's Town on the 24th of April.

Dr. Edington, the Director of the Institute, being absent, Dr. Sinclair Black took in hand the cultivation of the fungus; several media were tried with more or less success, and pure cultivations were obtained of the fungus. Locusts having been obtained in the neighbourhood of Graham's Town, experiments were made to ascertain whether the cultivations would be successful against them. The results of the experiments are quite satisfactory, the affected locusts died in five or six days, and on microscopical examination I was gratified to observe the same results and conditions as I had seen in the dead specimens sent to me in February by Mr. Nicholson, and which had appeared in the successful experiments I had made at Richmond, and as appeared in locusts destroyed at Graham's Town in an experiment in which locusts obtained there had been affected directly by some of the material sent to me from Richmond.

The results of the investigations so far must be considered very satisfactory, and justify further research and experiments with the view to spreading the disease in other localities, and over South Africa.

Measures of destruction have been taken from time to time against injurious insects in other countries, by means of diseases somewhat similar to the one now under consideration with more or less success, but I am not aware of any great measure of success having been attained. From information which I have gathered, and from reports which I have seen, I learn that in most instances these measures were tried with fungi which were not natural either to the injurious insects it was sought to destroy or to the localities or countries.

In the case under consideration the fungus appeared naturally as an epidemic amongst the locusts, and is probably indigenous. The only case which appears to be at all parallel to the present one is that of the Muscardine disease amongst the silkworms, before mentioned; in that case the object was to stay the disease, which was done with difficulty, in this case the object is to disseminate it, and there appears to be good grounds to hope that this may be done.

The fungus, although not the same as that causing "Muscardine," grows very rapidly in artificial cultivations in suitable media, and developes an immense quantity of spores, which, on coming into contact with the locust, immediately germinate, the growth at once penetrating the outer skin and the mycelium rapidly spreads through the fatty matter in the body of the locust, and through the internal organs, thus preventing their proper and natural action, and causing death. It is probable that climatic influences may either lengthen or diminish the term of five or six days observed in the experiments, although much variation is not likely.

The life-history of the fungus, with illustrations, and a further account of its action will form the material for a more detailed report when investigations are more complete.

As the result of the observation and investigations up to the present time the following facts may be learned:—

1. That the fungus disease broke out amongst the locusts in an epidemic form, and appears to be natural to the country.

2. That it is fatal to the locusts in all stages of growth (except the egg).

3. That the fungus can be easily cultivated artificially in quantity in suitable media, and artificially communicated to locusts.

4. That when the locust is attacked by the disease it is, from the nature of the fungus, fatal.

5. That no evil results to stock or pasture are likely to ensue from the dissemination of the fungus.

Recommendations.

That investigations be continued in Natal, with suitable experiments, in order to ascertain the extent and localities of the fungus. The manner in which, and the extent to which, locusts may be best destroyed.

That provision be made for the cultivation of the fungus, and that field experiments be undertaken.

Remarks.

Most, if not all, the material required to carry out these suggestions and recommendations may be had in the Colony or Cape

Town. The expenses of the investigations will not be heavy, and there are good grounds upon which satisfactory results may be looked forward to.

Dr. Edington considers that the spores of the fungus, which are very numerous when grown in proper media, may be easily obtained from cultivations and spread on a large scale by means of spray pumps, the locusts when sprayed would carry, and further spread the disease; there would be no practical difficulty in the way of carrying out this experiment, as a good pump would throw the medium, with which the spores should be mixed, to a considerable distance.

Richmond, *May* 11, 1897.

EXPLANATION OF PLATES.

Plate III.

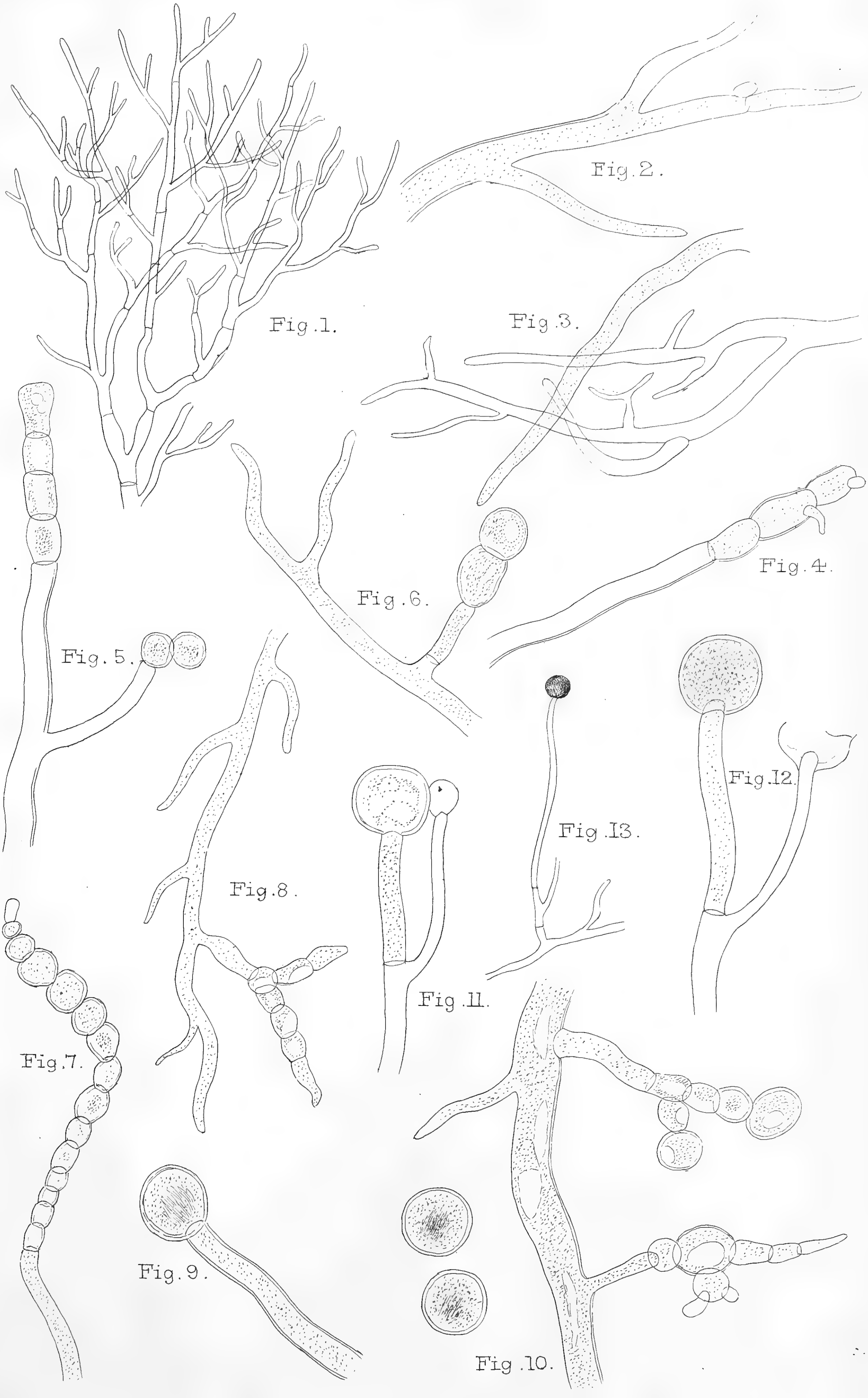
FIG.
1. Growing edge of fungus on glycerine-agar, × 200.
2. Branch of growing edge, × 600.
3. Clear and granular branches, × 600.
4. Filament showing commencing segmentation and budding, × 600.
5. Segmenting filament; one branch throwing off conidia, × 600.
6. Granular filament with branch forming conidia, × 600.
7. Branch showing rapid budding, × 600.
8. Branch showing rapid budding, × 600.
9. Branch with single conidium, × 600.
10. Rapid budding and separated conidia, × 600.
11. Conjugation, × 600.
12. Enlarging oospore and atrophy of one of the conjugating cells, × 600.
13. Spore cysts and sporophores springing from filament, × 150.

Plate IV.

14. Sexual and vegetative forms of reproduction on a filament, × 150.
15. Rupture of spore cyst and shedding of spores, × 200.
16. Spore cyst before rupture containing numerous oval spores, × 600.
17. Ruptured spore cyst, showing capitellum, the two layers of the cyst wall and the spores, × 600.
18. Spores, × 600.
19. Ruptured and atrophied spore cyst, × 600.
20. Shed spores clinging to filament, × 150.
21. Five spores sown in gelatine, the shaded area is an opacity in the film of gelatine, × 150
22. The same spores 24 hours afterwards, enlarging, × 150.
23. ,, 48 ,, sprouting, × 150
24. ,, 72 ,, sprouts branching, × 150
25. Spores beginning to sprout, × 600.
26. Sprouts elongating, branching and segmenting, × 600

Plate V.

27. Polymorphic form of vegetative growth in bouillon, × 400.
28. The growth of the fungus in tubes of glycerine-agar.
    (a) 24 hours of inoculation.
    (b) 36 ,, ,,
    (c) 48 ,, ,,
29. Growth of fungus in tubes (a) Beef bouillon. (b) Sugar-starch solution. } 4 days old.
30. Fatty degeneration of mycelium and cells in sugar-starch solution culture, 10 days old, × 600.
31. Mycelium and conidia in teased connective tissues of dead locusts, × 600.



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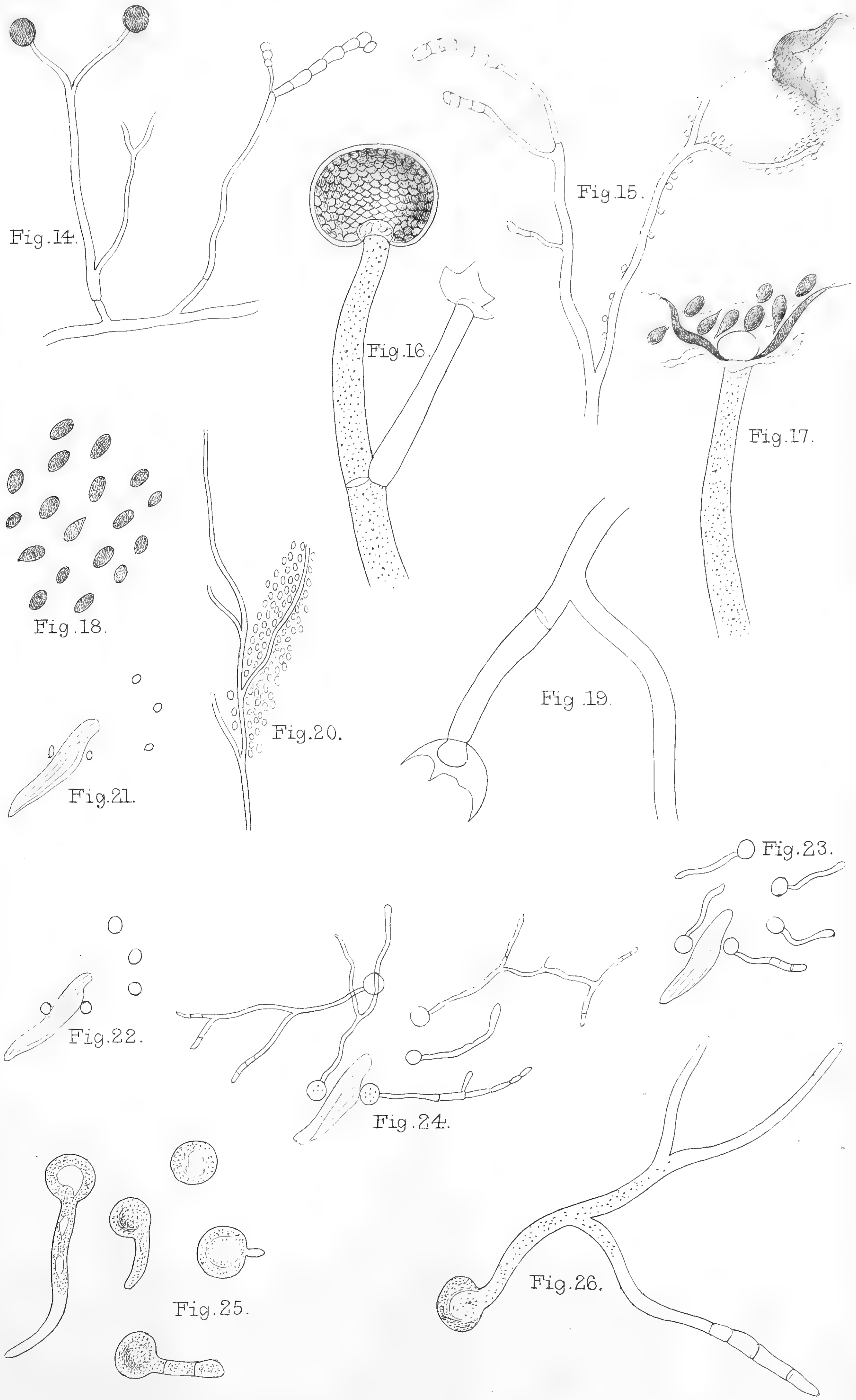

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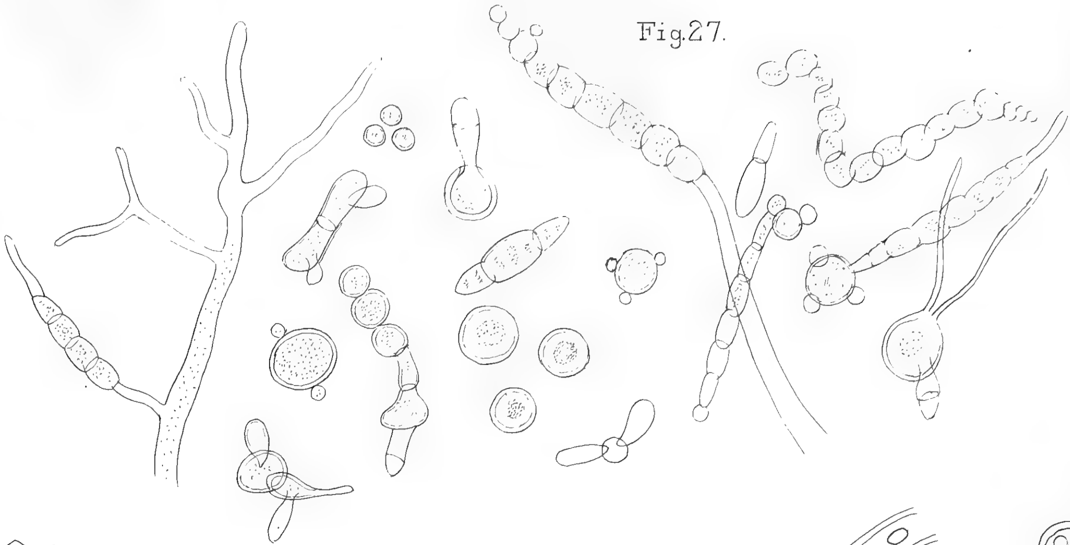
Fig. 27.

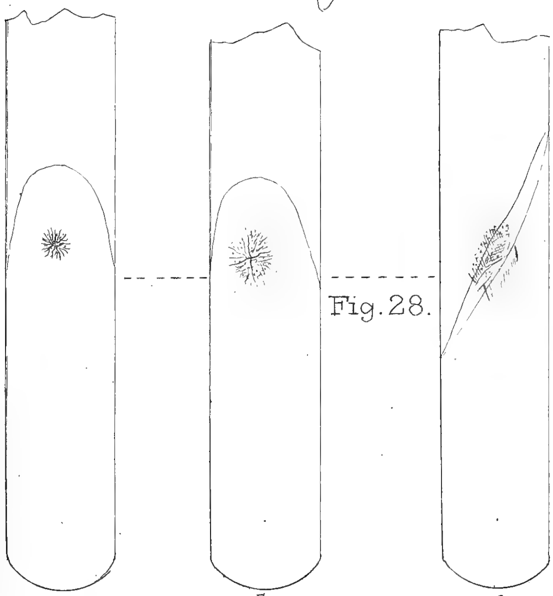
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Fig. 28.

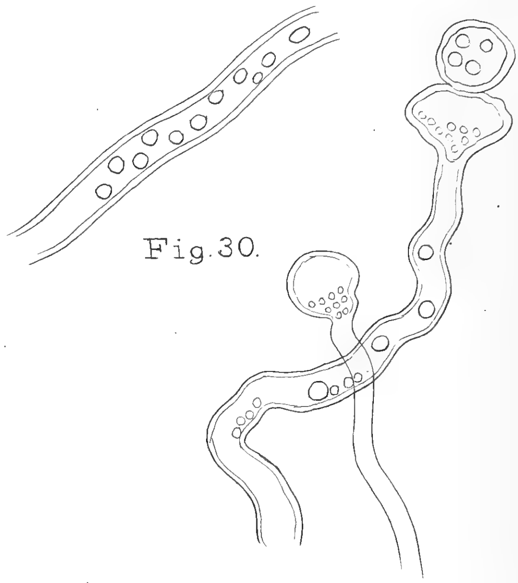
Fig. 30.

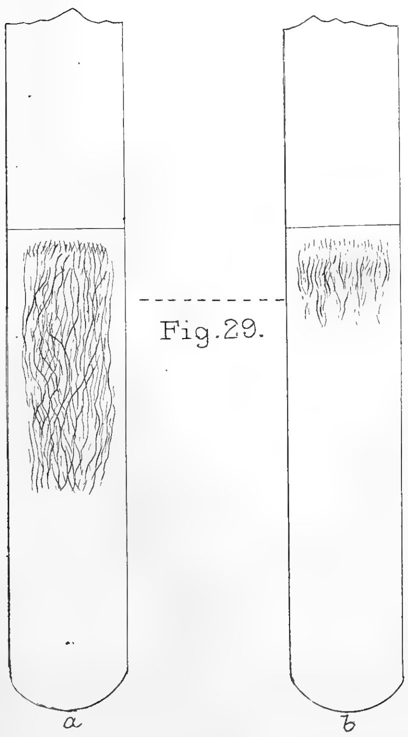
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Fig. 29.

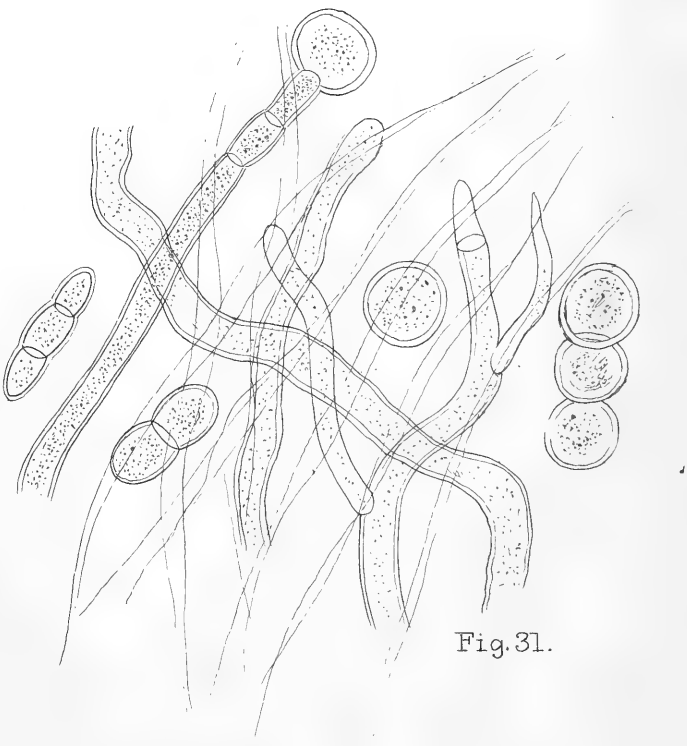
Fig. 31.

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